Base Construction for Bomarc

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THE Air Force Bomarc supersonic missile, for which development began in 1949, is in operation as an area-defense unmanned interceptor to seek out and destroy enemy high-flying bombers. One model, the IM-99A, uses liquid rocket fuel for the initial take-off, with a range of some 200 miles; and the advanced B model uses solid fuel for the initial rocket boost and has an increase in range to more than 400 miles.

Operational and support facilities for the Bomarc brought about a demand for new and complex design criteria and specifications. Launching the Bomarc, either singly or in salvo, ties together the split-second time-sequence of the opening of the missile shelter roof, the electronic feed-in, and firing, all controlled from a distantly located Semi-Automatic Ground Environment (SAGE) control center.[1]

To launch the missile, the shelter roofs separate at the center and slide open horizontally in seconds (Figure 1). After firing, and when the missile has reached cruising altitude, twin Marquardt ramjet motors provide the required power during the cruising phase. The missile is controlled during cruise flight by the SAGE center until the target seeker, contained in the missile, locks on the target. Then the needle-nosed Bomarc continues on its self-contained guidance system, without SAGE, to the kill. Firing from tactical bases will be permitted only in the event of an enemy attack. Testing and training is being conducted at Eglin Air Force Base, Florida, with missile flights over the Eglin Test Range in the Gulf of Mexico.

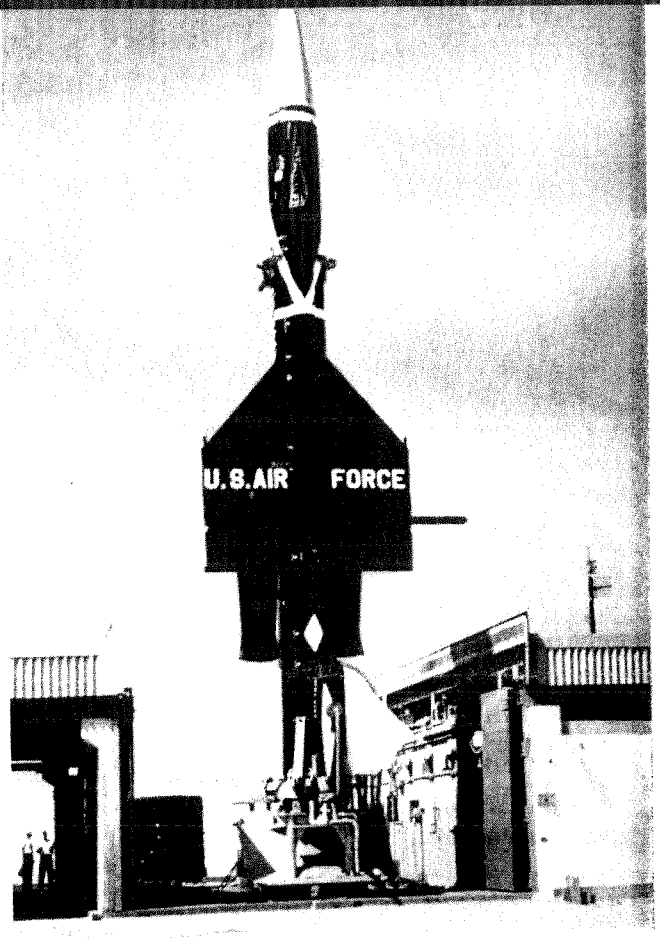

Figure 1. Bomarc Poised for Flight

BASE FEATURES

Bomarc sites are located in the vicinity of established military bases to take maximum advantage of base facilities and Government-owned land. Ample safety spacing is provided to protect the population nearby.

IM-99A bases have either 28 or 56 launching shelters (Figure 2) in the missile launching area. A compressor plant for each group of 28 shelters supplies high- and low-pressure air and helium used for conditioning and purging the missile. The launching area has an adjacent missile support area with a large, high-bay assembly and maintenance shop; a combined heat, power, and chilled-water plant; special propellant fueling facilities; a building for vehicle storage, fire station, and security control; and a diesel oil storage facility. The squadron operations center is located in the assembly and maintenance building. A ground-to-air transmitter building in the vicinity of the launching site provides the radio control link for the SAGE control.

