Army Spurs Missile Defense Technology

By Clarence A. Robinson, Jr.

Nekoma, N. D.—Advanced interceptor technology program is being formulated this year by the Army's Advanced Ballistic Missile Defense Agency (ABMDA) to develop and flight test anti-ballistic missile interceptors with sharply improved reaction time and acceleration capability for battle at lower altitudes.

The deployment of the Safeguard anti-ballistic missile system in the USAF/Boeing Minuteman intercontinental ballistic missile field near Grand Forks, N. D., will provide protection for a portion of the U. S. land-based deterrent force. It also will supply an operational data base for research and development of more complex advanced protection systems now in development.

The initial operational capability of the Safeguard site is scheduled for June, 1975. The Safeguard system has undergone a series of tests at the Army's range at Kwajalein Atoll (AW&ST Cover Apr. 9, 1973) in the Pacific. Seven more tests remain as part of the Safeguard system series.

In the first tests—1970 and 1971—12 of 16 intercept attempts were successful, two partially successful and two unsuccessful. In a second series, which is scheduled for conclusion in July, 33 launches were completed through December, 1973—30 were successful and three unsuccessful.

The Safeguard site will introduce an uncertainty in Soviet attack planning, Defense Dept. officials said in response to criticism that the system was not designed for its present mode of operation. Congressional leaders and the General Accounting Office have been questioning the Safeguard concept.

It will protect a portion of our land-based deterrent force and provide invaluable experience in the test and operation of a deployed tactical ballistic missile defense system, Defense Dept. officials added.

Pentagon officials admit that if the Army had started out to deploy only one ballistic missile defense (BMD) site specifically to defend a USAF Minuteman ICBM field as the Safeguard site will now be utilized, they would likely have used another system.

The radars, computers and software were all selected along with the missile interceptors with the idea of providing protection for the whole country from 17 locations, one Defense Dept. official said. A secondary mission was protecting Minuteman fields. The threat when the concept was established was vastly different from today's, he added.

"If we started from scratch today, we would likely employ the Army/McDonnell Douglas Site Defense System, and within the limits of the ABM treaty with the Soviets, deploy at least one module containing three radars, all smaller than the Safeguard's missile site radar, and 100 Sprint 2, modified Martin Marietta Sprint missiles," he said.

Without exceeding the limits of the present interim offensive strategic arms limitation agreement, the Soviets can be expected to acquire by the late 1970s a significant first-strike capability with nuclear-armed multiple independently-targetable reentry vehicles (MIRV) (AW&ST Feb. 25, p. 20).

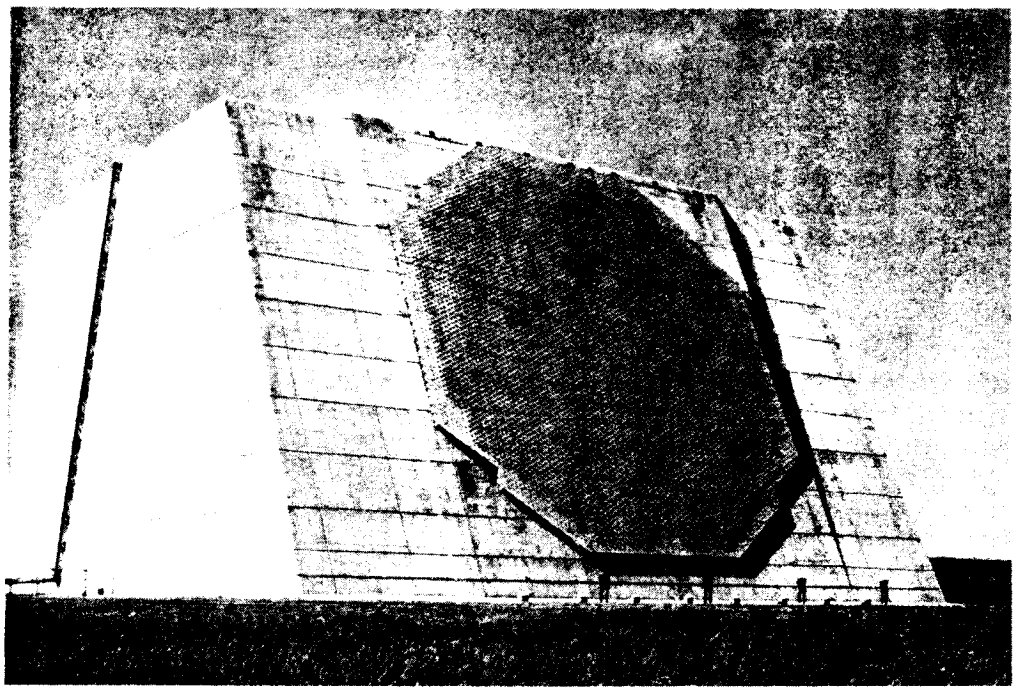
Site Defense involves a prototype demonstration of the system design with interceptor flight tests against reentry vehicles scheduled for Kwajalein. It is the orderly development of a second-generation system for Minuteman defense and supports the U. S. position in present SALT negotiations in Geneva, a Defense official said. It also provides a hedge against "abrogation of the ABM treaty. . . . It also assists in design and evaluation of U. S. strategic offensive systems," the official added.

