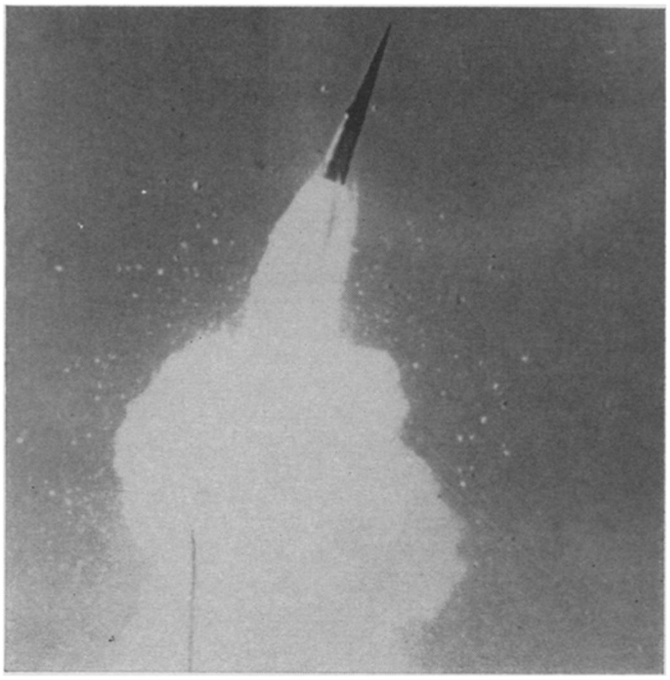
ANTIMISSILES

Far from deployed

Although the green light has been given, the ABM system faces technical problems



DOD

Sprint missile: Safeguard's second line of defense.

The great ABM debate is over, but the issue is not yet settled. The Senate decision to deploy last week merely gave the go-ahead for the Defense Department to put radars and computers in place and to carry out research and development work at two Air Force bases in Montana and North Dakota.

Safeguard can still be strangled in 1970 or in later years by Congressional withholding of funds for the actual procurement of the antiballistic missiles.

There are also technical obstacles that must be eliminated before Safeguard can be a working reality.

If and when it is finished in the mid-70's, the system is to consist of 12 missile sites to protect Minuteman missiles and bombers from Soviet attack and cities from the Chinese. It employs two types of missiles: a long-range (400-mile) Spartan and short-range (25-mile) Sprint, the latter to knock out those missiles that get by Spartan. The eyes for the Spartans are long-range radar called Perimeter Acquisition Radar (PAR), which can spot incoming missiles 2,500 miles (10 minutes) out. The radar for Sprint is called Missile Site Radar (MSR). If the radar is the eyes of the system, then the computers are the brains, which perform all necessary calculations to intercept incoming missiles.

The radar is Safeguard's Achilles' heel. It can be affected by a variety of penetration aids ranging from nuclear blast to electronic jamming. The more vulnerable of the two radars is the PAR, which can be easily blacked out by a nuclear explosion. The blackout is caused by ionized air, either resulting from the heat of the fireball or the emission of beta rays. The ionized air reflects or absorbs the electromagnetic waves of the radar so the instrument no longer sees the targets.

One of the objectives of future testing of the Spartan warheads at Amchitka in the Aleutian Islands will be to determine the best design to minimize the blackout from the system's own missiles (SN: 4/19, p. 376).

In addition to nuclear explosions, PAR can be hampered or deceived by electronic jamming and devices such as chaff (fine metal wires dispersed as a cloud), aluminum balloons or exploded segments of rocket boosters. Although ABM supporters contend that such simple penetration aids are not a threat, they do admit that highly sophisticated, complex and costly ones are.

The MSR, since it uses short wavelengths and the intercept heights are relatively low, is far less vulnerable than PAR. But it is still not invincible. Since all radar must be exposed above ground to transmit and receive, there are limits to how much an MSR can be hardened, or protected, with concrete. It is estimated that radar can withstand a pressure of 20 to 30 pounds per square inch. A one-megaton explosion closer than one and a half miles could produce more than that.

Another area requiring further work is missilery. Although the validity of the ABM concept was first proved in 1962 with the intercept of an Intercontinental Ballistic Missile by the Nike-Zeus system, and backed up by subsequent tests, still, missile failures will occur. According to Dr. Daniel Fink, former deputy director of defense research and engineering, ICBM's in general have a probability of failure of 34 to 59 percent. The Spartans are close enough to ICBM's to have the same failure probability and although the Sprints are smaller and have two stages instead of three, their tremendous acceleration would give them a significant failure probability. The solution is either improve ABM missile reliability or increase their number.

At the computer end of the system, there are three potential trouble spots: men, equipment and programming.

The human factor will be present in Safeguard from the President down to the men who fire the missiles. Since there would be 10 minutes to act at most, but less if attack comes from under the sea, slow-reacting human hands and minds impose a delay in the system. An option open to the Safeguard builders is to automate the system and eliminate virtually all human control, a disquieting thought especially to those who remember when the Ballistic Missile Early Warning System once mistook the moon for a flood of incoming missiles.

A major concern with equipment is not so much breakdown—although this possibility exists for small components and major segments—but rather with modifications and unusual maintenance problems that always crop up after rapid installation.

"There is a tremendous problem to get the computer to work at speeds required," adds Prof. J. C. R. Licklider of the Massachusetts Institute of Technology's electrical engineering department. "The amount of calculating depends on the complexity of what's going on in the environment. If the sky is full of decoys and lots of things are happening, present circuits can't do the job in time. The length of time increases drastically with the complexity."

