ESTIMATED CEP OF WEAPON DELIVERY
FOR ATTACKS AGAINST AIRCRAFT SHELTERS

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May 15, 1970

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Classification changed to: Unclassified
Authority: E05

By:     Date: L-20-77
Operating Entity: The Rand Corporation
ABSTRACT

For use in the Air Base Attack Study report, the document presents estimates of delivery CEP's for various air-to-ground weapons released from F-4D/E, F-111A, and A-7D aircraft using tactics most appropriate to the weapon/aircraft combination. The probability of target acquisition is not covered in this document.
Colonel J. L. Sibley is putting together a set of tables/charts summarizing the work of the Air Base Attack study group on attacks against aircraft shelters. This input paper makes estimates of the delivery accuracy attainable in combat of three Air Force tactical strike aircraft—the F-4D/E, the F-111A, and the A-7D.

Other inputs closely pertinent to the attack phase are the following:

- Aircraft ordnance loads: C. B. East, et al
- Target acquisition and identification: H. H. Bailey
- Target hit probabilities: R. N. Snow
- Attack tactics: J. L. Sibley

The following types of ordnance are considered in the study; they are grouped by ordnance-type/delivery-tactic:

1. Unguided/unretarded/unpowered (bombs)
   - (45° dive/6500' release altitude/450 knots)
     - M-117 750# bomb
     - MK-81 250# bomb
     - MK-82 500# bomb
     - MK-83 1000# bomb
     - MK-84 2000# bomb
     - Hi density blunt bomb
     - FAE (fuel-air expl.) bomb

2. Unguided/retarded/unpowered (bombs)
   - (level/500' release altitude/450 knots)
     - M-117R 750# bomb
     - MK-82 Snakeye Bomb

3. Homing/unretarded/unpowered ("launch and leave")
   - (delivery = drop bomb into wide "basket")
     - WALLEYE I ......... EO homer
     - WALLEYE II ......... EO homer
     - MK-82 (EO) ......... EO homer
     - MK-84 (EO) ......... EO homer
     - MK-82 (EOAC) ....... EO homer - area correlator
     - MK-84 (EOAC) ....... EO homer - area correlator
     - MK-82 (IR) ......... IR homer
     - MK-84 (IR) ......... IR homer
     - MAVERICK ............ EO homer
     - BULLDOG ............ IR homer (?)
     - HSM ................. EO homer
4. **Homing/unretarded/unpowered** ("launch and stay")
   (delivery = drop bomb into wide "basket", hold laser spot on target)
   MK-82 (LASER)........... Laser-spot homer (PAVEKNIFE)
   MK-84 (LASER)........... Laser-spot homer (PAVEKNIFE)
   BULLDOG ................. Laser-spot homer (PAVEKNIFE)?

5. **Guided/unretarded/powered** ("launch and stay")
   (delivery = visibly guide weapon by remote steering)
   AGM-12B (BULLPUP A)
   AGM-12C (BULLPUP B)

6. **Guided-homing/unretarded/powered** ("launch remotely")
   (delivery = launch remotely, through TV steer to target area and set point on which weapon homes to target)
   AGM-53A (CONDOR)

7. **Homing/unretarded/powered** ("launch remotely, and leave")
   (delivery = launch remotely, weapon uses area correlator to get to target area and home on target)
   AGM-X

8. **Unguided/retarded/unpowered** (area bomblets)
   (delivery = level/300' release altitude/450 knots)
   BLU-67 type, medium size
   BLU-67 type, heavy size
   FAE bomblet

9. **Unguided/retarded/powered** (vertical-powered rockets)
   (delivery = level/500' release altitude/450 knots; after reaching near-vertical, rockets drive weapons downward)
   Reb-Lek .................. single 1300# weapon
   ZUNI .................... cluster of 7 ZUNI's

10. **Unguided/unretarded/unpowered** (area bomblets)
    (delivery = 45° dive/6500' release altitude/450 knots), also
    (delivery = level/15,000' release altitude/450 knots)
    REBIT ..................... 2.7# hardened bomblets

11. **Unguided/unretarded/powered** (rockets)
    (delivery = 45° dive/6500' release altitude/450 knots)
    ZUNI ..................... 5" dia., 4 each in LAU-10 pod
CEP's FOR THE VARIOUS WEAPONS WITH STATED RELEASE CONDITIONS

The numbers given here include the aiming error and the ballistic dispersion error. In those cases where more than one weapon is released in train, the CEP values refer to the center of the stick. For those cases involving bomblets, the CEP values refer to the center of the blanket of ordnance. The release altitude specified refers to the release of the middle piece of ordnance in the stick or blanket. For some case, delivery CEP has no pertinence or meaning; the controlling factor is stated in each such case. In all cases, it is assumed that the specific aiming point has been identified early enough.

Case 1 The dive-toss delivery mode can be used by each of the three aircraft and is assumed here. Fifteen mls CEP is assumed for the F-111A and A-7D, and 20 mls for the F-4D/E. Release slant range is 9000 ft.