The Pentagon is asking for $160 million in Fiscal 1975 to continue Site Defense Work. "I believe this program [Site Defense] a prudent and necessary hedge," Defense Secretary James R. Schlesinger said. "It would give us the option to defend our Minuteman force against a Soviet ballistic missile attack should that become necessary, or in the event that an acceptable permanent agreement on the limitation of strategic offensive arms cannot be achieved. It would also give us the option to deploy a more advanced ABM system for the defense of the National Command Authorities, if that should be found desirable some time in the future."

Advanced ballistic missile defense technology is considered critical to U. S. strategic defense, and the Defense Dept. wants $91.4 million to continue research and development in this area at about the same level as in other years.

In referring to advanced ballistic missile defense technology, Schlesinger said, "The rationale for continued research and development in BMD, as well as reentry systems (ABRES) technology, is founded on two specific SALT-related objectives. One is to provide the Soviet leaders with strong incentives to negotiate additional strategic arms limitation agreements. The other is to motivate them to keep the treaties and agreements already made."

Schlesinger added that if the U. S. fails to advance ABM technology while the Soviets continue their rapid development



Perimeter acquisition radar (PAR), located about 25 mi. northeast of the MSR Safeguard site, uses a General Electric phased-array radar facing north to detect and track targets out to about 1,800 naut. mi. as hostile ICBMs would cross the North Pole. PAR's structure is reinforced concrete 200 ft. on a side at the base and 110 ft. high. An administrative building and underground power plant support the PAR, which has a single face with about 120-deg. horizontal coverage. The PAR provides initial track data to Safeguard's MSR for launch of Spartan and Sprint missile interceptors with nuclear warheads. Spartan can be launched by the PAR and then handed over to the MSR for engagement against reentry vehicles.

program, which is clearly permitted by the present interim agreement, the balance could be shifted drastically in the Soviets' favor.

"Despite advanced technology development and continuation of Site Defense, we shouldn't discard too quickly what we have in Safeguard capability," a Defense official said. "It has technology to perform against the threat that now exists and that is likely to continue for another five years or longer."

Safeguard will provide a big training data base, and it will serve to verify maintainability/reliability of the system's components and provide a hard data base to work from in some areas for Site Defense, the official said.

A budget request in Fiscal 1975 for $60.8 million will end the Army's funding for the research and development phase of Safeguard. The total cost of constructing the site near here is $483 million. In all, the total cost for Safeguard will run about $5.4 billion, according to an Army selected acquisition report issued in January.

In addition to research and development funds in Fiscal 1975, the Army is asking for $3 million in procurement money for Safeguard system spare parts and $75 million for operation and maintenance. With a $6.9-million request for Army pay, the total Safeguard request for the coming fiscal year is for $145.7 million.

The Safeguard's Raytheon phased-array missile site radar (MSR) has a detection range of more than 300 naut. mi. Four array faces, each containing 5,002 phase shifters, are housed in a hardened reinforced concrete pyramid turret. The arrays face the four points of the compass, and the turret rises 75 ft. above the ground.

