

Appendix F

Risk-Estimate Distances

Risk-estimate distances allow commanders to estimate the risk in terms of percent of friendly casualties that may result from an air attack against the enemy. Risk-estimate distances are based on fragmentation patterns. *Risk-estimate distances are for combat use and are not minimum safe distances for peacetime training.* See the FMFM 5-2 series of *Joint Munitions Effectiveness Manuals (JMEMs)* and appropriate Service or command guidance for peacetime restrictions.

Computations

All attacks are parallel to the FLOT. Distances are computed from the intended impact point of the center of a stick of bombs or a pod of rockets. Deflection distance (from the aiming point toward friendly troops) is built into the risk-estimate distance. The deflection distance equals the distance from the aircraft centerline to the farthest outboard station plus the lateral distance that a weapon travels because of rack-ejection velocity.

Relationships Between Weapon Impact and Point of Intersection

For all determinations in table F-1 (p. F-4), the position of a prone man was assumed to be on a line perpendicular to the line of flight (or line of weapon impacts) at the midpoint of the line (stick) of weapons. For all sticks of weapons, a weapon was assumed to impact at the point of intersection of these two lines. Thus, for the

weapons evaluated, the following relationships between weapon impact and the point of intersection were assumed:

- **GP bombs.** The center bomb of the stick impacts at the point of the intersection.
- **Rockets.** The center rocket impacts at the point of intersection for an odd number of rockets (e.g., four of seven). The midpoint between the impacts of the center two rockets for an even number of rockets (e.g., rockets two and three of four) is at the point of intersection.
- **Cluster weapons.** The center of the pattern created by the middle CBU is located at the point of intersection.
- **Flas**middle round of a single strafe impacts at the point of intersection.
- **Maverick.** Single-weapon delivery impacting at point of intersection.

Weapon Reliability and Delivery Parameters

A weapon reliability of 1.0 was used for all weapons evaluated and shown in table F-1. Delivery parameters and considerations for specific weapons are in MCRP 5-6.3.7, *Risk Estimates for Friendly Troops (C)*.

Casualty Criterion

The casualty criterion is the 5-minute assault criterion for a prone soldier in winter clothing and helmet. Physical incapacitation means

that a soldier is physically unable to function in an assault within a 5-minute period after an attack. A probability of incapacitation (PI) value of less than 0.1% can be interpreted as being less than or equal to one chance in one thousand.

Warning: Risk-estimate distances do not represent the maximum fragmentation envelopes of the weapons listed.

Troops in Contact

Unless the ground commander determines otherwise, the terminal controller should regard friendlies within 1 kilometer of targets as a “troops in contact” situation and should advise the ground commander accordingly. However, friendlies outside of 1 kilometer may still be subject to weapon effects. Terminal controllers and aircrews must carefully weigh the choice of ordnance and delivery profile in relation to the risk of fratricide. The ground commander must accept responsibility for the risk to friendly forces when targets are inside the 0.1% PI distance. When ground commanders pass their initials to terminal controllers, they accept the risk inherent in ordnance delivery inside the 0.1% PI distance. Ordnance delivery inside 0.1% PI distances will be considered as “danger close.”

<p>Warning: Risk-estimate distances are for <i>combat use</i> and are not minimum safe distances for peacetime training. See JMEMS and appropriate Service</p>

or command guidance for peacetime restrictions.

Item	Description	Risk-Estimate Distance (meters)	
		10% PI	0.1% PI
Mk-82 LD	500-lb bomb	250	425
Mk-82 HD	500-lb bomb (retarded)	100	375
Mk-82 LGB	500-lb bomb (guided bomb unit (GBU)-12)	250 ¹	425 ¹
Mk-83 HD	1,000-lb bomb	275	475
Mk-83 LD	1,000-lb bomb	275	475
Mk-83 LGB	1,000-lb bomb (GBU-16)	275 ¹	475 ¹
Mk-84 HD/LD	2,000-lb bomb	325	500
Mk-84 LGB	2,000-lb bomb (GBU- 10/24)	225 ¹	500 ¹
Mk-20 ²	Rockeye	150	225
Mk-77	500 lb napalm	100	150
CBU-55/77 ²	Fuel-air explosive (FAE)	___ ¹	___ ¹
CBU-58/71 ^{2,3}	CBU (all types)	350	525
CBU-87 ²	CBU (all types)	175	275
CBU-89/78 ³	CBU (all types)	175	275
2.75" folding-fin aircraft rocket (FFAR)	Rocket with various war-heads	160	200
5" ZUNI	Rocket with various war-heads	150	200
SUU-11	7.62-mm minigun	___ ¹	___ ¹
GAU-12	25-mm gun	100	150

Figure F-1. Risk-Estimate Distance.

or command guidance for peacetime restrictions.

Item	Description	Risk-Estimate Distance (meters)	
		10% PI	0.1% PI
M-4, M-12, SUU-23, M-61	20-mm Gatling gun	100	150
GPU-5A, GAU-8	30-mm Gatling gun	100	150
AGM-65 ⁵	Maverick (TV-, IIR-, laser-guided)	25	100
Mk-1/Mk-21	Walleye II (1,000-lb TV-guided bomb)	275	500
Mk-5/Mk-23	Walleye II (2,400-lb TV-guided bomb)	___ ¹	___ ¹
AC-130	105-mm cannon	80 ⁴	200 ⁴
	40-/25-/20-mm gun	35	125

¹Risk-estimate distances are to be determined. For LGBs, the values shown are for weapons that do not guide and that follow a ballistic trajectory similar to general-purpose bombs. This does not apply to GBU-24 bombs, because GBU-24s do not follow a ballistic trajectory.

²Not recommended for use near troops in contact.

³CBU-71/CBU-84 bombs contain time-delay fuzes that detonate at random times after impact. CBU-89 bombs are antitank and antipersonnel mines and are not recommended for use near troops in contact.

⁴AC-130 estimates are based on worst-case scenarios. The 105-mm round described is the M-1 high-explosive (HE) round with the M-732 proximity fuze. Other fuzing would result in smaller distances. These figures are accurate throughout the firing orbit. The use of no-fire headings has no benefits for reducing risk-estimate distances and should not be used in contingency situations.

⁵The data listed applies only to AGM-65 A, B, C, and D models. AGM-65 E and G models contain a larger warhead, and risk-estimate distances are not currently available.

Figure F-1. Risk-Estimate Distance (continued).