APPENDIX B

HIGH ALTITUDE RELEASE POINT CALCULATION

The effects of variable wind directions and speed must be accounted for when determining the high altitude release point (HARP) for each MFF mission. Accurate wind data is essential to calculate the HARP precisely. Commanders are cautioned against planning pinpoint landings on targets when wind data is questionable due to the source, timeliness of repoting, or other dynamic meteorological conditions (for example, thunderstorms or changing fronts). Wind will affect the parachutist during free-fall and canopy performance after deployment.

Obtaining Wind Data

A variety of sources such as military airfields, civilian airports or weather services, artillery meteorological sections, or pilot teams in the operational areas can provide wind data. Aircrew personnel can also determine wind data during flight as the aircraft passes through different flight levels. (It is not advisable to use this technique for actual infiltrations, as the data obtained en route to the objective area may not reflect conditions at the objective area.)

Recording Wind Data

The jumpmaster records the reported wind data according to altitude in feet, direction in degrees, and speed (velocity) in knots. He records the wind data for every 2,000 feet of altitude during free-fall and every 1,000 feet of altitude under canopy.

Calculating and Plotting the HARP

The jumpmaster calculates and plots the HARPs location in reverse sequence for a HALO mission (Figure B-1). First, he calculates the distance and direction from the desired impact point (DIP) to the parachute opening point. Second, he calculates the distance and direction from the parachute opening point to the preliminary release point. Third, he calculates the distance and direction from the preliminary release point (to compensate for forward throw) to the HARP.

Calculation of the HARP during HAHO operations may or may not require calculation of free-fall drift, depending upon the length of free-fall required. For HAHO missions requiring less than 2,000 feet of free-fall, the jumpmaster disregards free-fall drift.

When plotting the HARP on a map, the jumpmaster converts the wind direction from True North to a grid azimuth using the declination diagram.

Using the Wind Drift Formula and Constants

The jumpmaster uses the wind drift formula D= KAV.

D = distance in meters.

K = constant (drift in meters per 1,000-foot loss of altitude in a l-knot wind).

A = altitude in thousands of feet.

V = average wind speed (velocity).

The jumpmaster also uses the following wind drift constants (K factors):

K = 3 (parachutist in free-fall).

K =25 (MC-3 parachute system and RAPS **[HALO]).**

K = 48 (RAPS [HAHO]).

NOTE: The jumpmaster calculating the HAHO wind drift uses the constant of the least performing canopy; for example, the U.S. Navy MT1-X-S uses the S-type reserve that has a K factor of 60. Therefore, if a parachutist has to activate his reserve parachute, he will still be able to glide to the DZ.

