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Airtanker Drop Guides

United States Department of Agriculture
Forest Service
Technology & Development Program

Ground Pattern Performance of the Siller Brothers S-64 Helicopter With the 2,000-Gallon SEI Industries Bambi Helibucket

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The Wildland Fire Chemical Systems (WFCS) Program tests a variety of fixed- and rotary-wing airtankers to determine the parameters for optimal ground-pattern coverage over a wide range of fuel and fire conditions. The Sikorsky S-64 Skycrane (military version is the Tarhe CH-54), owned and operated by Siller Brothers, Inc., is one of a family of helicopters designed for fire suppression and is designated as a Type 1 helicopter (figure 1). It was tested using the 2,000-gallon SEI Industries Bambi helibucket (referred to as the Siller Brothers S-64 with 2,000-gallon Bambi helibucket).

The Bambi helibucket is constructed of a heavy, coated fabric mounted to a collapsible frame. The dump valve is electrically actuated from the helicopter using 28 volts dc aircraft power. The helibucket's maximum volume is 2,000 gallons. The volume of a given drop is controlled by the rate at which the helibucket is lifted from the water (faster lift produces more volume) or by adjusting a cinch strap inside the helibucket.

The Missoula Technology and Development Center tested the Siller Brothers S-64 with 2,000-gallon Bambi helibucket with a series of drops over an array of plastic bowls much like Cool Whip containers. The quantity of material in each bowl was measured and the data were used to determine the drop pattern.

Tests included airspeeds from 35 to 82 knots (40 to 94 miles per hour) and drop heights from 32 to 100 feet from the bottom of the tank to the ground. The drops were made with three different materials: water, foam, and gum-thickened retardant.

Figure 1—The Siller Brothers S-64 with 2,000-gallon Bambi helibucket.

Flow rate, drop height, and airspeed all affect the drop pattern. Because this type of helicopter is normally used over a narrow range of heights and speeds and because this system produces a single flow rate, information about an average drop is presented. Figures 2, 3, and 4 show the effect of increasing airspeeds from 49 to 80 knots (56 to 92 miles per hour) with drop heights ranging from 38 to 74 feet while using gum-thickened retardant.

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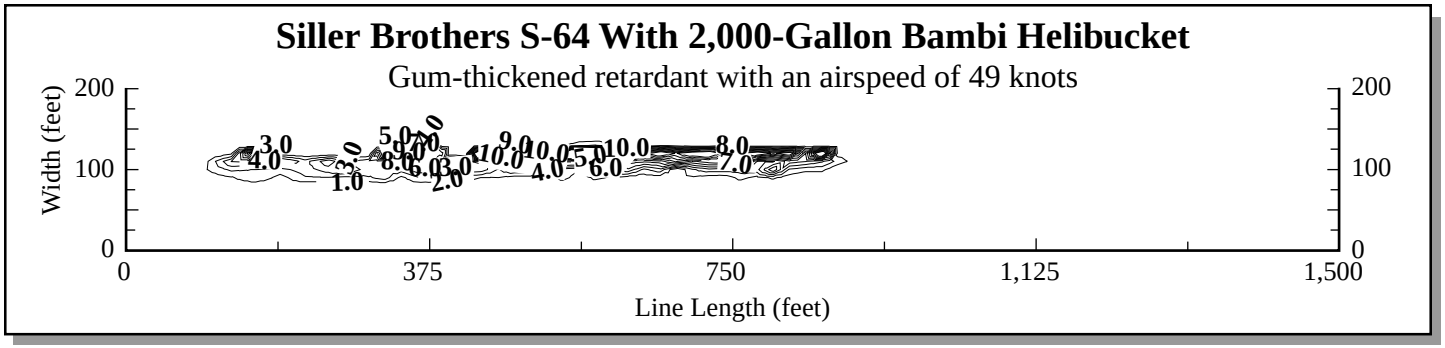

Figure 2—Drop pattern characteristics for the Siller Brothers S-64 with 2,000-gallon Bambi helibucket using gum-thickened retardant at an airspeed of 49 knots (56 miles per hour) and a drop height of 52 feet. The contour lines are at coverage levels of 0.5, 1, 2, 3, 4, 6, 8, and 10 gallons per 100 square feet.

