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A STUDY PROPOSAL FOR SHORT-RANGE AIR-TO-SURFACE MISSILES

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W. F. Roherty, 5123

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ABSTRACT

Short-range boosting of our strategic gravity bombs is proposed as a means of decreasing the number of aircraft required to attack defended targets.

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A STUDY PROPOSAL FOR SHORT-RANGE AIR-TO-SURFACE MISSILES

Two types of weapons are under development today for high-altitude strategic bombardment: free-fall bombs such as the TX-27 and TX-28, and air-to-surface missiles such as the B-63 and B-58 pod. The horizontal range of weapons in the first category is approximately eight nautical miles, while the second type can achieve maximum ranges of 100 to 500 nautical miles. In addition to differing in horizontal range, weapons in the two categories have large time-scale differentials which result from the range and accuracy requirement imposed on the air-to-surface missiles. If the primary advantage of the air-to-surface missile is that it reduces aircraft attrition in the local defense area and thereby increases the probability of destroying the target, one is led to ask whether this same end might not be achieved with rocket-boosted bombs having both shorter ranges and time scales.

To answer this question it is necessary to know:

1. The probability of delivering a weapon on target with a given number of aircraft, as a function of weapon range, allowance being made for the unreliability introduced in the process of rocket boosting.
2. The inaccuracy of delivery as a function of range and the effect of this inaccuracy on the probability of destroying the target when a delivery is made.

In addition, all designs considered must be within the length, diameter, and weight limitations imposed by the delivery aircraft and within the range limitations of the bombing radar.

If the above information is available, then the over-all probability of destroying the target (the product of the foregoing probabilities) as a function of weapon range can be obtained and hence a decision can be made between free-fall and boosted bombs.*

An alternative method of approaching this decision would be to estimate the number of aircraft required to achieve a given over-all probability of destroying the target as a function of weapon range.

In the absence of the necessary data regarding Soviet missile defenses and delivery inaccuracy versus range to carry out the above procedures, some insight into the problem can be gained by considering our own defenses and estimating the comparative value of free-fall and boosted bombs against them. The attached graph gives the number of missiles launched, as a function of range from the defense ring, against a formation attack from one azimuth with negligible (taken to be zero) depth in range. This type of attack was chosen since it minimizes the time that the aircraft are in the interval between maximum defense missile range and the bomb release line (assumed to be at the defense ring) and hence minimizes the number of shots which the defense can fire. The defense considered -- two Nike B battalions on a circle of 20,000-

*Consistent with Project Lamp Light, it is assumed that a short-range, supersonic air-to-surface missile cannot be brought under attack.

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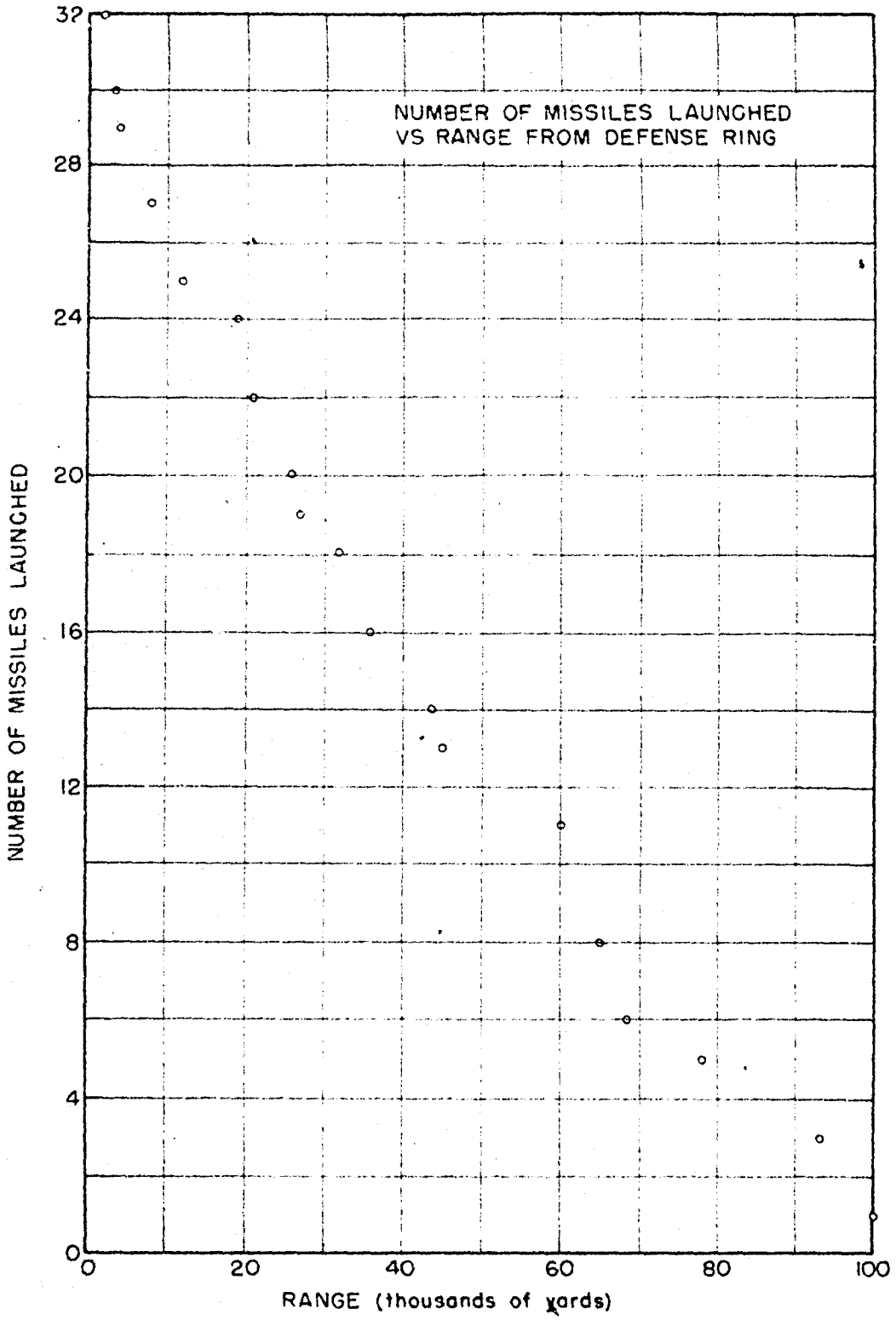