Beneath the pyramid, radar and data processing equipment are housed underground in a building 230 ft. sq. The MSR provides close-in precise target data on enemy reentry vehicles and will ready Martin Marietta Sprint and McDonnell Douglas long-range Spartan missiles to intercept targets in defending USAF ICBM fields.

Safeguard's success depends on detection and tracking of Soviet reentry vehicles at long ranges and a General Electric perimeter acquisition radar (PAR) is employed for this purpose. The PAR is at a site approximately 25 mi. northeast of the MSR near Cavalier, N. D. The PAR can detect targets at ranges of about 1,800 naut. mi. or just as they would come over the North Pole if the U. S. were attacked from that direction. The PAR has a single phased-array face pointing north with more than 6,200 antenna elements that are steered electronically.

If an attacking warhead is detected by the PAR, its computers determine the trajectory, and because the PAR is linked to the MSR, it relays the information.

PAR detection of a reentry vehicle at its extreme range would provide the U. S. with about 6 min. in which to plan the battle, launch interceptors and engage incoming warheads, according to Defense Dept. officials. PAR is designed to work in conjunction with the MSR, but it can be used to launch the Spartan missiles based on its tracking data and then shift control of the missile to the MSR to conduct the final intercepts.

Thirty Spartan missiles are co-located with 16 Sprint missiles in a field adjacent to the MSR building. In addition, four Sprint remote launch sites are located within a 15-mi. radius of the MSR to the northwest, northeast, southeast and southwest.

Under the existing U. S.-Soviet ABM treaty, each side is limited to two sites—one for protection of the national capital and the other for an ICBM field protection. At each site no more than 100 interceptor missiles can be deployed, and the area of the ABM system is restricted to a radius of 94 mi. Both sides have agreed not to develop, test or deploy ABM launchers that boost more than one missile at a time and this included a ban on more than one independently guided warhead for an ABM missile.

The PAR has detected, verified and tracked earth orbiting satellites at the maximum detection range of the system as part of the installation and test operations with the radar, Defense officials said. Satellite detecting/tracking was effective throughout the PAR field of view, and various size satellites tracked provided data on both small and large targets at minimum and maximum ranges to confirm concepts used in the PAR design, they added.

The MSR is now in its installation test phase involving evaluations of components and subsystems and their integration in the MSR. Satellite tracking with the MSR for testing is now being accomplished.

The Safeguard site, including the PAR, is scheduled to be turned over to the Army in October when the prime contractor for Safeguard, Bell Laboratories/Western Electric, will reach the equipment readiness date.

Safeguard uses a high-speed data processing and communications system developed specifically for Safeguard to tie all components into an integrated weapons control system for radar control and management of the complex engagement planning and execution.