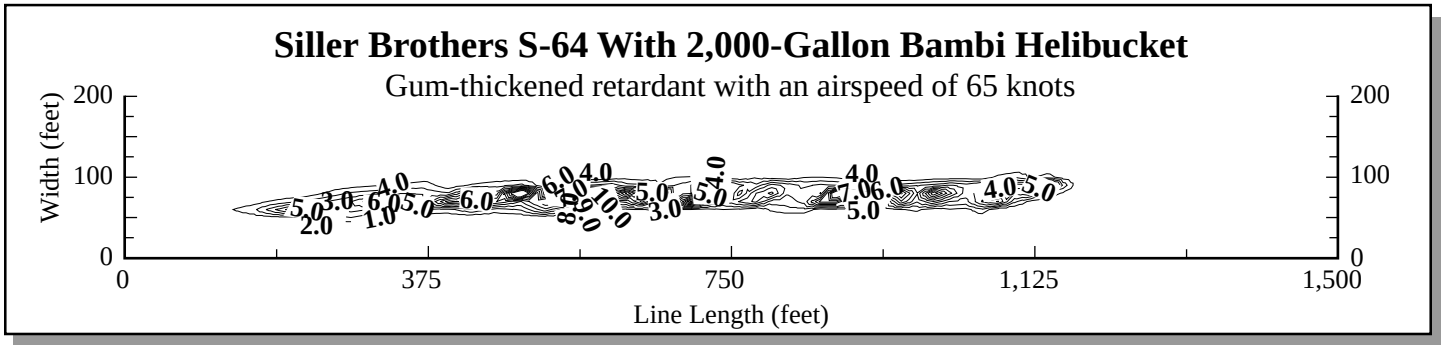

Figure 3—Drop pattern characteristics for the Siller Brothers S-64 with 2,000-gallon Bambi helibucket using gum-thickened retardant at an airspeed of 65 knots (75 miles per hour) and a drop height of 38 feet. The contour lines are at coverage levels of 0.5, 1, 2, 3, 4, 6, 8, and 10 gallons per 100 square feet.

