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Airtanker Drop Guides

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Technology & Development Program

Ground Pattern Performance of the Siller Brothers S-61N Helicopter Using the 1000-Gallon Griffith Big Dipper Helibucket

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The Wildland Fire Chemical Systems(WFCS)program tests a variety of fixed-and rotary-wing tankers to determine the parameters for optimal ground pattern coverage over a wide range of fuel and fire conditions. The 1000-Gallon Griffith Big Dipper Helibucket Model 1000 (referred to as the 1000-gallon Griffith helibucket) is one of a family of helibuckets designed for use with a variety of Type 1 helicopters.

The helibucket is constructed of "double bond" polyurethane mounted to a steel-reinforced rim and bottom (Figure 1). The bottom opening is sealed from the inside by a round door. The bucket is evacuated by activating a 28-volt dc electric motor that lifts the door $2^1/_2$ inches in 2 seconds, producing a flow rate of 50 to 60 gallons per second. The bucket's inside diameter is $65^1/_2$ inches at the top and $57^1/_4$ inches at the bottom. It is 84 inches tall. The drops in these tests were made with a maximum volume of 780 gallons. Tests included airspeeds from 17 to 86 knots (20 to 99 mph) and drop heights from 28 to 153 feet from the bottom of the helibucket to the ground. The drops were made with three different materials: water, foam, and gum-thickened retardant.

The Missoula Technology and Development Center tested the Siller Brothers S-61N helicopter using the 1000-gallon Griffith helibucket with a series of drops over an array of plastic bowls much like Cool Whip contain-ers. The quantity of material in each bowl was measured and the data were used to determine the drop pattern.

Figure 1—Siller Brothers S-61N helicopter using the 1000-gallon Griffith helibucket.

Flow rate, drop height, and airspeed all have an effect on the drop pattern. Since 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, 4, and 5 show the effect of increasing the airspeed from 24 knots to 86 knots (28 to 99 mph) at drop heights ranging from 60 to 85 feet.

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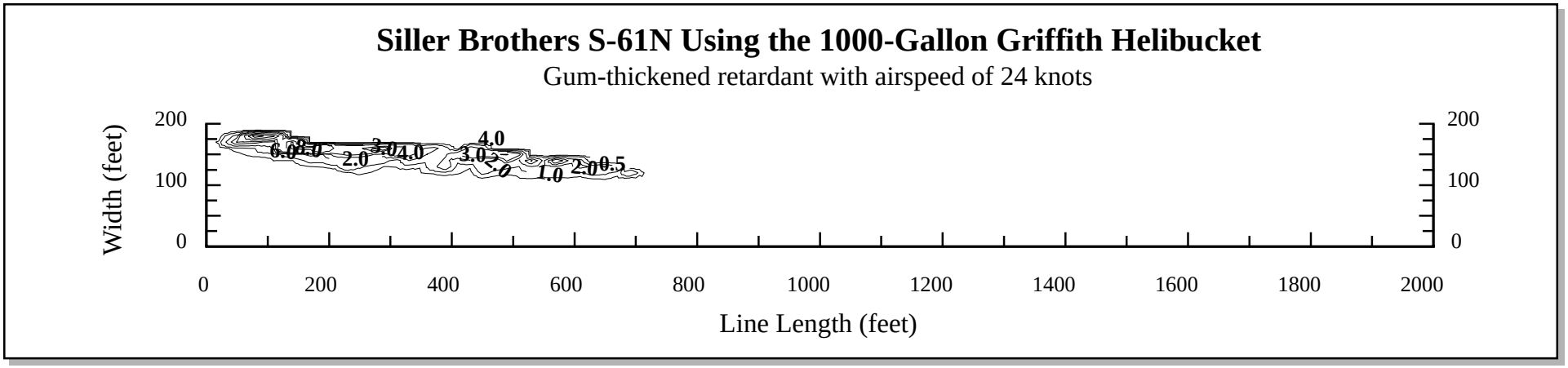

Figure 2—Drop pattern characteristics for the Siller Brothers S-61N helicopter using the 1000-gallon Griffith helibucket with gum-thickened retardant at an airspeed of 24 knots (28 mph) and a drop height of 60 feet. The contour lines are at coverage levels of 0.5, 1, 2, 3, 4, 6, 8, and 10 gallons per 100 square feet.

