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United States Department of Agriculture
Forest Service
Technology & Development Program

Airtanker Drop Guides

Ground Pattern Performance of the Columbia BV-107 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 (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 hydraulic cylinder that lifts the door 6 inches in 1 second producing a flow rate of 140 to 160 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 1000 gallons. Tests included airspeeds from 31 to 85 knots (36 to 98 mph) and drop heights from 40 to 96 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 Columbia BV-107 using the 1000-gallon Griffith 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.

Flow rate, drop height, and airspeed all have an effect on the drop pattern.

Figure 1—Columbia BV-107 helicopter using the 1000-gallon Griffith helibucket.

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, and 4 show the

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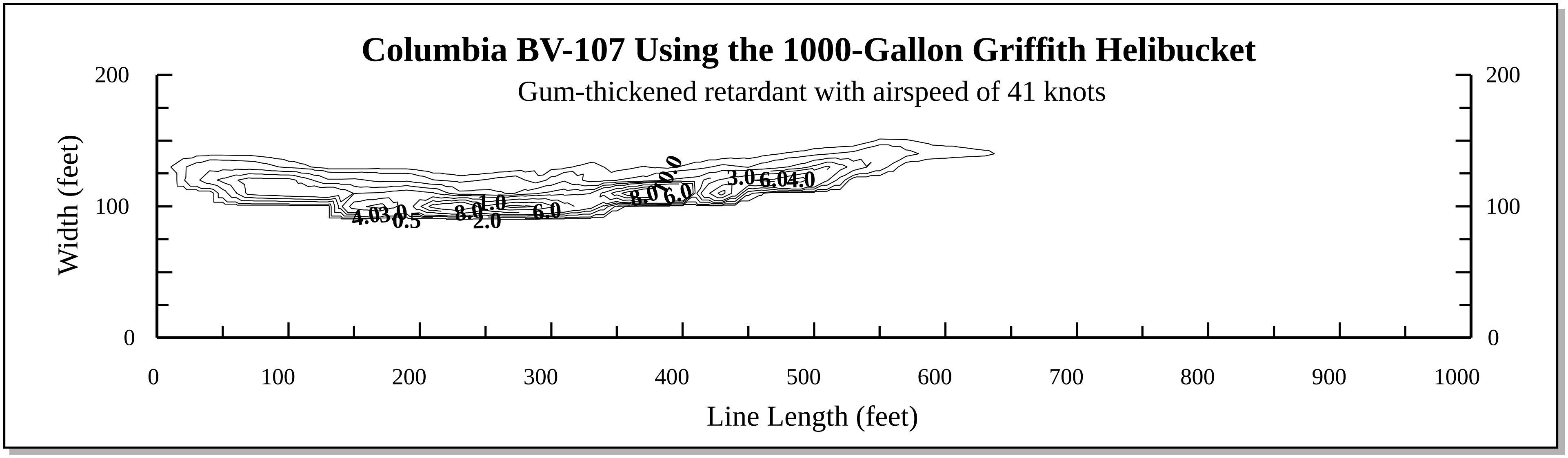

Figure 2—Drop pattern characteristics for the Columbia BV-107 helicopter using the 1000-gallon Griffith helibucket with gum-thickened retardant at an airspeed of 41 knots (47 mph) and a drop height of 49.5 feet. The contour lines are at coverage levels of 0.5, 1, 2, 3, 4, 6, 8, and 10 gallons per 100 square feet.