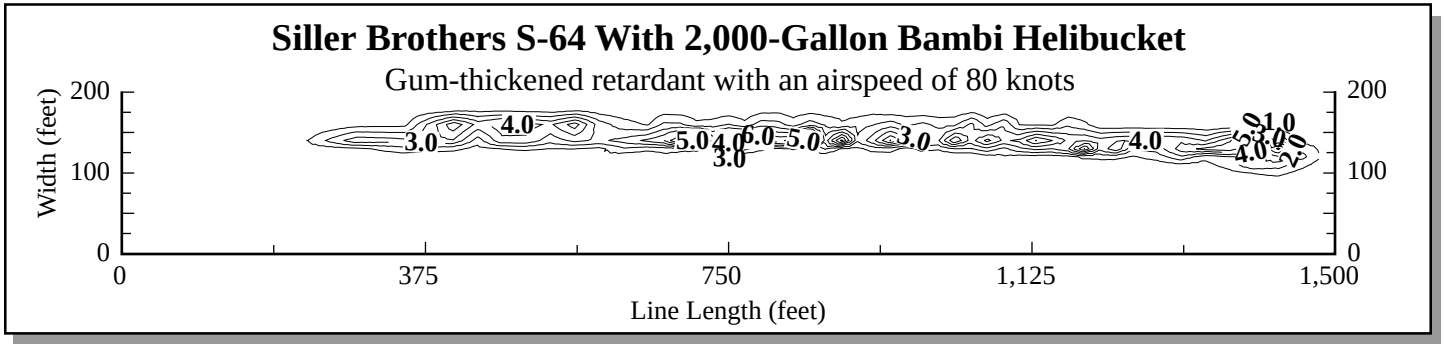

Figure 4—Drop pattern characteristics for the Siller Brothers S-64 with 2,000-gallon Bambi helibucket using gum-thickened retardant at an airspeed of 80 knots (92 miles per hour) and a drop height of 74 feet. The contour lines are at coverage levels of 0.5, 1, 2, 3, 4, 6, 8, and 10 gallons per 100 square feet.

The proper amount of fire-retarding materials to be applied (expressed as coverage level in gallons per 100 square feet) differs depending on the fuel model. Table 1 shows the coverage needed for specific fuel models using both the National Fire Danger Rating System (NFDRS) and Fire Behavior Fuel Model descriptions.

The results of drop tests allow managers to estimate the length of line a specific airtanker produces at various coverage levels. Table 2 or figure 5 can be used to determine the drop speed required to obtain the longest line of water at each coverage level. Table 3 or figure 6 can be used to determine the drop speed required to obtain the longest line of foam at each coverage level. Table 4 or figure 7 can be used to determine the drop speed required to obtain the longest line of gum-thickened retardant at each coverage level.

Table 1—The retardant coverage needed for specific fuel types.

Fuel Model		Coverage Level (gal/100 ft²)	Description
National Fire Danger Rating System (NFDRS)	Fire Behavior		
A, L, S	1	1	Annual and perennial western grasses, tundra
C	2		Conifer with grass
H, R	8	2	Shortneedle closed conifer; summer hardwood
E, P, U	9		Longneedle conifer; fall hardwood
T	2		Sagebrush with grass
N	3		Sawgrass
F	5	3	Intermediate brush (green)
K	11		Light slash
G	10	4	Shortneedle conifer (heavy dead litter)
O	4		Southern rough
F, Q	6	6	Intermediate brush (cured), Alaska black spruce
B, O	4		California mixed chaparral, high pocosin
J	12	Greater than 6	Medium slash
I	13		Heavy slash

The line-length graphs predict line length (in feet) as a function of airspeed (in knots). The tables are constructed by selecting the drop producing the longest line at each coverage level. Either the graphs or tables may be used to estimate the airspeed required to produce the longest line for a given coverage level. The tables show an ideal case, while the graphs represent an average.

Table 2—Water tests producing the longest line at various coverage levels.

Coverage Level (gal/100 ft²)	Line Length (feet)	Airspeed (knots)
0.5	1,223	82
1	1,223	82
2	1,098	81
3	860	68
4	829	68
6	543	46
8	447	46
10	328	46