The IM-99B missile base (Figure 3) has a similar shelter area. These shelters are of a modified and more economical design. Since the walls are not reinforced or as thick as in the earlier model, the units are spaced farther apart to meet explosive safety rules. The missile support area consists of only three buildings: the composite building, right, which includes a squadron operations center, the heat and power plant, special missile vehicle shop, and spare parts and vehicle storage; a smaller assembly and maintenance shop, left; and a fire station and security control building near the gate.

The nearby air base cantonment facilities will be used. At localities where the road distance or travel time to the base would prevent rapid response, there will be a small building on the base with sleeping quarters and a messing facility for approximately 15 officers and men on alert status.

DESIGN

Base design requirements were originally defined during the advanced stages of the IM-99A missile development. Thirteen architectural and engineering firms have been employed on various phases of the standard plans and base design, under guidance of the Air Force Directorate of Civil Engineering, and supervised by the Army Corps of Engineers. The first launching shelter used at Cape Canaveral in research and development testing was designed in 1956, as was the testing and training site on Santa Rosa Island, Eglin Air Force Base. Lessons learned during the design and construction of the Santa Rosa facilities were incorporated in design for the first tactical base. These plans were modified in 1957 and sites were adapted at three additional bases by various architectural engineering firms. The Corps of Engineers then developed standard plans for subsequent site adaptation based on Air Force criteria.

[1] See "SAGE—The New Aerial Defense System of the United States" [M.E. Mar.-Apr. 1956].

Figure 2. A 56-unit IM-99A Launcher Base under Construction

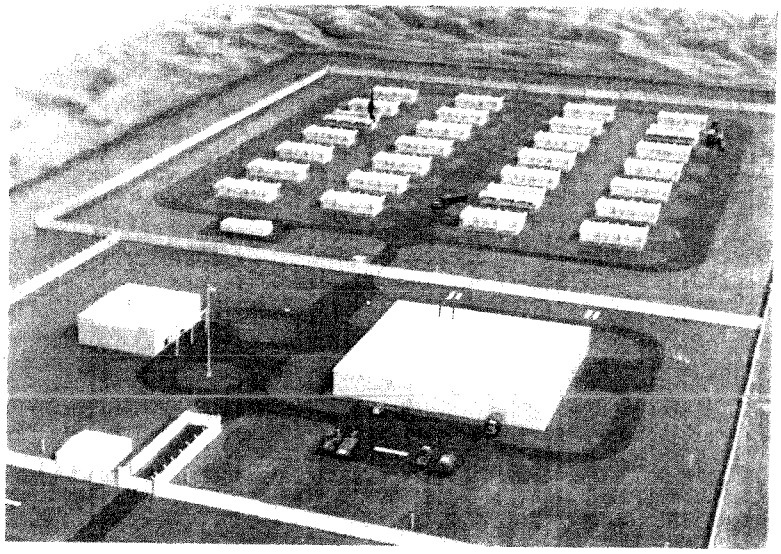

Figure 3. Sketch of a 28-unit IM-99B Launcher Base

Figure 4. Covered Concrete Utilidors

Some major facilities were redesigned to effect savings at the third, fourth, and fifth bases. For example, the heat and power plant was reduced in scope at the third and fourth IM-99A bases and to a still greater extent at the later IM-99B follow-on bases. At the fifth base, the compressor plant was deleted and the facilities necessary to handle compressed air and helium were included in the central utilities building. Many of the improvements were made possible by modifications in the weapon system equipment. In the design for the IM-99A missile shelters it was considered necessary to provide accurately controlled temperature and humidity for protection of intricate electronic equipment. In the follow-on base design for the B missile, the air conditioning was deleted with no detriment to the missile. Dust-free air is maintained, however, and the missile is cooled by its own cooling system while in the shelter.

The heat and power plants for the first two bases include air conditioning and 360-hp boilers (12,000,000-Btu output) for temperature control in shelters. Four diesel-powered generators provide power with backup reserve for alert conditions. The IM-99B bases will have two 172-hp boilers at sites in 20-degree temperature zones. The power requirement has been reduced to permit use of commercial power with one 400-kw generator for standby.

To simplify maintenance of high- and low-pressure air, helium, and utility lines to the launching shelters, utilidors—covered concrete tunnels with laterals to individual shelters—were installed at the third, fourth, and fifth IM-99A bases (Figure 4). The lines in the utilidors are easily accessible on racks. For the IM-99B it was possible to eliminate costly fueling facilities, stainless steel pipe, and helium and high-pressure lines, so the utilidors will be unnecessary for their bases. Mobile vans now perform the functions that previously required space and utilities in the assembly and maintenance building.