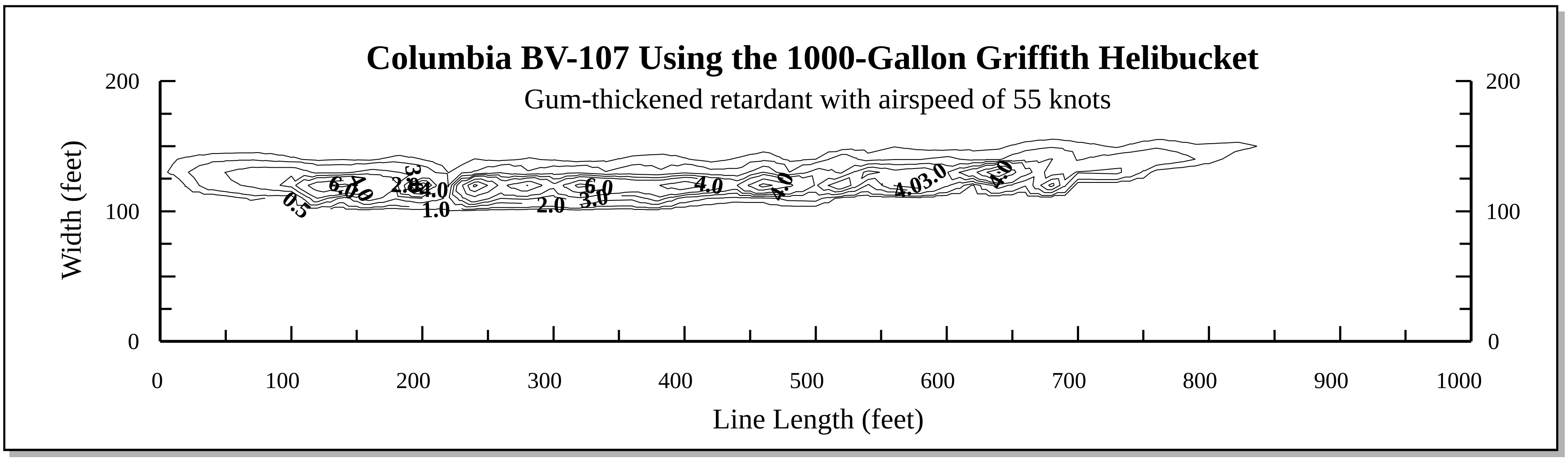

Figure 3—Drop pattern characteristics for the Columbia BV-107 helicopter using the 1000-gallon Griffith helibucket with gum-thickened retardant at an airspeed of 55 knots (63 mph) and a drop height of 40 feet. The contour lines are at coverage levels of 0.5, 1, 2, 3, 4, 6, 8, and 10 gallons per 100 square feet.