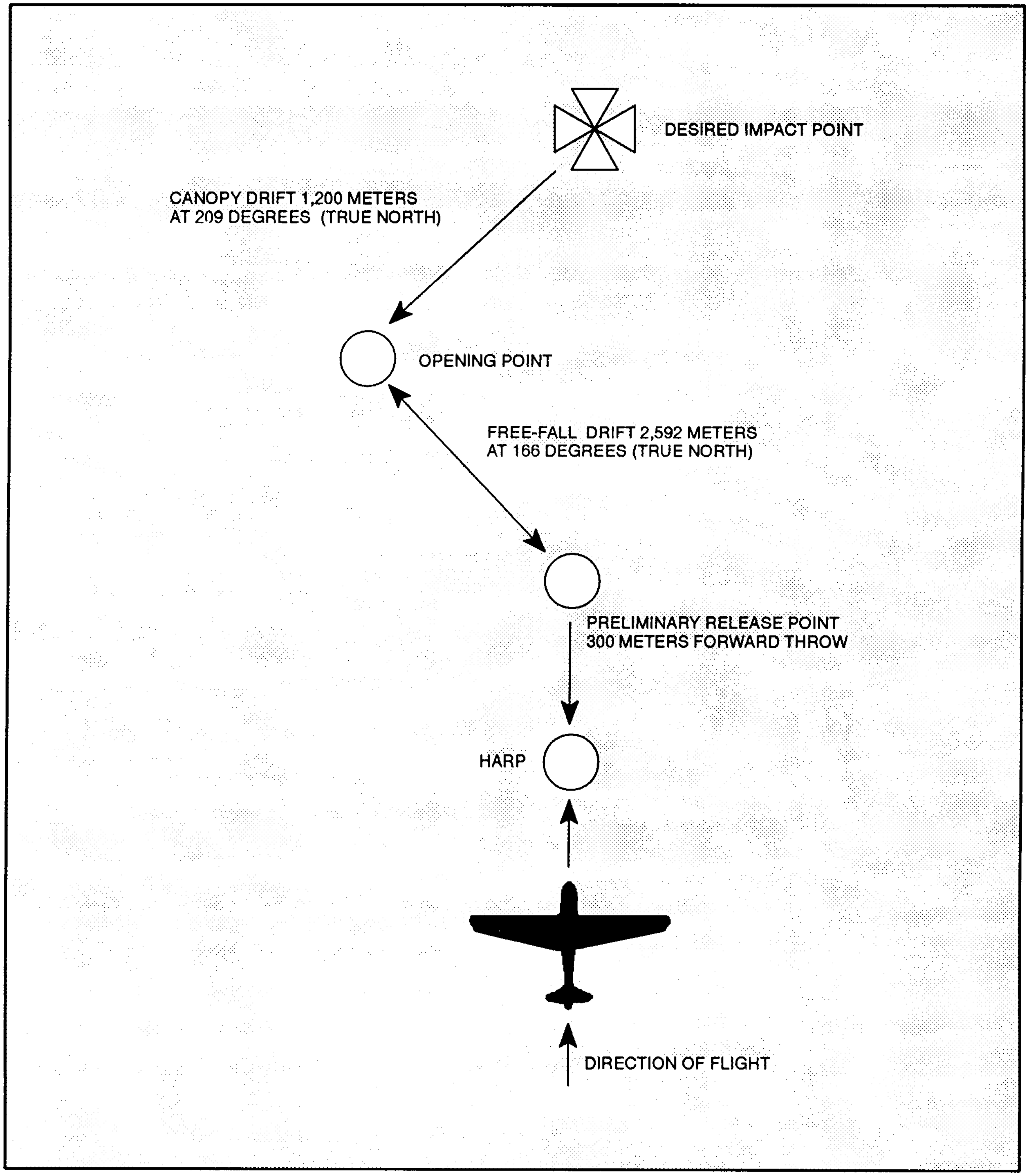

Figure B-1. Calculating and plotting the HARP for a HALO mission.

Calculating HALO Free-Fall Drift and Direction

To determine the parachutist's drift in free-fall, the jumpmaster calculates the average wind speed (velocity) and average wind direction from the exit to the opening altitude. Opening altitude (4,000 feet in this example) is not in-eluded since that is where the free-fall stops. The wind data from 4,000 feet to 1,000 feet is calculated using the canopy drift constant.

EXAMPLE: Altitude Velocity Direction

Altitude	Velocity	Direction
20,000	85	160
18,000	75	160
16,000	75	165
14,000	65	165
12,000	50	155
10,000	45	150
8,000	20	185
6,000	20	190
	435 knots	1330 degrees

The jumpmaster determines the averages by-

1. Determining the total free-fall distance from the exit (20,000) to the opening (4,000). A = 20,000-4,000 = 16,000, or A = 16.
2. Dividing the sum of the wind velocities (435) by the number of velocities (8). V = 435+8= 54.375, or V = 54 (rounded to nearest whole number) knots average wind speed (velocity).
3. Dividing the sum of the wind directions (1330) by the number of directions (8). Direction = 1330 ÷ 8 = 166.25, or Direction = 166 degrees (round to nearest whole number) average wind direction.
4. Substituting the numerical values for the letters of the D = KAV formula.

   D = (3) (16) (54)

   D = 2,592 meters at 166 degrees (True North).

NOTE If using wind directions from 315 degrees to *045* degrees to calculate the average wind direction, erroneous averages may result. To compensate, the jumpmaster adds 360 degrees to directions of 001 to 045 degrees.