In redesign, the squadron operations center was included in the composite building, thereby reducing the assembly and maintenance building to shop space only.

Rigid requirements and close tolerances of the intricate weapon system equipment, combined with continuing refinements in the equipment, made necessary the extremely close coordination between Air Force agencies, the Army Corps of Engineers, and the contractors. Predesign conferences and on-board reviews at the 30- to 60-per cent design stage were held, and project officers and project engineers were given wide leeway in making decisions at the field conferences.

The IM-99B missile was scheduled for operational bases months earlier than originally planned, necessitating a greatly shortened redesign schedule to convert plans from the A to the B configuration.

STATUS OF CONSTRUCTION

Construction of testing and training facilities for the IM-99A was completed at Eglin Air Force Base in the fall of 1958. Major construction has been completed at four IM-99A bases.[2] Construction is essentially completed at a combined IM-99A–IM-99B base near Langley Air Force Base, Virginia, and at three IM-99B bases.[3] Sixteen prime contractors and

[2] In the vicinity of McGuire AFB, New Jersey; Suffolk County AFB, New York; Otis AFB, Massachusetts; and Dow AFB, Maine.
[3] Near Niagara Falls, New York; Kincheloe AFB, Michigan; and Duluth AFB, Minnesota.

numerous sub-contractors employed on the eight sites had an average of 300 construction workers at each site. The IM-99A bases will continue in operation after the IM-99B is operational. Construction will be started by spring of 1961 for augmentation of several existing sites with additional missile shelters and support facilities.

Installation of equipment, calibration, and checkout required 8 to 10 months for the first four sites. Some overlap with construction activity was necessary where schedules were compressed. Labor strikes at one base delayed construction and equipment installation several weeks. Considerable effort including overtime was necessary to meet required dates. At the first several bases, change orders resulted from refinements in the weapon system. Other changes were made to effect savings when they could be accomplished without delaying completion.

The first launching shelter at Cape Canaveral was a heavy 73-by-42-foot structure with 12-inch reinforced concrete walls and a clamshell-type roof. Model II shelters were built at Eglin and at the first four tactical bases. This model (Figure 5) was reduced in all dimensions but retained a 12-inch reinforced concrete wall structure. The mechanical and electrical equipment was housed in a side room with 8-inch masonry outer walls. The roof is actuated by hydraulic pressure. Shelter savings were important because shelters represent a large proportion of the program cost.

A Model III shelter at Eglin Air Force Base was of metal with a pitched roof which opened downward from the center in two sections by gravity. Concurrently, a Model IV prototype was erected at Seattle. The cost was reduced mainly by incorporating the mechanical and electrical equipment in a pit beneath the launcher erector, reducing the wall thickness, reducing the compressed air requirement, and eliminating air conditioning. Although Model III had merit from an economical standpoint, the Model IV shelter (Figure 6) was selected for the IM-99B bases since it was more compatible with the currently designed weapon system equipment. Figure 7 shows precast concrete wall panels being placed on a Model IV B tactical launching shelter.

The cost of the first two 56-launcher bases, including government overhead and contingencies, averaged about $13,000,000 each. They were the first facilities of their kind to be built. The third and fourth bases, with 28 launchers each, cost $7,500,000 each. Greater improvements in design will be reflected in the fifth and subsequent bases. The cost of IM-99B bases now under construction has been reduced to $3,000,000 to $4,000,000 each, depending on the geographical area. Thus, through continual appraisal of requirements and timely design changes, notable reductions are being made. These costs do not include weapon system equipment.

Because of the rapid pace of missile development and compressed schedules needed to attain goal dates, design and construction must start prior to final development tests of the missiles. In the case of Bomarc this procedure was successful. Also major redesign, resulting in considerable savings, was accomplished satisfactorily without delaying completion or jeopardizing operational dates. This represents a gratifying achievement in the civil engineering phase of the program.