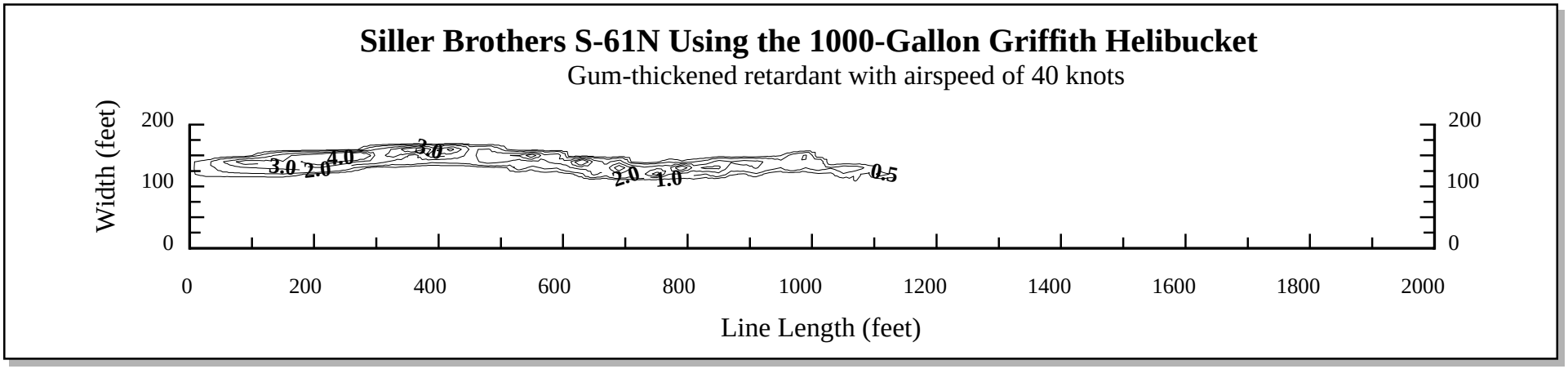

Figure 3—Drop pattern characteristics for Siller Brothers S-61N helicopter using the 1000-gallon Griffith helibucket with gum-thickened retardant at an airspeed of 40 knots (46 mph) and a drop height of 76 feet. The contour lines are at coverage levels of 0.5, 1, 2, 3, 4, 6, 8, and 10 gallons per 100 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 cover-age 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 helitanker produces at various coverage levels. Table 2 or Figure 6 can be used to determine the maximum line length at each coverage level produced by water using the 1000-gallon Griffith helibucket. Table 3 or Figure 7 can be used to determine the maximum line length at each coverage level produced