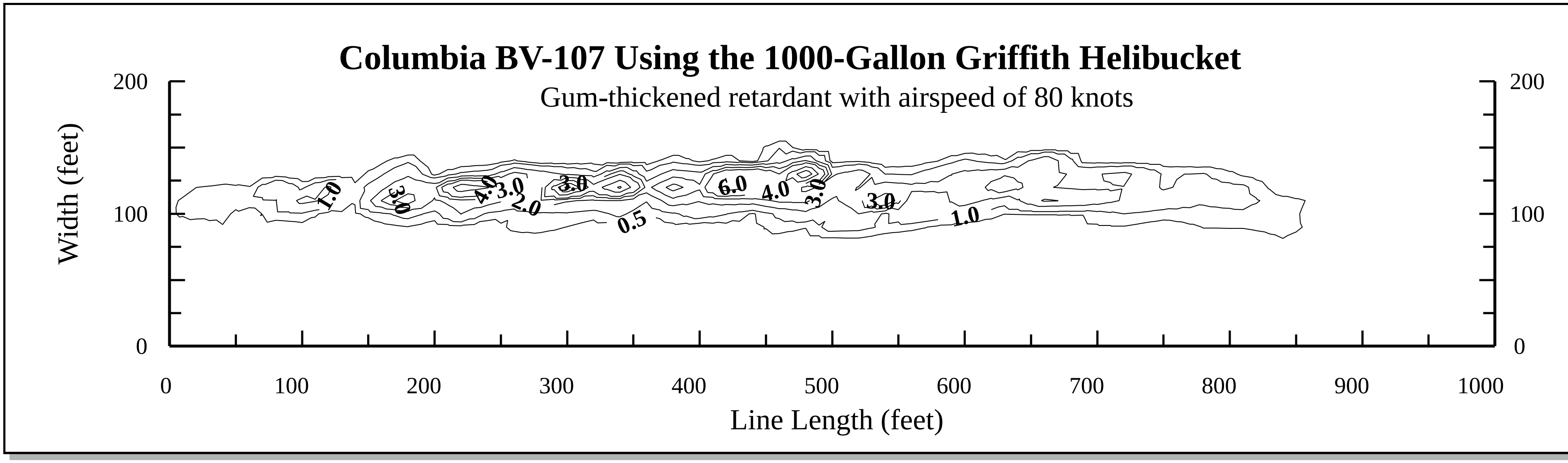

Figure 4—Drop pattern characteristics for the Columbia BV-107 helicopter using the 1000-gallon Griffith helibucket with gum-thickened retardant at an airspeed of 80 knots (92 mph) and a drop height of 52.5 feet. The contour lines are at coverage levels of 0.5, 1, 2, 3, 4, 6, 8, and 10 gallons per 100 square feet.

effect of increasing the airspeed from 41 knots to 80 knots (47 to 92 mph) at drop heights ranging from 40 to 52.5 feet.

The proper amount of fire-retarding materials to be applied (expressed as coverage levels 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 helibucket produces at various coverage levels. Table 2 or Figure 5 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 6 can be used to determine the maximum line length at each coverage level produced by foam using the 1000-gallon Griffith helibucket. Table 4 or Figure 7 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, first use Table 1 to determine the coverage level required by the National Fire Danger Rating System 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 coverage level. The same information can be found in the appropriate drop table.

For example, if a fire is burning in NFDRS Fuel Model T (Fire Behavior Model 2), represented by sagebrush with grass, Table 1 shows that a coverage level of 3 is required. The graph for gum-thickened retardant shows that for coverage level 3, a speed of about 55 knots produces the longest line (575 feet).

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

Fuel Model			
National Fire Danger Rating System (NFDRS)	Fire Behavior	Coverage Level (gal/100 sq. ft)	Description
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

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	78	1027
1	78	898
2	54	699
3	49	505
4	40	429
6	40	276
8	40	173
10	40	95

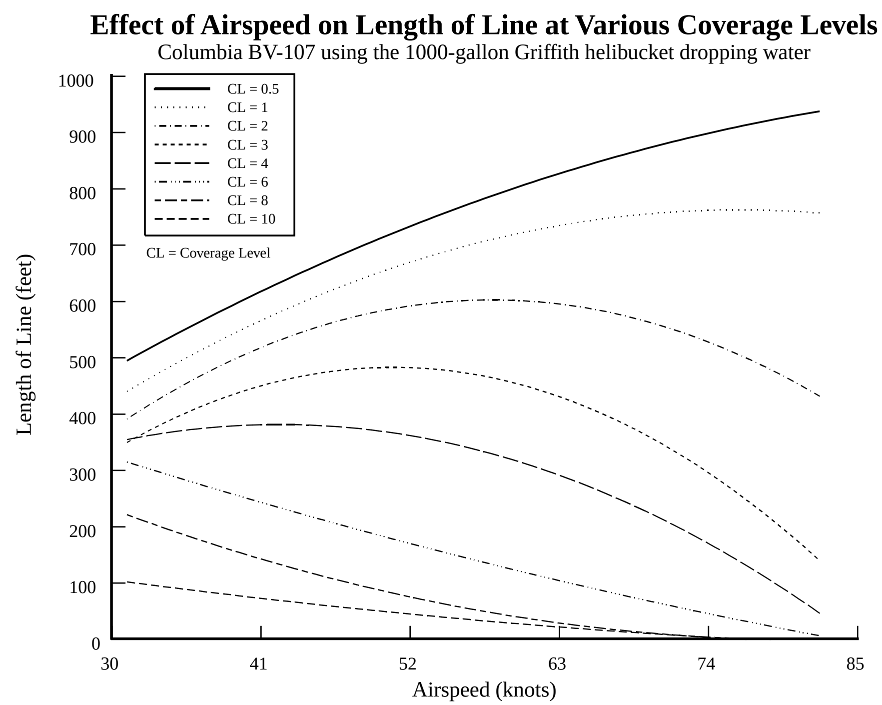

Figure 5—Use this graph to estimate the drop speed needed to produce the maximum line length of water at various coverage levels.

The ground drop characteristics for the Columbia BV-107 helicopter using the 1000-gallon Griffith 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.

