APS Study Points to Severe Limits on Boost-Phase Missile Defense

A two-year study challenges many of the assumptions behind the Bush administration's $600 million boost-phase program.

Boost-phase missile defense, the strategy of destroying a hostile intercontinental ballistic missile (ICBM) as it climbs into the sky during the first few minutes of flight, is virtually impossible in all but a few limited circumstances, according to a 476-page report released in July by the American Physical Society. Although the report's authors were careful not to make any policy statements or recommendations, they did conclude that "when all factors are considered none of the boost-phase defense concepts studied would be viable for the foreseeable future to defend the nation against even first-generation solid-propellant ICBMs."

Physicists Frederick Lamb of the University of Illinois at Urbana-Champaign and Daniel Kleppner of MIT, cochairs of the study, said they were careful to deliver an impartial report based entirely on scientific and technical aspects of the boost-phase concept. Lamb said the report, which relied on unclassified material and took some two years to produce, was intended to be both "compelling and sophisticated" in the depth of its analysis and "bulletproof" to scientific challenge.

"What I would hope for is that it is read in the executive branch, in the Defense Department, and in Congress, and that it is taken very seriously in evaluating what are the best choices to make in defending the US," Lamb said. Kleppner echoed Lamb's sentiment. "This fills a real need," he said. "I expect that it will influence the debate and decisions about boost-phase defenses over time."

Some Capitol Hill staff members were concerned that delays in getting the report done—APS first envisioned a more limited study that was to be completed about a year ago—had allowed the boost-phase program to become more entrenched in the overall missile defense program. For the 2004 budget, the Bush administration has proposed more than $600 million for boost-phase work as part of a $9 billion request for missile defense funding. Of the $600 million, about $60 million is for research on a high-speed interceptor rocket. The remainder is for continuing work on an airborne laser.

"It's a rock-solid report, but it would have been more useful if it had been released sooner," said Peter Zimmerman, a Capitol Hill veteran and consultant on science issues for the Democrats on the Senate Committee on Foreign Relations. "Had it come out before last November when the Democrats controlled the Senate, there would have been hearings held." Zimmerman also worried that the report, coming after the 2004 budget was essentially set, would lose some of its impact in the missile defense debate. Comments from the House reflected similar concerns.

Lamb and Kleppner said the study took longer than originally planned because APS expanded the study's scope to include analysis of the airborne laser and space-based interceptors. "Furthermore," Lamb said, "the study group discovered it would have to carry out a great deal of original research. This was a larger project than we had anticipated."

Overwhelming and devastating

Joseph Cirincione, a senior associate at the Carnegie Endowment for International Peace who spent more than a decade working on Capitol Hill, predicted that the report will have tremendous influence in the missile defense debate. "The report is just an overwhelming and devastating critique of boost-phase missile defense," he said. "It is hard to see how boost-phase proponents can push their programs in the face of this serious, detailed, and exhaustive study."

After the APS study was released, the Pentagon's Missile Defense Agency (MDA) issued a statement saying it was studying the report but remained confident in its program. "We continue to believe that boost-phase technology has great potential for playing a vital role in a layered missile defense," the statement said. The layered defense includes attacking missiles during their boost phase, midcourse flight in space, and the termination phase as their warheads reenter the atmosphere. Members of the APS study team briefed MDA officials about the report in private meetings last October. "Clearly they are going to be concerned about our findings," Lamb said.

The two-volume report analyzes boost-phase defensive systems involving very high-speed hit-to-kill interceptors, a space-based hit-to-kill system, and an airborne laser. The report's six conclusions are as follows:

- Defense of the entire US against relatively slow liquid-propellant ICBMs "may be technically feasible" using land-, sea-, or air-based interceptors, but "the interceptor rockets would have to be substantially faster (and therefore necessarily larger) than those usually proposed."
- Defense against faster solid-propellant missiles "is unlikely to be practical."
- Space-based interceptor rockets could work, but the interceptors would have to be fairly large to attain the speed needed to be effective. Although the technology for such a system could become available within 15 years, "defending against a single ICBM would require a thousand or more interceptors. . . . Deploying such a system would require at least a five to ten fold increase over current US space-launch rates."
- The airborne laser now under development might have some capability against slower liquid-fueled ICBMs, but "it would be ineffective against solid-propellant ICBMs, which are more heat-resistant."
- The US Navy's existing Aegis missile defense system "should be capable of defending against short- or medium-range missiles launched from . . . platforms off the US coast." To work, however, the interceptors would have to be within "a few tens of kilometers" of the attacking missiles.
- Although a successful intercept could prevent a warhead from reaching its designated target, the warhead would continue on a ballistic trajectory. As a result, "live nuclear, chemical, or biological munitions [could] fall on populated areas short of the target. . . . Timing intercepts accurately enough to avoid this problem would be difficult."