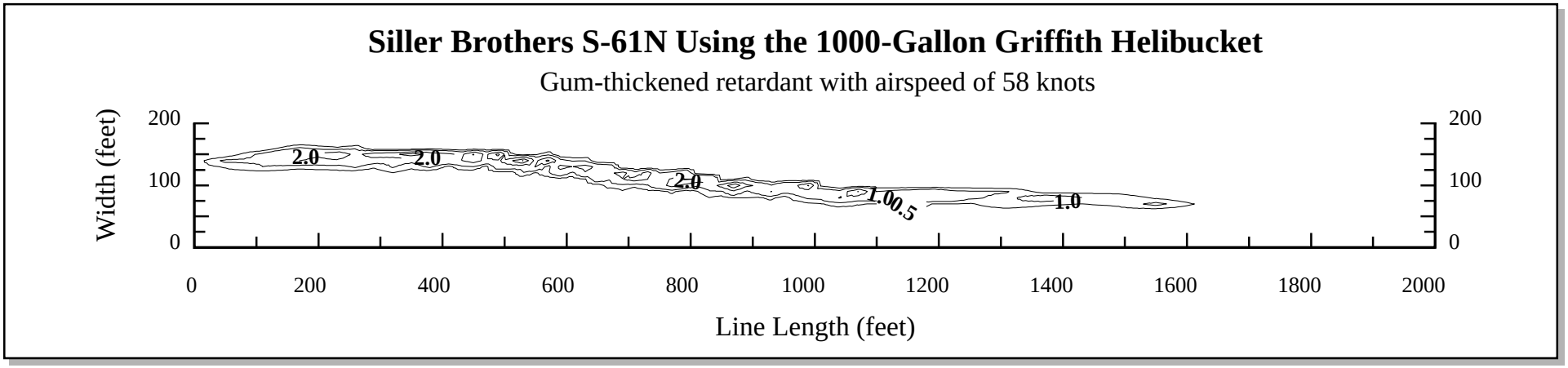

Figure 4—Drop pattern characteristics for the Siller Brothers S-61N helicopter using the 1000-gallon Griffith helibucket with gum-thickened retardant at an airspeed of 58 knots (67 mph) and a drop height of 60 feet. The contour lines are at coverage levels of 0.5, 1, 2, 3, 4, 6, 8, and 10 gallons per 100 square feet.

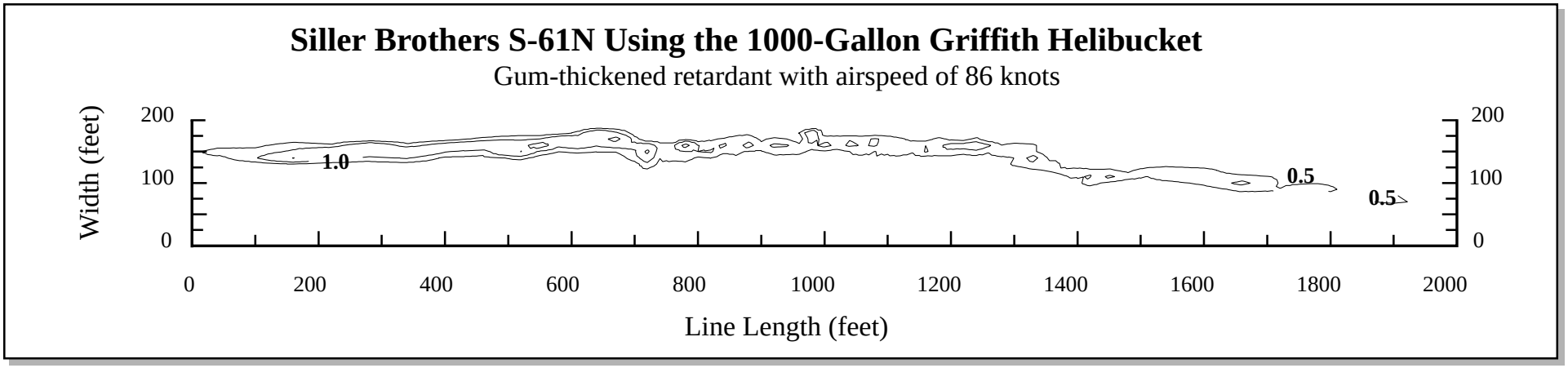

Figure 5—Drop pattern characteristics for the Siller Brothers S-61N helicopter using the 1000-gallon Griffith helibucket with gum-thickened retardant at an airspeed of 86 knots (99 mph) and a drop height of 85 feet. The contour lines are at coverage levels of 0.5, 1, 2, 3, 4, 6, 8, and 10 gallons per 100 square feet.

by foam using the 1000-gallon Griffith helibucket. Table 4 or Figure 8 can be used to determine the maximum line length at each coverage level produced by gum-thickened retardant using the 1000-gallon Griffith helibucket.

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

To select the proper helicopter speed,

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

Fuel Model		Coverage Level (gal/100 sq. ft)	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

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 graph for the material dropped (water, foam, or gum-thickened retardant) to find the airspeed that produces the longest line for the desired

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

Coverage Level (gal/100 sq. ft)	Airspeed (knots)	Line Length (feet)
0.5	77	1343
1	80	947
2	59	806
3	40	608
4	40	507
6	27	310
8	27	227
10	27	151