But the area requiring the greatest attention is the software, the programming, that instructs the computer what to do. Because the computer programming must identify incoming missiles, distinguish between them and penetration aids, correct for blackout errors, guide the defending missiles to their targets and then arm and fire them in addition to checking and correcting, the job of getting such a program with its myriad instructions to work without a major hitch is overwhelming.

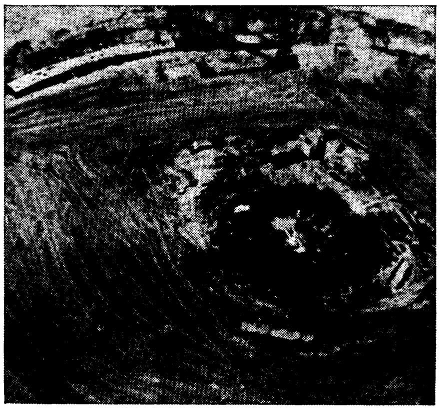
The final problem for the Safeguard system is testing. It compounds all the rest. There is no way other than nuclear war for a complete run-through of the system. At present it is being tested in a piecemeal fashion. For example, in 1970, an MSR and computer will be tested in an actual missile intercept at Kwajalein Atoll in the Pacific. This will be followed by the first intercept of multiple targets. Since the PAR is not built yet—a prototype test model is 40 percent complete and the PAR computer is 25 percent complete—it will not be tested at Kwajalein. Instead, as Secretary of Defense Melvin R. Laird informed a House appropriations subcommittee, "We have a radar out there which can be used to simulate PAR in the overall systems test. It operates on the same frequency as the PAR."

Commenting on the Defense Department test program for Safeguard, Dr. George B. Kistiakowsky, former Presidential Science Adviser and now professor of chemistry at Harvard University, says, "I would certainly feel a more reliable way of proceeding would be to set up PAR, MSR and missiles at Kwajalein, and then they could be exercised completely against reentry vehicles from Vandenburg (Air Force Base, Calif.)." Dr. Kistiakowsky feels that the two missile sites in Montana and North Dakota would not be satisfactory "for complete testing because you can't launch reentry vehicles against them."

Strictly speaking, whether or not the system will work is problematical. Opponents say it will not and amass facts to prove it. Supporters say it will and marshall their data. The only thing certain is that both sides hope they are never proved right.

BUBBLES FOR BATAVIA

Planning for the giant



AEC

Scraping and tunneling at NAL.

The purpose of a national laboratory is to provide equipment not available elsewhere that scientists from all over the country and outside of it as well can come and use.

Use by visitors is expected to be especially large at the National Accelerator Laboratory now under construction at Batavia, Ill. (SN: 7/5, p. 7). When NAL is complete it will have the world's most powerful particle accelerator — with eventually 400 billion electron volts energy—and will be the only place in the world for physicists to go for certain experiments.

But physics changes while the NAL is being built. So the laboratory management has been holding a series of summer seminars in which staff members meet with physicists from universities and other institutions to discuss the kinds of research the university people are interested in doing and to see how the 200-400 GeV accelerator can be made to fit their needs as it is built.

"We don't want to build a machine that can't do what university people want to do," says Dr. Edwin L. Goldwasser, deputy director of NAL.

One result of this year's discussions, held at Aspen, Colo., is that NAL staff and consultants agree that the laboratory will need a large bubble chamber, and it now plans to build one in collaboration with Brookhaven National Laboratory. The multimillion-dollar item was included in the original plans for NAL but was removed as part of an economy drive.

Meanwhile a group of 12 or 15 Canadian physicists was meeting in Montreal to discuss what they would like to do if their Government accepts a proposal, now before it, to make some financial participation in the Batavia project (SN: 3/29, p. 305). For the experimentation they would like to do, the Canadians found they will have to build a magnetic spectrometer, a device that separates different kinds of particles from one another. "The NAL will need some sort of particle spectrometer," says Dr. J. D. Prentice of the University of Toronto, and the Canadian physicists concluded that this could be a good contribution for them to make. (The proposal for Canadian participation is now being considered by the National Research Council of Canada, which is expected to make its decision in the fall.)

A large bubble chamber was one of the suggestions made when Canadian participation was first discussed, but now, says Dr. Prentice, "Brookhaven is so well set up for this, they're so far ahead that there's no point in forming a group in Canada for that."

According to present plans the NAL-Brookhaven bubble chamber would be 25 feet long and contain about 100 cubic meters of liquid hydrogen. It would be bigger than any that now exist although some European plans rival it in size. The laboratory's original plan, which envisaged a total cost of $375 million, included $30 million for such a chamber. The laboratory's estimated cost has now been trimmed to $240 million. The bubble chamber now planned could be built for $15 million, Dr. Goldwasser estimates, and the laboratory will ask Congress for a separate appropriation for this.

The need for the bubble chamber arises from the desire of physicists to study the neutrino. Study and simulation of the experiments that might be done in this line convinced the people meeting at Aspen that a bubble chamber, rather than electronic devices, would be required for particle detection.

Another line of experiment where the big accelerator will be especially useful is the search for new particles, both those expected and those unexpected by theory. Those that may be looked for include quarks (SN: 5/31, p. 538), intermediate vector bosons, (SN: 11/16, p. 500) and ultraheavy particles called resonances. One important point will be to determine whether there is an upper limit on the mass that particles may have. Some present experimental evidence seems to show that particles cannot be heavier than the mass equivalent of five GeV energy, but current theory does not include such a cut-off.

Another topic in which much interest was shown at Aspen was in study of electromagnetic forces by collisions among mu mesons. Physicists want to know whether the laws they have evolved for electromagnetic forces apply at subatomic distances, and mu-meson collisions give them an interaction that involves only electromagnetic forces. The big accelerator will provide a sufficient flux of mu mesons.