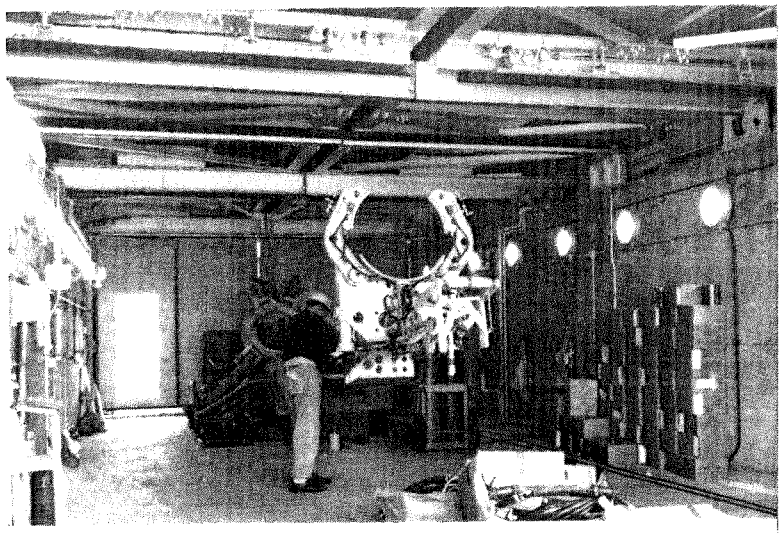

Figure 5. Interior of Model II Bomarc Launching Shelter

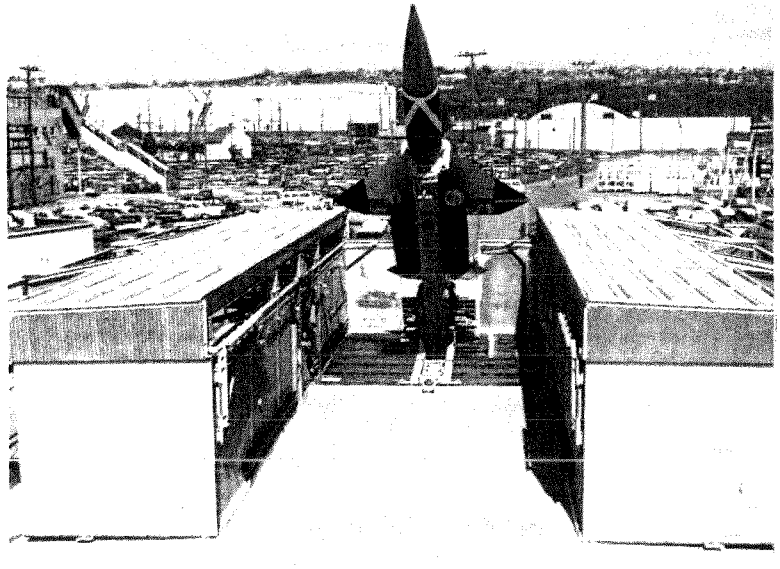

Figure 6. Model IV Launching Shelter

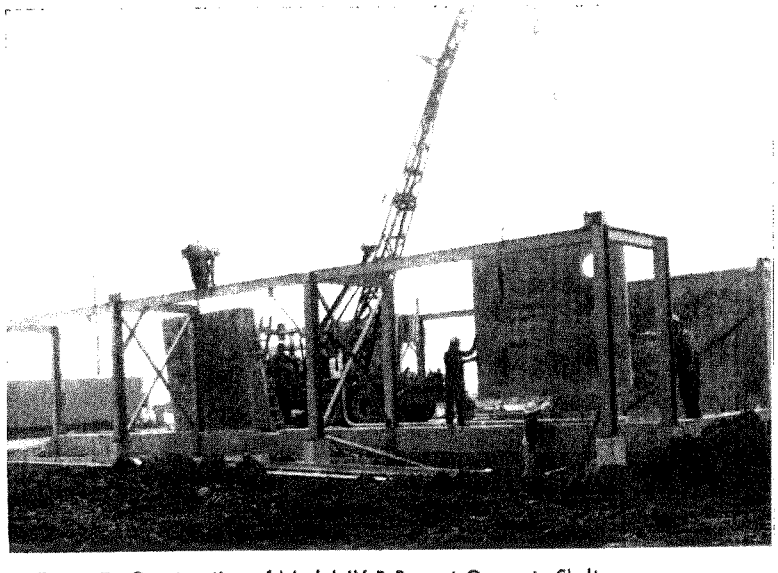

Figure 7. Construction of Model IV B Precast Concrete Shelter