EXAMPLE: Direction Direction

Direction	Direction
345	345
350	350
345	345
010	010(+360) = 370
015	015(+360) = 370
350	*350*
1415 degrees	2135 degrees

Direction = 1415+6=235.83 or D = 236 degrees (incorrect)

Direction = 2135+6= 355.83 or D =356 degrees (correct)

Calculating Canopy Drift

To determine the parachutist's drift under canopy, the jumprnaster calculates the average wind speed (velocity) and direction from 1,000 feet to the opening altitude.

EXAMPLE: Altitude Velocity Direction

Altitude	Velocity	Direction
4,000	15	190
3,000	14	220
2,000	11	205
1,000	9	220
	49	835

(Disregard Surface Winds)

The jumpmaster determines the averages by—

1. Dividing the sum of the velocities (49) by the number of velocities (4). V = 49 ÷ 4 = 12.25, or V = 12 (rounded to nearest whole number) average wind speed (velocity).
2. Dividing the sum of the wind directions (835) by the number of direction (4). Direction = 835 ÷ 4 = 208.75 degrees, or 209 degrees (rounded to the nearest whole number) average wind direction.
3. Substituting the numerical values for the letters of the D = KAV formula.

   D = (25) (4) (12)

   D = 1,200 meters at 209 degrees (True North).

Calculating Forward Throw

Compensation must be made for the distance a parachutist's body initially travels into the direction of flight due to forward speed (velocity). The average forward throw, at normal high-performance aircraft exit speeds, is 300 meters.

Calculating Doglegs

Wind direction changes of 90 degrees or more are known as doglegs. Doglegs require separate calculations from the altitude where the wind direction changes.

Calculating the HAHO HARP

To calculate the HAHO HARP, the jumpmaster uses the modified D = KAV formula, as the intention is to maximize the linear distance traveled using the RAPS' gliding capability.

The jumpmaster uses the following HAHO gliding distance-formula:

$$D = \frac{(A - SF)(V + 20.8)}{K}$$

D = gliding distance in nautical miles (nm).

A = altitude in thousands of feet.

SF= safety factor in thousands of feet.

V = average wind speed (velocity) in knots.

20.8 = canopy speed constant.

K = 48 (canopy drift constant).

The jumpmaster calculates the safety factor. It provides a buffer area after exit to permit the parachutists to assemble under canopy and to establish the landing pattern over the DZ. For example, the element commander desires 1,000 feet for canopy assembly after exit and 2,000 feet to establish the landing pattern. The safety factor is 3,000 feet. Therefore, SF= 3.

The jumpmaster calculates the total gliding distance in nautical miles. To convert nautical miles to kilometers (km), multiply by 1.85.

When an element exits the aircraft in stick formation, the jumpmaster compensates for dispersion between the parachutists. He obtains this figure by dividing the total number of parachutists by 2 and then multiplying the result obtained by 50 meters. He plots the calculated distance back into the aircraft's line of flight. This procedure places the middle of the stick on the desired opening point.

The jumpmaster plots 300 meters back into the aircraft's line of flight to compensate for forward throw.

The following are examples of HAHO HARP calculations:

Calculating the HAHO HARP

EXAMPLE 1: HAHO HARP CALCULATION.

Situation. The exit altitude is 14,000 feet. Twelve parachutists exit the aircraft in stick formation. The element commander desires 1,000 feet for canopy assembly and a 1,000-foot arrival altitude over the DZ. Wind speed and direction at altitude are—

Altitude	Velocity	Direction
14,000	25	090
12,000	22	*080*
10,000	21	*090*
9,000	21	*090*
8,000	20	*085*
7,000	18	*080*
6,000	18	*080*
5,000	17	*085*
4,000	16	080
3,000	12	075
2,000	12	080
1,000	08	080
	210 knots	995 degrees

Jumpmaster Calculations.

The jumpmaste—

1. Determines the average wind speed. V = 210 ÷ 12 = 17.50, or V = 18 (rounded to nearest whole number) average wind speed.
2. Determines the average wind direction, D = 995 ÷ 12 = 82.91, or D = 83 (rounded to nearest whole number) degrees (True North) average wind direction.
3. Determines the safety factor is 2 (minimum).
4. Substitutes the numerical values for the letters of the formula.