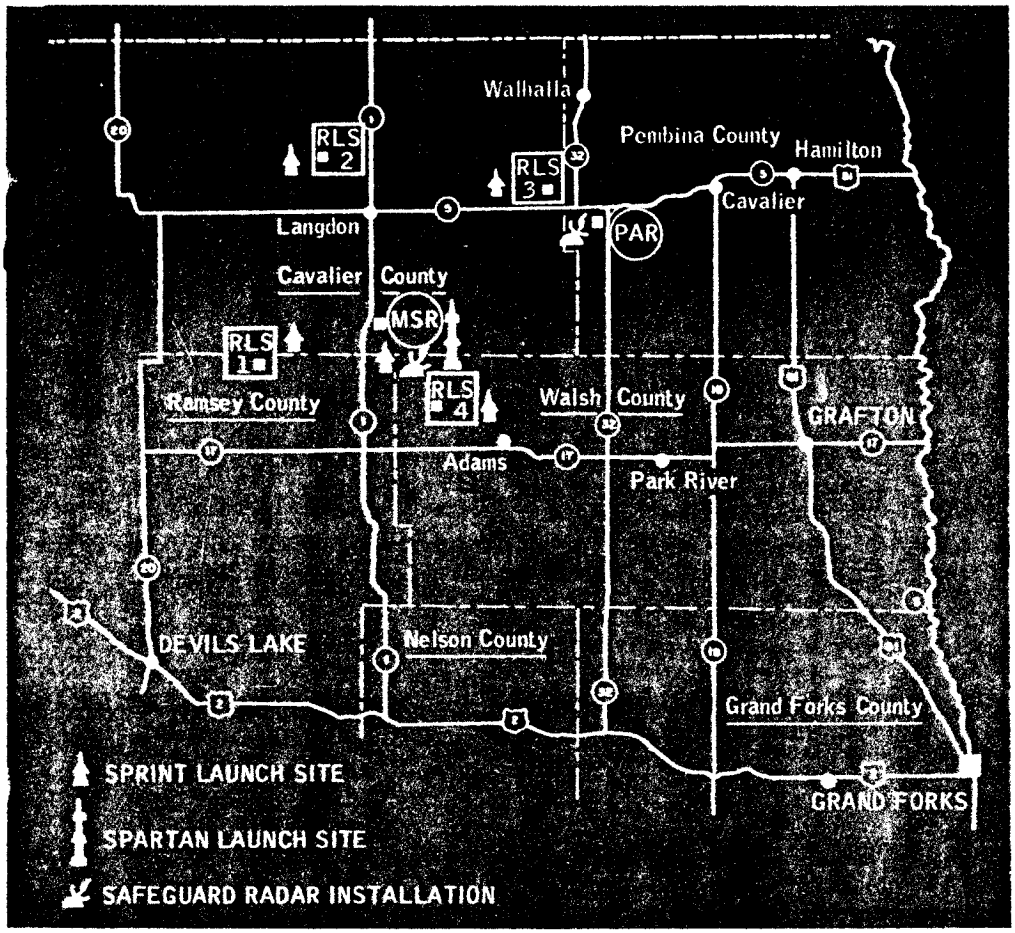
The computer for Safeguard was designed for the system in 1967, when there were no commercial computers on the market with the required capacity. It was designed by Bell Laboratories and built by Western Electric. Called a central logic computer the system has a capacity of 20-million constructions per second. The software routine, with some sections still being tested, is the heart of the Safeguard system, Defense officials said. The software tests are being conducted at Bell's Madison, N. J. facility where there is a computer identical to Safeguard's. Radar simulations are used by Bell with the computer for software testing.

Army's Safeguard/Sprint missile breaks through the cover of its launcher during tests at White Sands, N. M. missile range. The missile's first-stage motor fires a few feet above the ground and it pitches over simultaneously to begin seeking out hostile reentry vehicles. Sprint is a hypersonic, two-stage, solid-fueled, command-guided interceptor. The Safeguard missile site radar at the North Dakota ABM site controls the missile and tracks the incoming reentry vehicle.

The software routine for Safeguard is the most complex ever written, Defense officials said, but the Army has confidence it will work when deployed, based on tests in detecting, tracking and launching actual interceptors against USAF ICBMs at Kwajalein and in simulations in the Bell laboratory.

The computer involves some advanced engineering technology to obtain the capacity needed for Safeguard, but commercial computers now on the market can be combined to provide a capacity necessary for Site Defense.

With the Spartan missile's long-range capability, Safeguard employes a terminal layer defense technique against incoming reentry vehicles. Spartan is used



Safeguard anti-ballistic missile system's missile site radar near Nekoma, N. D., is depicted in map above with relative location of Sprint remote missile fields within a 15-mi. radius and the perimeter acquisition radar 25 mi. away.

for intercept outside the atmosphere, and the high-speed Sprint missile is for intercept inside the atmosphere at closer ranges. The Sprint is designed to destroy reentry vehicles that evade a Spartan intercept in space. Spartan's range and Safeguard's radar, computer and software also provide a secondary capability of defending large areas of surrounding states against attack.

The Army took the technology embodied in the Safeguard system, which was developed with the idea of deploying 17 sites—later reduced to 12 sites and finally to one by Congress—and used it as best it could after the ABM treaty was signed.

The McDonnell Douglas Spartan missile interceptor ejects hot X-rays from its nuclear warhead, which travel in a straight line and are deadly to a nuclear-armed reentry vehicle at tens of miles.

The Martin Marietta Sprint missile interceptor uses its nuclear warhead's high-aenergy neutron kill mechanism, designec specifically for intercept in the earth's atmosphere. Sprint's warhead is designed to minimize the effects of blast and nuclear debris in the engagement area.

