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NSA review completed

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Declass Review by NIMA/DOD

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THE SOVIET SA-2 SURFACE-TO-AIR MISSILE SYSTEM*

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[redacted]
Defensive Systems Division
OSI/CIA

With Contributions By

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CONCLUSIONS

The Soviet SA-2 system, the most extensively deployed surface-to-air missile (SAM) system in being, constitutes the major air defense weapon of the USSR and the European Satellites. It is also installed or being deployed in eight other countries, both Communist and non-Bloc. Since its initial deployment in 1958, the SA-2 system has been upgraded frequently. With further revisions in the design of the system and subsequent modification of the deployed units, the SA-2 will probably continue to be an essential component of the Soviet Bloc air defense system for the next decade.

The existing SA-2 system poses a serious threat to all operational Western attack and reconnaissance aircraft, except those flying at very low altitudes. As deployed in quantity and depth, this

weapons system has a potentially high kill probability against medium- and high-altitude targets operating at velocities up to Mach 2 with a reduced capability against faster targets. The SA-2 has been previously reported to be effective against targets flying between

[redacted] Recent design changes, which may not have been extended to all units, probably will provide a system capability against targets flying as low as 1,600 feet. With degradation in maximum intercept range and lethal radius, the SA-2 system probably can be employed successfully against targets flying at altitudes somewhat under 1,600 feet. Low-altitude capability will vary somewhat from site to site depending upon terrain.

* Reprint of Conclusions and Summary of OSI-SR/65-18, 3 May 1965, SECRET/

[redacted] cent modifications in the FAN SONG radar suggest further efforts to reduce

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weapons systems, and the other drawbacks are compensated largely by the great number of deployed SA-2 sites.

The major limitations of the SA-2 system are its inability to cope with high-altitude, high-speed targets at long range; marginal effectiveness against very low altitude targets; inability to handle more than one engagement at a time per site; and long reloading period following the expending of the six missiles on the launchers. Additionally, while the system is transportable, it requires 4 to 6 hours to disassemble a site and a similar period to set up in a new location. The first two limitations presumably are problems which must be overcome by the employment of other

The Soviet SA-2 system has been designed to emphasize simplicity in operation and high kill probability against single targets through intentional limiting of intercept range and application of weapon redundancy. Design features of the system include conservative engineering practices, a minimum of automatic procedures, and fairly simple operation that can be carried out by relatively unskilled operators. However, the system does require large unit strengths and, apparently, an extensive maintenance effort involving skilled technicians.

SUMMARY

The SA-2 system, probably first deployed in 1958, is the most widely deployed SAM system in the Communist Bloc. At least 1,100 SA-2 sites have been identified in the Soviet Bloc (about 950 of them within the USSR) and in Communist China, North Korea, and Cuba. Approximately 20 additional sites are deployed in such nonaligned countries as Indonesia, Egypt, India, Yugoslavia, and Afghanistan.

The SA-2 system is transportable and is relatively simple in design and operation. Unlike the earlier SA-1 system, all components of the SA-2 system, including the missile launchers and radar, are on wheels. The design concepts on which the SA-2 system is based are different from

those followed by the United States in the design of the Nike systems. Whereas the Nike systems have multiple radars for target and missile tracking and as a source of missile guidance signals, the SA-2 uses one radar, the FAN SONG, for these functions. The use of one radar alleviates to a large extent the problems of parallax, boresighting, and synchronization which a surface-to-air system would normally encounter.

Of the five different FAN SONG models which have been identified, three of them, FAN SONGs A, B, and probably D, operate [REDACTED] and appear to be essentially similar to each other. The other two models, FAN SONGs C and E, operate [REDACTED] and appear to differ

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significantly from the [] models and from one another. Regardless of model, the FAN SONG radar is a track-while-scan type which combines target and missile tracking functions in one radar along with the missile guidance function. The antennas, transmitters, receivers, tracking circuits, and guidance computers and transmitters utilize combinations of standard techniques. The radar system relies on manually aided automatic tracking in fulfilling most of its functions.

An SA-2 site consists of (i) a FAN SONG tracking and guidance radar, which

[]

[] (ii) six launchers arranged in a ring around the FAN SONG; (iii) one Guideline missile per launcher and provisions for 6 additional missiles in hold positions; (iv) missile transporters; (v) operational vans, including separate ones probably for power distribution, control, computer, and generators; (vi) an acquisition and identification section, usually SPOON REST A radar and IFF equipment of the SCORE BOARD A type with associated equipment; (vii) a Mercury Grass communications van; (viii) support equipment; and (ix) administrative and housing facilities.