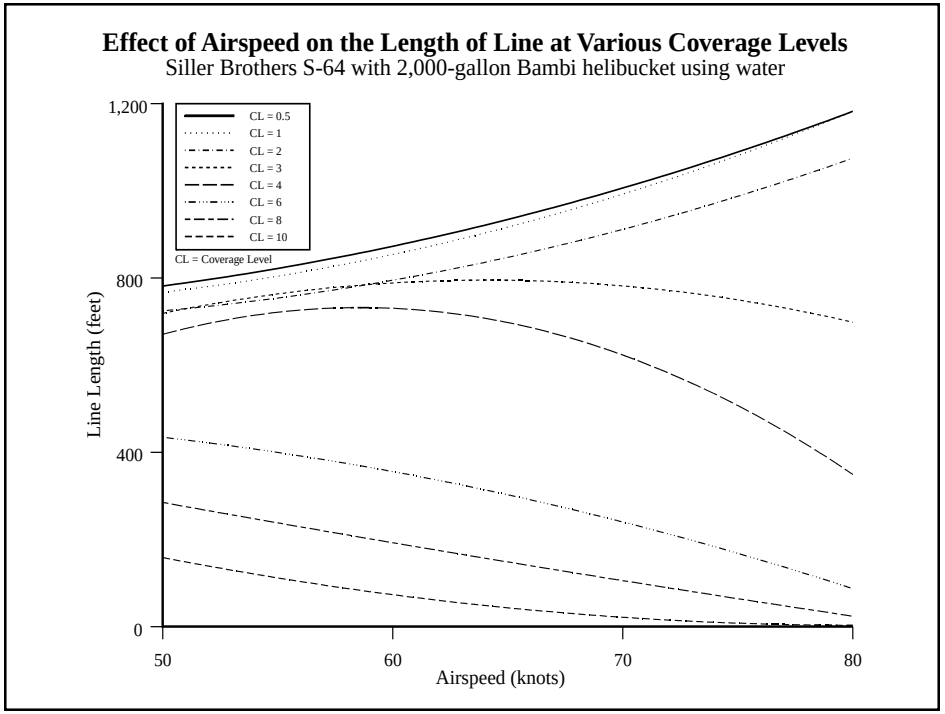

Figure 5—Use this graph to estimate the airspeed needed to provide the longest line of water at various coverage levels.

Table 3—Foam tests producing the longest line at various coverage levels.

Coverage Level (gal/100 ft²)	Line Length (feet)	Airspeed (knots)
0.5	1,290	82
1	1,290	82
2	1,179	81
3	911	68
4	484	68
6	465	46
8	369	46
10	279	46

Table 4—Gum-thickened retardant tests producing the longest line at various coverage levels.

Coverage Level (gal/100 ft²)	Line Length (feet)	Airspeed (knots)
0.5	1,297	80
1	1,297	80
2	1,221	80
3	1,154	80
4	977	75
6	668	62
8	513	49
10	410	49

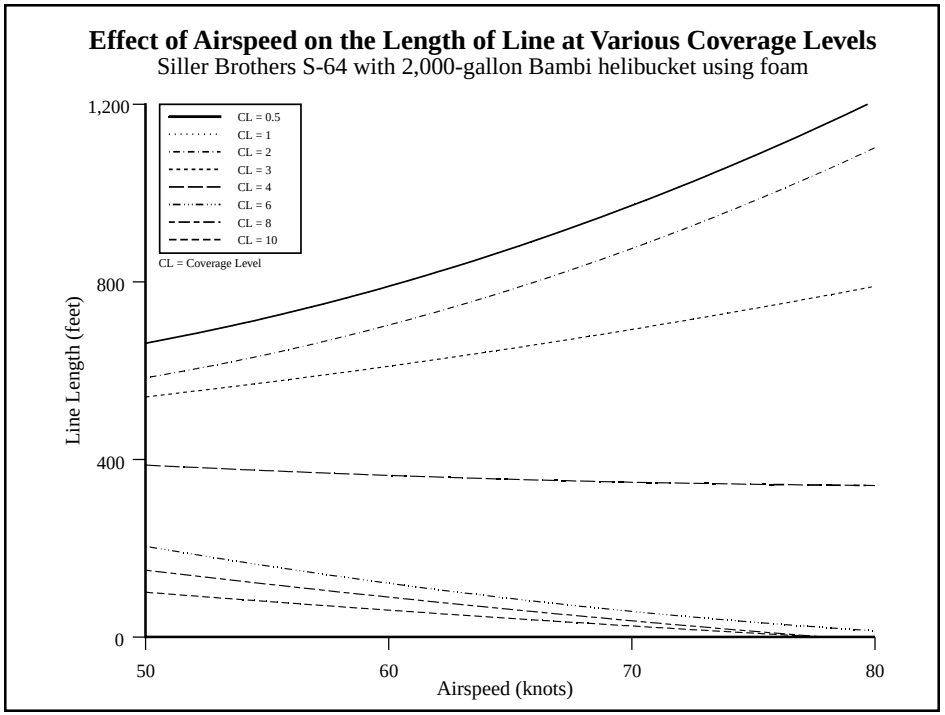

Figure 6—Use this graph to estimate the airspeed needed to provide the longest line of foam at various coverage levels.