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	82	927
1	82	832
2	63	562
3	60	432
4	40	419
6	38	269
8	38	66
10	—	—

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	76	873
1	76	805
2	57	686
3	55	572
4	55	482
6	45	318
8	45	207
10	42	160

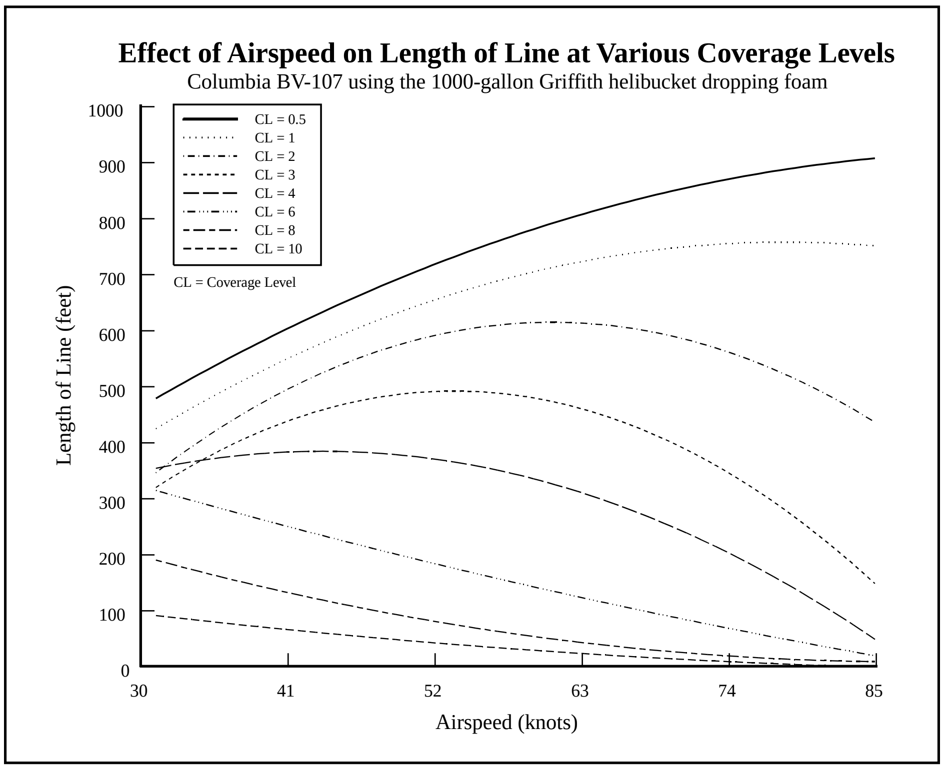

Figure 6—Use this graph to estimate the drop speed needed to produce the maximum line length of foam at various coverage levels.