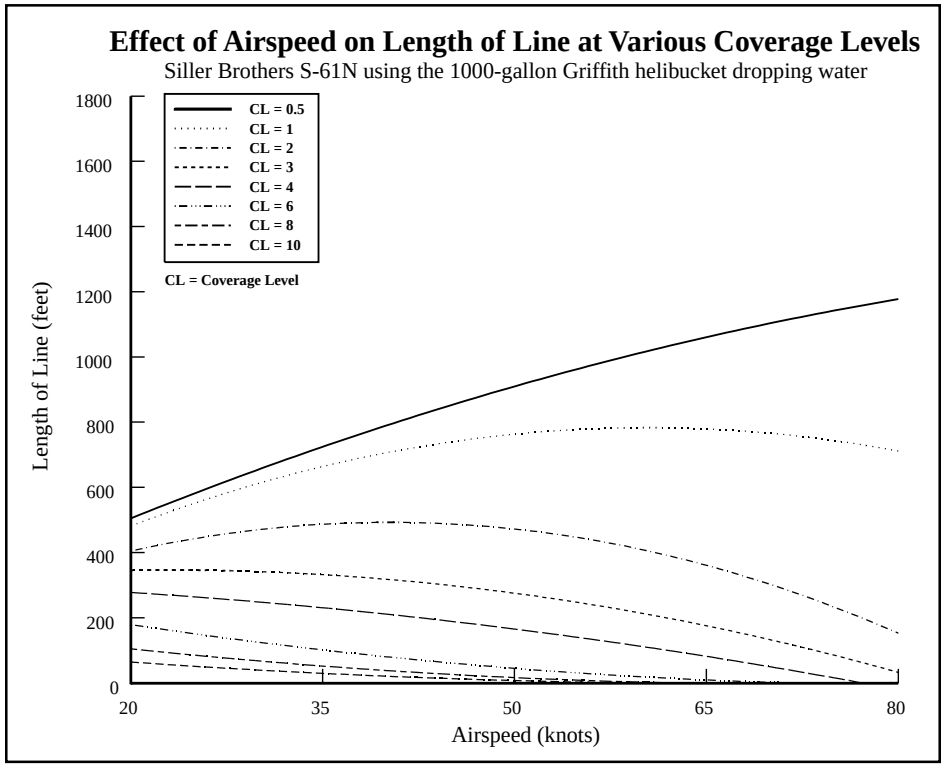

Figure 6—Use this graph to estimate the drop speed needed to produce the maximum line length of water at various coverage levels.

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

Coverage Level (gal/100 sq. ft)	Airspeed (knots)	Line Length (feet)
0.5	69	1803
1	69	1207
2	63	716
3	22	554
4	22	517
6	22	318
8	19	176
10	19	90