   D = {12 -2) (20.8+ 18)+ 48,

   D = (10) (38.8÷ 48.

   D = 388.0 ÷ 48.

   D = 8.0 nm at 83 degrees (True North).
5. Determines the gliding distance. 8.0 nm X 1.85 = 14.80 km.
6. Determines dispersion = (12 ÷2)X 50 = 300 meters.
7. Determines forward throw. 300 meters.
8. Converts the average wind direction to a grid azimuth and plots it on the map to determine the opening point.
9. Plots the dispersion factor to determine the preliminary release point and compensates for forward throw to determine the HARP.
10. Determines the grid azimuth from the opening point to the DIP. Converts the grid azimuth to a magnetic azimuth. The magnetic azimuth is the compass heading followed to the DZ.

Calculating the HAHO HARP

EXAMPLE 2: HAHO HARP CALCULATION WITH A DOGLEG.

Situation. The exit altitude is 15,000 feet, Twelve parachutists exit the aircraft in stick formation. The element commander desires 1,000 feet for canopy assembly and a 2,000-foot arrival altitude over the DZ. A change of wind direction creates a dogleg at 9,000 feet AGL. Wind speed and direction at altitude are-

Altitude	Velocity	Direction
14,000	33	210
12,000	30	210
10,000	29	180
	92 knots	600 degrees
9,000	26	075
8,000	24	080
7,000	22	085
6,000	20	090
5,000	18	090
4,000	14	085
3,000	12	090
2,000	10	085
1,000	8	080
	154 knots	760 degrees

Jumpmaster Calculation (Below the Dogleg from 9,000 to 1,000 feet).

The jumpmaster calculates the gliding distance and direction from the DIP to the dogleg at 9,000 feet. He—

1. Determines that the average wind speed (velocity) from 1,000 feet to 9,000 feet is 17.11 or V = 17 (rounded to the nearest whole number) knots average wind speed.
2. Determines that the average wind direction from 1,000 feet to 9,000 feet is 84.44 or 84 (rounded to the nearest whole number) degrees (True North).
3. Determines that the safety factor is 3. He must remember that in a formula for a HAHO dogleg, the safety factor is 2 on the base leg and 1 on the dogleg to equal a total safety factor of 3.
4. Establishes that altitude = 9,000 feet or A=9.
5. Substitutes the numerical value for the letters of the formula.

   D =(9 -2) (20,8 + 17)÷ 48.

   D = (7) (37.8)÷ 48.

   D=264.6÷ 48=5.5 nm Xl.85=10.lkm gliding distance at 84 degrees (True North).

Calculating the HAHO HARP

Jumpmaster Calculation (Above the Dogleg from 10,000 to 14,000 feet).

The jumpmaster calculates the gliding distance and direction from 10,000 feet to the exit altitude. He—

1. Determines that the average wind speed (velocity) from 10,000 feet to 15,000 feet is 30.66 or 31 (rounded to the nearest whole number) knots.
2. Determines that the average wind direction from 10,000 feet to 15,000 feet is 200 degrees (True North).
3. Determines that the safety factor is 1.
4. Establishes that altitude = 5,000 feet or A=5.
5. Substitutes the numerical vaIue for the letters of the formula.

   D =(5 -1) (20.8+ 31) ÷ 48.

   D = (4) (51.8) ÷ 48.

   D = 207.2 ÷ 48 = 4.3 nm X 1.85 = 7,9 km gliding distance at 200 degrees (True North).

The jumpmaster converts the True North azimuths to grid azimuths. Plots the glide path from the DIP to the dogleg. Plots the glide path from the dogleg to the opening point Calculates the dispersion for 12 parachutists (300 meters). Plots the preliminary release point from the opening point. Compensates for forward throw and plots the HARP,

The jumpmaster determines the grid azimuth from the opening point to the DIP. Converts the grid azimuth to a magnetic azimuth. The magnetic azimuth is the compass heading followed to the DZ. By holding a single compass heading, the parachutist will maintain direction and follow a ctig path from the opening point to the DZ, rather than a path with distinct turns.

NOTE: The safety factor above the dogleg and below the dogleg when combined, mathematically incorporates the desired effect over the complete group.