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yard radius -- approximates the planned defense of Milwaukee and Norfolk. A battery's first interception occurs at 100,000 yards, and the interval between intercept and succeeding launch is assumed to be 15 seconds. Aircraft altitude is 50,000 feet, and speed is 900 ft/sec. If the kill probability per shot is fixed, then the average number of aircraft lost in attempting to reach a given range is the product of the per-shot kill probability and the number of shots delivered between that range and maximum defense missile range (if the defense is assumed to be perfectly co-ordinated and no more than one kill per shot is possible). In the case chosen, an attack with gravity bombs would cost an average of 23 aircraft for the estimated Nike B (atomic) kill probability of 0.72.* Boosting the bomb range by 20,000 yards or 40,000 yards would reduce the average aircraft cost from 23 to 16 and 10, respectively. Suppose that to achieve the same level of damage as one gravity bomb, a number of weapons A is required at an increase of 20,000 yards in range, and B weapons are required at an increase of 40,000 yards (as a result of degradation in accuracy, reliability, and possibly yield). Then, while approximately 27 aircraft are required to achieve a 0.9 probability of one or more penetrations with a gravity bomb, 16 + A + C and 10 + B + D aircraft will be required at 20,000 and 40,000 yards, respectively. These numbers, A + C and B + D, must be less than (27 - 16) = 11 and (27 - 10) = 17 if fewer aircraft are to be committed to this target.

*Project Lamp Light, Vol III, NR-ORI-078, March 15, 1955

Consider, for example, that the only degradation due to increased weapon range is in CEP and that the CEP at a range r over gravity range is approximated by

$$\text{Gravity CEP}(1 + r/K);$$

i.e., the CEP is twice the gravity CEP at an increase of K yards, three times the gravity CEP at an increase of 2K yards, etc.. Then, to achieve not less than a 0.9 probability of destroying a point target (chosen for sensitivity to CEP) requires that the following number of weapons be delivered as a function of added range:

Added Range/K	No. of Weapons Required
0	1
0-0.42	2
0.42-0.73	3
0.73-1.00	4
1.00-1.25	5
1.25-1.45	6
1.45-1.63	7
1.63-1.83	8
1.83-2.08	9

The following table gives the number of aircraft (one weapon per aircraft) which must attack a target, defended as in the attached graph, to achieve not less than a 0.9 probability that the required number reach the bomb-release line at range r for K = 40,000 yards. Also given is the expected number of aircraft lost during penetration.

Range, r (yards)	No. of Aircraft Required	Expected No. of Aircraft Lost Inbound
0	27	23
16,800	22	17
29,200	18	13
40,000	16	10
50,000	15	8
58,000	16	8
65,200	13	4
73,200	13	4
82,300	12	2

For the defense, target, and CEP versus range assumed here, fewer aircraft are needed if the CEP is not doubled in less than an additional 10,000 yards; i.e., K must be greater than approximately 10,000 yards.

The trends of the above example imply that considerably fewer aircraft are required with only a slight range-boosting of our gravity weapons. For this reason, Department 5140 has been requested to make an informal estimate of the characteristics of boosted TX-27 and TX-28 weapons. Of course, when data on attrition and CEP versus range, yield, reliability, targets, etc., are known, the preferred characteristics of boosted bombs can be obtained both for high-altitude and low-altitude tactical and strategic bombing.

W. F. Roherty, 5123

November 15, 1956