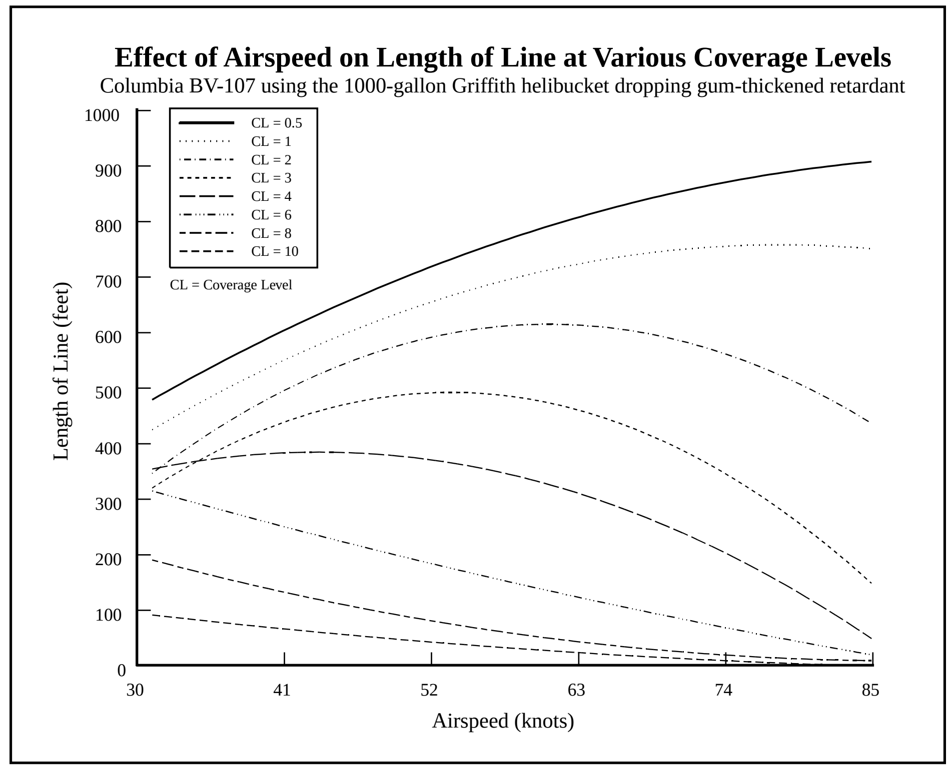

Figure 7—Use this graph to estimate the drop speed needed to produce the maximum line length of gum-thickened retardant at various coverage levels.

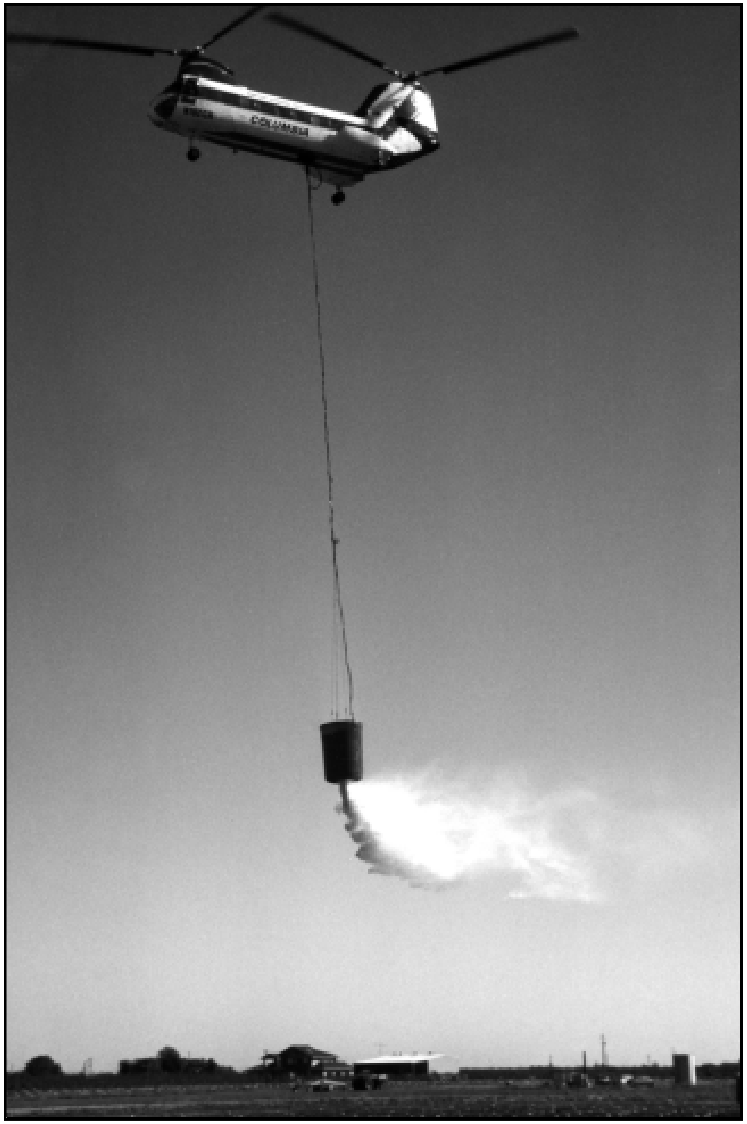

Figure 8—Drop test of the Columbia BV-107 helicopter using the 1000-gallon Griffith helibucket to drop gum-thickened retardant.

About the Authors...

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