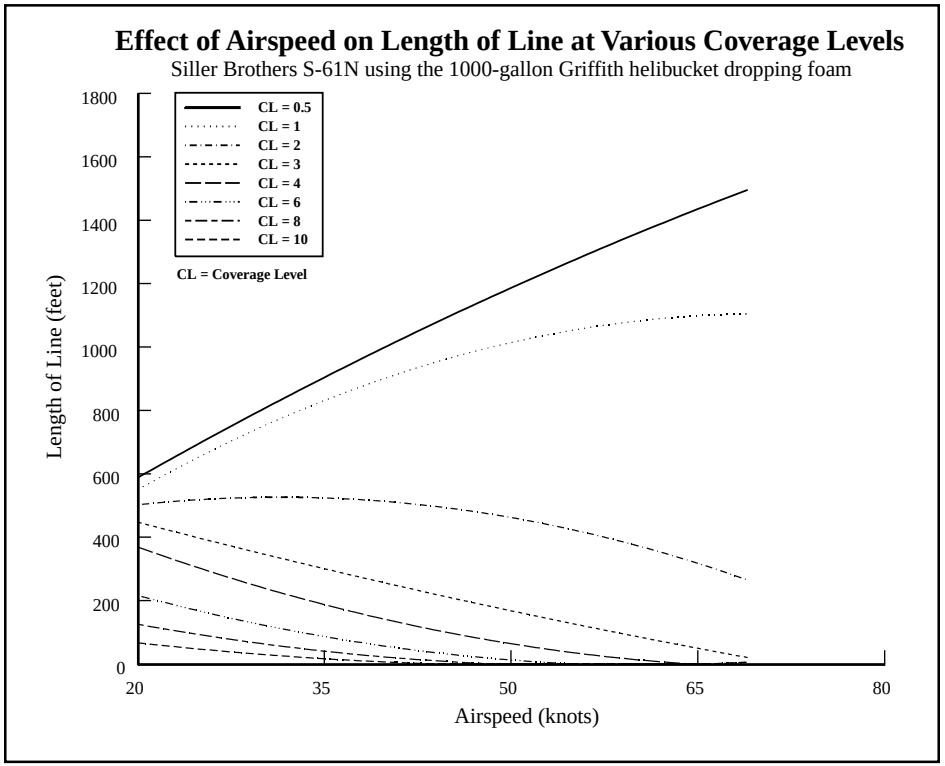

Figure 7—Use this graph to estimate the drop speed needed to produce the maximum line length of foam at various coverage levels.

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

Coverage Level (gal/100 sq. ft)	Airspeed (knots)	Line Length (feet)
0.5	86	1879
1	58	1435
2	52	940
3	40	571
4	18	444
6	31	290
8	31	187
10	18	126

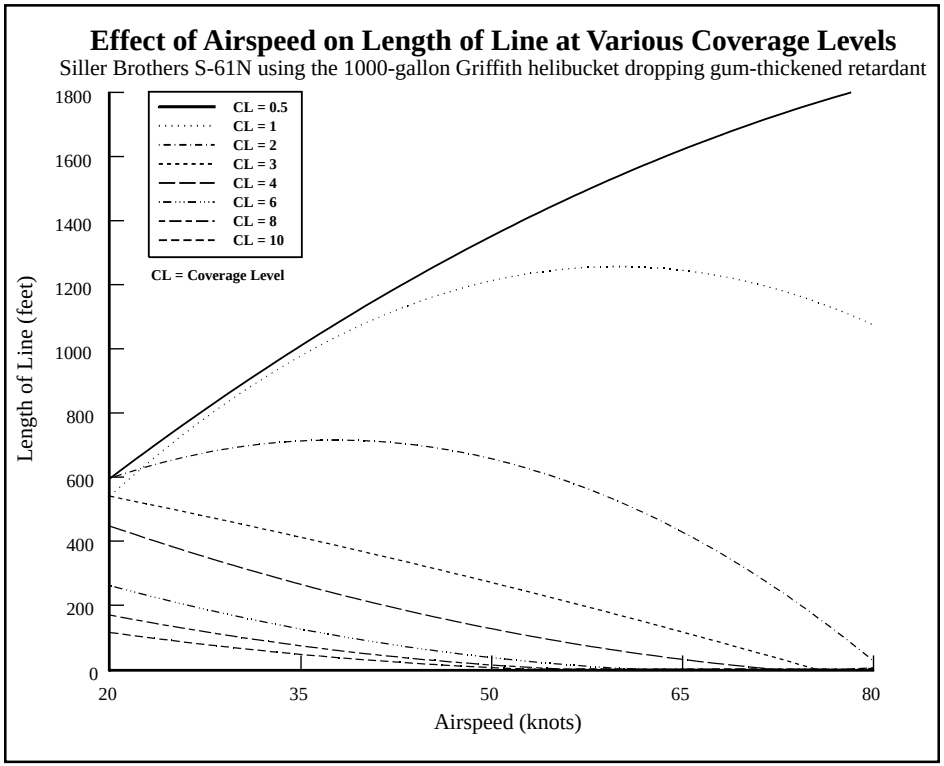

Figure 8—Use this graph to estimate the drop speed needed to produce the maximum line length of gum-thickened retardant at various coverage levels.

coverage level. The same information can be found in the appropriate drop table.

For example, if a fire is burning in NFDRS Fuel Model N (Fire Behavior Model 3), represented by sawgrass, Table 1 shows that a coverage level of 3 is required. The graph for water shows that for coverage level 3, a speed of about 40 knots produces the longest line (608 feet).

The ground drop characteristics for the 1000-gallon Griffith helibucket were derived through controlled test drop procedures on flat ground (Figure 9). 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 9—Drop test of the Siller Brothers S-61N helicopter using the 1000-gallon Griffith helibucket dropping water.

About the Authors...

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