Using Sprint in the atmosphere allows time for bulk filtering with the Safeguard radar to sort out enemy decoys, penetration aids and missile body fragments. Sprint travels at hypersonic speeds and is launched from its underground cell by ignition of a gas generator that tosses the missile out of the launcher before the missile's motor is ignited.

The 27-ft. long, two-stage, solid-propellant Sprint has a burn rate well beyond that of other missiles and is capable of surviving shock and acceleration loads without cracking, Defense officials said.

Sprint is engulfed in an ionized plasma sheath after second-stage ignition, causing it to glow white hot and giving it the appearance of a comet tail. As Sprint reaches peak velocity, the outside skin temperature becomes hotter than the interior of the motor. An ablative heat shield is used to protect and keep cool the guidance and control systems.

Electronic and mechanical components of Sprint can withstand acceleration loads in excess of 100g. Sprint has:

- Nuclear hardening of the entire system is insure survivability in a nuclear blast.
- Communications link to insure penetration of command signals through the missile's exhaust plume, the plasma sheath and the ablative products.

Sprint is being produced in Orlando, Fla., under a $250-million production contract with about $40 million of that amount still remaining to be obligated. The Sprint research and development contract was for $530 million, and all but $5 million has been spent. Martin Marietta's basic production program for Sprint has about a year left.

Sprint's major subsystems are assembled in the plant, but the missile is not put together in its entirety until it is in its launch cell at the Safeguard site.

Both Spartan and Sprint test missiles are selected from the production line in the form of major components. They are flown to Kwajalein, assembled and tested as a method of quality control. Some tests of both missiles from the production lines have already occurred and others are scheduled this summer and fall.

After the Safeguard site goes into its tactical phase, both missiles will be selected at random from their launch cells and taken to the Pacific for tests. The tests will be carried out continually as long as the site is operational, Army officials said.

The Spartan missile is a 55-ft. long, three-stage, solid-propellant missile being produced under a $332-million contract that is about 90% complete. The third stage, which operates outside the atmosphere, is command ignited by the MSSR on the ground.

McDonnell Douglas is now preparing the Spartan launch cells at the Safeguard location to accept the 30 Spartans that will be housed in the adjacent missile field. The missiles will be assembled at the site and put into the cells toward the end of 1974.

Spartan is capable of maneuvering both in and out of the atmosphere. The missile uses a reaction control system in the third stage, with the propellant system gases exhausted through the end of canard aerodynamic control surfaces.

The missile components are required to have a five-year shelf life in the deployed mode. McDonnell Douglas is now involved in research to locate critical items in the subsystems and in tests to extend the shelf life of those items.

Both Spartan and Sprint have been tested extensively against U. S. ICBMs in single and multiple simultaneous launches from the range at Kwajalein Atoll.

Installation and test of the hardware at the perimeter acquisition radar site and missile site radar are basically complete and subsystem testing is nearing completion. Final versions of the radars' software will be delivered to the Safeguard site by the end of Fiscal 1974.

The Safeguard system test program is continuing at Kwajalein in support of software development and validation of system models, Army officials said.

The Army's emphasis now is no longer on the deployment of the operational Safeguard system. It is now directed toward research and development of advanced ballistic missile defense systems.

The advanced terminal interceptor will be a broadly based program aimed at doing more than determining a specific flight test configuration. New fuels, controls and structural materials will be de-

veloped along with the approaches to software to reduce development time.

Laboratory work is now under way to seek new non-nuclear kill mechanisms, and the technology for limited miss distances with them. In addition to non-nuclear ABM warheads, some work is under way with newer nuclear warheads for interceptors. The main concern with non-nuclear warheads is to get data on the effects of high-speed projectiles on reentry vehicles and miss distances within tens of feet.

The Army believes that optics research offers promise in developing new guidance techniques for ABMs. Optical and infrared systems may be used to circumvent difficulties inherent in radar observation in a nuclear environment.

The study of nuclear effects also is necessary to find ways to attenuate them. Radar technology with new wave forms, greater effectiveness and economy of operation also are being sought.

(This is the first article in a series.)