F-111A and A-7D ...... CEP 135' ... REP 90' ... DEP 68'
F-4D/E ............... CEP 180' ... REP 120' ... DEP 90'
(An REP/DEP ratio of 4:3 is assumed)

Case 2 All three aircraft normally range to the target by radar which unfortunately is not usable in low fast approaches. It is assumed that the depressed reticle in the heads-up display must be used. The values used are based on RM-4470-PR, pages 31-35.

All three aircraft .. CEP 320' ... REP 300' ... DEP 40'
(A combat degradation factor of 1.5 was used)

Case 3 Since these weapons home on the target, delivery (launch) CEP has to be only good enough to hit a fairly large "basket"; it is assumed that all three aircraft can do this 100% of the time (if the aiming point has been identified early enough). The homing accuracy of the missile is extremely good, to the point that a CEP value by itself is not enough. SEA data on the WALLEYE I indicates that something like three-quarters of the missiles dropped made direct hits on the target. It is assumed here that of the WALLEYE I missiles dropped, 75% hit the target, 15% missed because of inadequate target lock-on or loss of lock,
and 10% missed because of unreliability. Thus, 84% (75/90) of the functioning missiles hit the target. It is assumed here that the average target size was 40' x 40' for the WALLEYE I targets. The predicted data for all the homing weapons then is taken as:

All 11 weapons .... CEP 14' .... REP 8' .... DEP 8'
(All three aircraft)

Case 4 SEA data is available for the M-117 laser-homing bomb. It has roughly the same hit/miss ratio as did the WALLEYE I; therefore, the CEP for laser-homing bombs will be taken as the same as for WALLEYE I. (The controlling error for laser-homing weapons is the accuracy with which the laser beam spot can be kept on the desired impact point).

All 3 weapons ..... CEP 14' .... REP 8' .... DEP 8'
(All three aircraft)

Case 5 SEA data is available for the BULLPUP weapons.

Both weapons ..... CEP 80' .... REP 65' .... DEP 32'
(All three aircraft)

(An REP/DEP ratio of 2:1 is assumed)

Case 6 Since this weapon (CONDOR) is steered all the way to the target area by the remote operator, and since the remote operator can either manually steer the missile all the way into the target, or reset the lock point, the missile should be even more accurate than the missiles in cases 3 and 4. It is assumed here that the 15% of the Case 3 and 4 missiles that had lock problems is reduced, for the CONDOR to 5%. This results in the following accuracy values:

CONDOR ............ CEP 10' .... REP 6' .... DEP 8'
(All three aircraft)
Case 7 Since this weapon (AGM-X) does optical map-matching all the way from its remote launch point to the target, the missile's CEP on the target will depend on the adequacy of the prior photo-reconnaissance match plate that is used. Probably, the missile will be tracking the ground area near the launch point prior to being launched, so the "target recognition" problem will not be serious. Since the final controlling of the missile will be by a process similar to that of the area-correlator weapons in Case 3, this weapon will be given the same terminal delivery capability.

AGM-X ................ CEP 14' .... REP 8' .... DEP 8' 
(All three aircraft)

Case 8 For these area bomblets, data is again taken from RM-4470-PR.

All three weapons .... CEP 300' .... REP 270' .... DEP 70' 
(All three aircraft)

Case 9 This writer has no rationale for estimating a CEP on this weapon which suffer great drag retardation immediately after release, and upon reaching near-vertical attitude, are given great thrust downward by rockets. While the release range is extremely short, the last target sighting by the pilot is at about the same range from target as for Case 2. The same magnitude of errors should apply.

Both weapons ....... CEP 320' .... REP 300' .... DEP 40' 
(All three aircraft)

Case 10 This weapon (REBIT) is dropped as a clean pod; at a present burst altitude, the bomblets spray out to cover a ground area. It is assumed here, for the dive bomb release, that the CG of the pattern suffers no variation from that which would be obtained if the pod went all the way to the ground. It is therefore assumed that the CEP is the same as for the weapons in Case 1.

F-111A and A-7D ...... CEP 135' .... REP 90' .... DEP 68' 
F-4D/E ................ CEP 180' .... REP 120' .... DEP 90' 
(An REP/DEP ratio of 4:3 is assumed)
For the proposed delivery mode of level at 15,000' release altitude at 450 knots, none of the three aircraft can accomplish this mode because of an inability to see or track the target under these conditions.

**Case 11** This weapon (ZUNI) is an unguided 5" rocket. Data from Krase's D-19434-PR gives the following values of accuracy:

All three aircraft .. CEP 210' .. REP 140' .. DEP 105'

(U) Krase's D-19434-PR indicates that some ordnance items used here are not currently compatible with one or more of the three aircraft examined. This was not considered a valid point for not considering all the aircraft/weapon combinations, since attaining such compatibility is not a big problem if the effectiveness of a combination looks promising.

(µ) (8) It should be pointed out that the F-111A is used here in a day dive-bomb and day low altitude attack role, in which it is no better or worse than the F-4D/E and the A-2D. Where the F-111A is unique is in its capability to attack at night and in weather at low altitude. In this case, the CEP is estimated (based on SEA results) to be the same as for a Case 2 daylight attack.

F-111 ............... CEP 320' .. REP 180' .. DEP 180'
(M117R and Mk-82 SE)