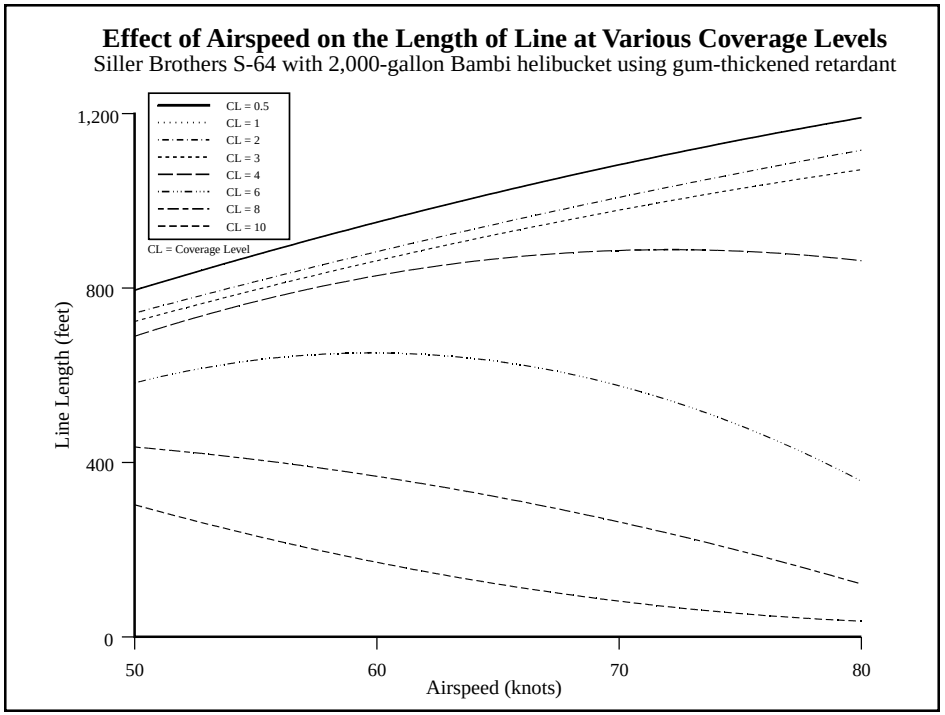

Figure 7—Use this graph to estimate the airspeed needed to provide the longest line of gum-thickened retardant at various coverage levels.

To select the proper airspeed, first use table 1 to determine the coverage level required by the NFDRS or Fire Behavior Fuel Model. The coverage levels in table 1 represent the coverage level required for average fire intensity for each fuel model. The required coverage level can be adjusted up or down depending on the actual fire intensity. Once the required coverage level is determined, the airspeed can be found. Use the table for the material dropped (water, foam, or gum-thickened retardant) to find the airspeed that produces the longest line for the desired coverage level. The same information can be found in the appropriate drop table.

For example, if a fire is burning in NFDRS Fuel Model K (Fire Behavior Fuel Model 11), represented by light slash, table 1 shows that a coverage level of 3 is required. The table for gum-thickened retardant (table 4) shows that for coverage level 3, an airspeed of about 80 knots produces the longest line (1,154 feet).

The ground drop characteristics for the Siller Brothers S-64 with 2,000-gallon Bambi helibucket were derived through controlled test drop procedures on flat ground (figure 8). This information is to serve only as a guide in assisting field personnel to determine the proper drop height and airspeed for delivering water, foam, or gum-thickened retardant. Actual coverage may vary depending on terrain, wind, weather, and pilot proficiency.

Figure 8—Drop test of the Siller Brothers S-64 with 2,000-gallon Bambi helibucket.

About the Authors...

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