The performance characteristics of the SA-2 system with the [] FAN SONG radar are believed to be as follows:

| | |
|--|---|
| [] | [] nautical miles |
| [] | [] nautical miles |
| Maximum missile guided flight time | 55 seconds |
| Missile flight distance (before self-destruct) | 22 nautical miles |
| Missile intercept capability: | |
| Minimum altitude | About 1,600 feet (possibly lower, depending upon terrain conditions and target velocity) |
| Maximum altitude | About 85,000 feet |
| Minimum range | 5 to 6 nautical miles |
| Maximum range | 17 nautical miles |

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Maximum target speed intercept capability

Mach 2 with a reduced capability above this velocity

Number of targets which can be engaged simultaneously

1 (group targets can be engaged when closely bunched)

Number of missiles which can be controlled simultaneously

Up to 3

The Soviet-stated probabilities of kill for 1, 2, and 3 missile firings against a single target are 70, 81, and 97 percent, respectively, within the estimated range and altitude limitations noted above.

pilot, and the receiver/transponder section. Additional unknown aspects of the

The specific performance characteristics attributed to the [redacted] FAN SONG SA-2 systems by the USSR are unknown but are estimated to be similar to or better than those of the [redacted] FAN SONG SA-2 system.

[redacted]
the twin parabolic dish reflectors that are mounted on top of the horizontal scanning antenna of the FAN SONG E, and the extent of [redacted] improvements over the [redacted] system. The most likely explanations of the purpose of the twin dishes on the advanced FAN SONG E are that they act as an electronic counter countermeasure (ECCM) modification or that they serve to enhance the detection capability of the radar against small targets. The former purpose is believed the more likely. However, these dishes may be for a completely different purpose.

[redacted]
missile intercept capability for the improved [redacted] SA-2 system probably has been increased to an estimated maximum range of about 27 nautical miles.

The Guideline missile in the SA-2 system uses a microwave radio fuze for detonation of the warhead after it is armed by the guidance link from the FAN SONG. A considerable amount of detail on the missile-associated electronics, however, still is not fully known.

Certain important characteristics of both the [redacted] systems are not known. These include (i) detailed sequences and times required for tracking and firing and (ii) some missile details relating to the radio fuze, the auto-

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In November 1963 a modified Guideline missile (Mark III) was identified at the SA-2 site at Glau, East Germany. The configuration of the missile and probably the propulsion parameters of its sus-

tainer engine had been modified, but the extent and purpose of these changes are unknown. Significant physical characteristics of the three known models of the Guideline missiles are as follows:

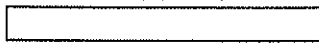
| | Mark I | Mark II | Mark III |
|------------------------------|--|---------|----------|
| Sustainer: | | | |
| Length (ft.) | 26.24 | 26.24 | 26.86 |
| Diameter (ft.) | 1.60 | 1.60 | 1.60 |
| Total weight (lb.) | 2,310 | 2,756 | Unknown |
| Burning time (sec.) | 42 | 48-50 | Unknown |
| Thrust (lb.) | 5,940 | 6,600 | Unknown |
| Booster: | | | |
| Length (ft.) | 8.57 | 8.57 | 8.57 |
| Diameter (ft.) | 2.12 | 2.12 | 2.12 |
| Total weight (lb.) | 2,266 | 2,266 | * |
| Thrust (lb.) | 59,400 to 110,000 depending on ambient air temperature of -40°C to +50°C | * | * |
| Duration of thrust (sec.) | 4.3 to 3.0 | . | . |

* Assumed to be the same as Mark I.

The SA-2 system has been upgraded frequently since its initial deployment in 1958. Technical improvements have been noted in each successive model of the three SA-2-associated Guideline missiles that have been detected since 1957. The five different versions and [redacted] of the FAN SONG radar also probably reflect improvements. Hence, the system

probably has been developed to meet a number of different operational situations in as simple a manner as possible and at the least possible cost. Further improvements expected in the system include (i) an increase in the missile booster thrust, (ii) a provision for launching the missile when the FAN SONG is [redacted] and (iii) the inclusion of an automatic facility

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to handle some of the tasks presently performed by human operators, particularly in the critical fire control area.

The SA-2 system has some serious limitations -- in particular, the inability to track more than one target or compact group of targets at the same time and the lack of good very low level coverage. For the earlier [] versions, a long time between detection and firing (up to 40 seconds) and a short "readiness" time (25 minutes) before recycling (which takes 10 to 15 minutes) were reported. These limitations for the [] version may have been reduced during the development of the newer [] systems.

The inability of the SA-2 system to track more than one target at a given time is due to design restrictions. Hence, to improve this particular characteristic, the complexity of the system

would have to be increased to a large degree.

The reported 40-second timelag for the [] system between detection and firing of a missile cannot be explained. The capability of the system could be handicapped severely if this 40-second period occurs at a critical time. It is probable that 40 seconds is an average figure rather than a minimum required time.

The 25-minute limit on the readiness state of the SA-2 system appears to be necessitated by overheating of missile components. A 10- to 15-minute recycling time is needed, apparently to allow the critical components to cool. If the problem of overheating is solved, the readiness time probably could be extended until some other factor, for example, gyro precession, becomes the []

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