The report also contained findings, which, in essence, gave an overview of the myriad problems boost-phase defense faces. Key findings include the following:

US NAVY

The US Navy's Aegis missile defense system, using an interceptor rocket as shown in the test launch at left, could protect the nation's coasts against some sea-launched attacking missiles, an American Physical Society report concludes. A target missile (above) was launched by the navy in June as part of the Theater Ballistic Missile Defense test program.

▶ In a hit-to-kill defense system, the time remaining after an interceptor is fired is so short—less than 170 seconds against a liquid-fueled ICBM and 120 seconds against a solid-propellant rocket—"that the defense could fire only once."

▶ Even solid-propellant ICBMs based on 40-year-old technology would have short enough boost-phase burn times to "call into question the fundamental feasibility of any boost-phase intercept." The report also notes that US intelligence estimates state that both North Korea and Iran, the nations most often cited as threats in the missile defense debate, could deploy solid-propellant ICBMs within the next decade. "Boost-phase defenses not able to defend against solid-propellant ICBMs risk being obsolete when deployed," the report says.

▶ In regard to building a boost-phase system, "few of the components that would be required for early deployment (within 5 years) . . . currently exist. Moreover, we see no means for deploying an effective boost-phase defense against ICBMs within 10 years."

Lamb said he expects challenges to the report to focus on political judgments rather than technical criticisms. The report looked at the performance required to defend all 50 states, the lower 48 states, the major US cities, and either the East or West Coast. "If you don't demand defense of most of the US, then it gets slightly easier," Lamb said.

"If North Korea developed an early version of a long-range missile that could reach Hawaii, then defending against that might be doable [with a boost-phase system]," he continued. While defending Hawaii may not be a basis for moving ahead with an extensive system, he said, for proponents it represents a feasible first step.

Lamb, Kleppner, and the others involved in the study made a conscious decision to avoid making any direct comments about what US policy should be on developing a boost-phase system. The many scientists who contributed to the study didn't air their personal views about the wisdom of pursuing boost-phase or other missile defense, Kleppner said, and all participants agreed that the report should be about science, not policy.

At the unveiling of the study at a 15 July press conference, a reporter asked Kleppner, Lamb, and study staff director David Mosher, a nuclear policy analyst with RAND, if the findings didn't indicate that the millions of dollars going into the program were "money down the drain." All three indicated they would let people draw their own conclusions. William Brinkman, former APS president, added that the "technical results of the report are fairly clear."

Jim Dawson

HERA Scientists Fight to Extend Strong Interaction Studies

When should a productive machine be turned off?

A particle physics drought looms in Germany, from the time the plug is pulled on the Hadron Electron Ring Accelerator Facility (HERA) at the end of 2006 until whenever activity on the world's next linear collider revs up. "We face the danger of shutting down a unique accelerator irrevocably, and then sitting here for a very long time without particle physics," says Christian Kiesling of the Max Planck Institute for Physics in Munich and a member of the team that is pushing to extend HERA's lifetime. For the extension to happen, proponents will have to scrape together money and manpower and win over the management of the accelerator's parent lab, the German Electron Synchrotron (DESY) in Hamburg.

Nicknamed the "super electron microscope" because, by colliding high-energy electrons (or positrons) with protons, it provides a glimpse of the proton interior, the 11-year-old HERA has undergone an upgrade to higher luminosity and is on the verge of starting its second phase. The main aims of HERA-II are to flesh out details of proton structure at scales approaching a thousandth of the proton radius and to study the dependence of electron–quark scattering on the orientation of the electron's spin. After that, some 200 HERA scientists from 50 institutions around the world want to optimize HERA—through modifications to the machine and a new or upgraded detector—for a closer look at the dense quark–gluon clouds inside protons. HERA-III would also probe neutrons through electron–deuteron collisions and be used for other deep inelastic scattering experiments and investigations of strong interactions.

"The picture of the proton is getting more and more complicated," says Allen Caldwell of Columbia University and the Max Planck Institute for Physics. "We found that there are a huge number of quarks, antiquarks,