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Airtanker Drop Guides

United States Department of Agriculture
Forest Service
Technology & Development Program

Ground Pattern Performance of the Columbia BV-234 Helicopter Using the Modified 3000-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 Columbia BV-234 using the Modified 3000-Gallon Griffith Big Dipper Helibucket (referred to as the modified 3000-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 of a hydraulic cylinder that pulls a door up off the bottom. The helibucket was modified with the use of an onboard computer that controls the door movement (and therefore the flow rate) as needed for various coverage levels. The bucket's inside diameter is 96 inches at the top and 80 inches at the bottom. It is 82 inches tall. The drops in these tests were made with a maximum volume of 3000 gallons. Tests included airspeeds from 33 to 99 knots (38 to 114 mph) and drop heights from 35 to 115 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-234 using the modified 3000-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.

Figure 1—The Columbia BV-234 using the modified 3000-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 multiple flow rates, information about an average drop is presented. Figures 2, 3, and 4 show the effect of increasing the flow rate from 100 gallons per second to 300 gallons

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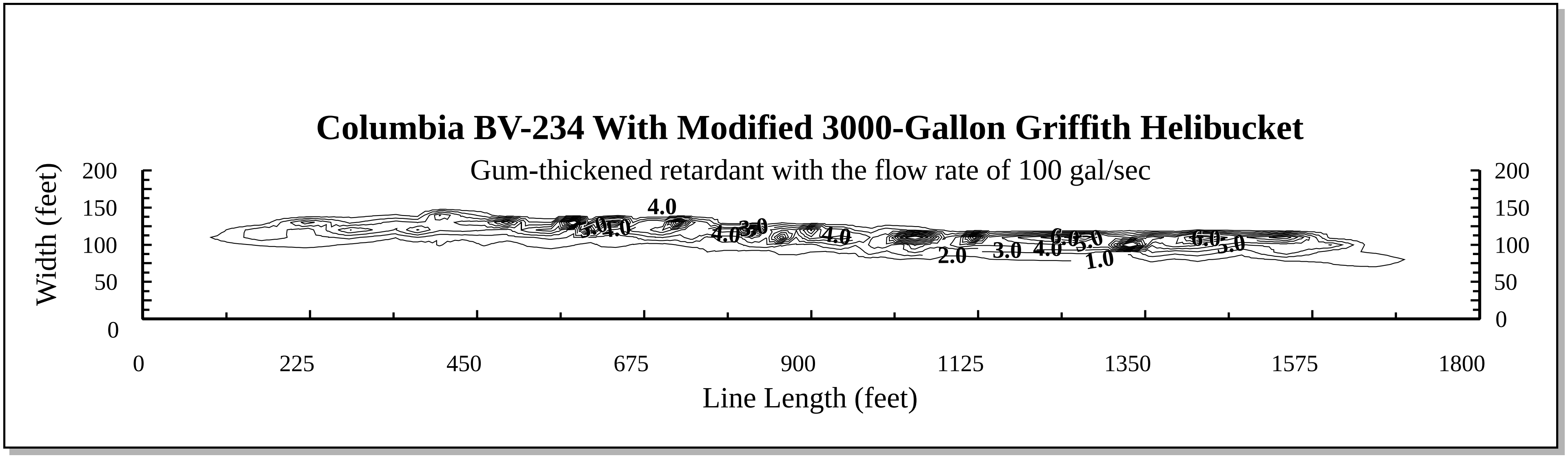

Figure 2—Drop pattern characteristics for the Columbia BV-234 using the modified 3000-gallon Griffith helibucket dropping gum-thickened retardant at an airspeed of 52 knots (60 mph), drop height of 74 feet, and flow rate of 100 gallons per second. The contour lines are at coverage levels of 0.5, 1, 2, 3, 4, 6, 8, and 10 gallons per 100 square feet.

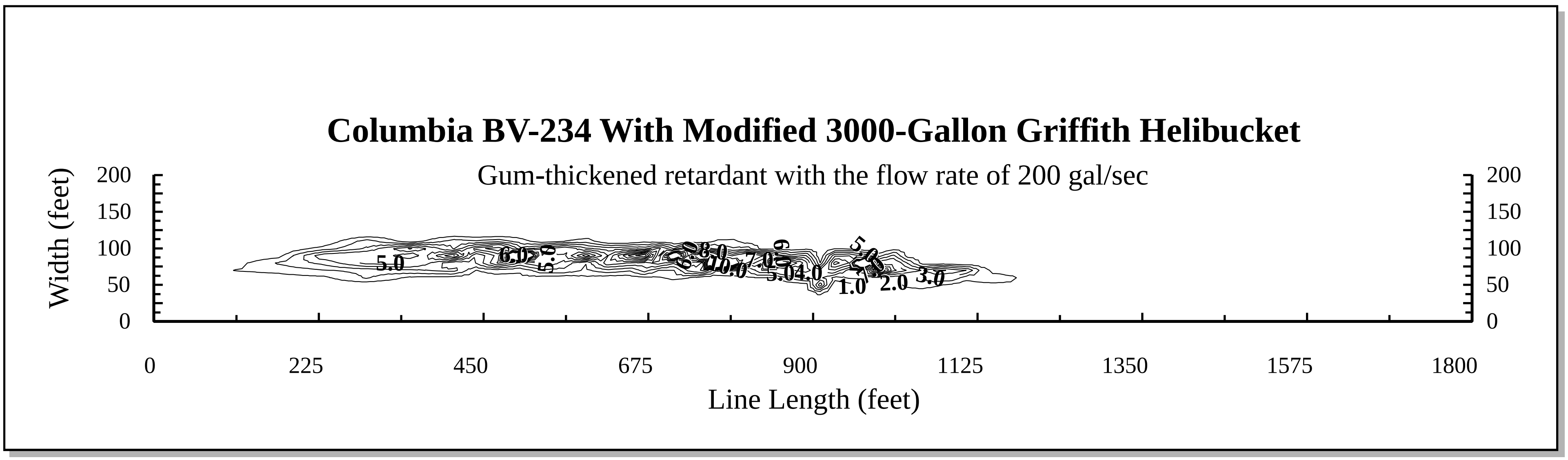

Figure 3—Drop pattern characteristics for the Columbia BV-234 using the modified 3000-gallon Griffith helibucket dropping gum-thickened retardant at an airspeed of 53 knots (61 mph), drop height of 73 feet, and flow rate of 200 gallons per second. The contour lines are at coverage levels of 0.5, 1, 2, 3, 4, 6, 8, and 10 gallons per 100 square feet.

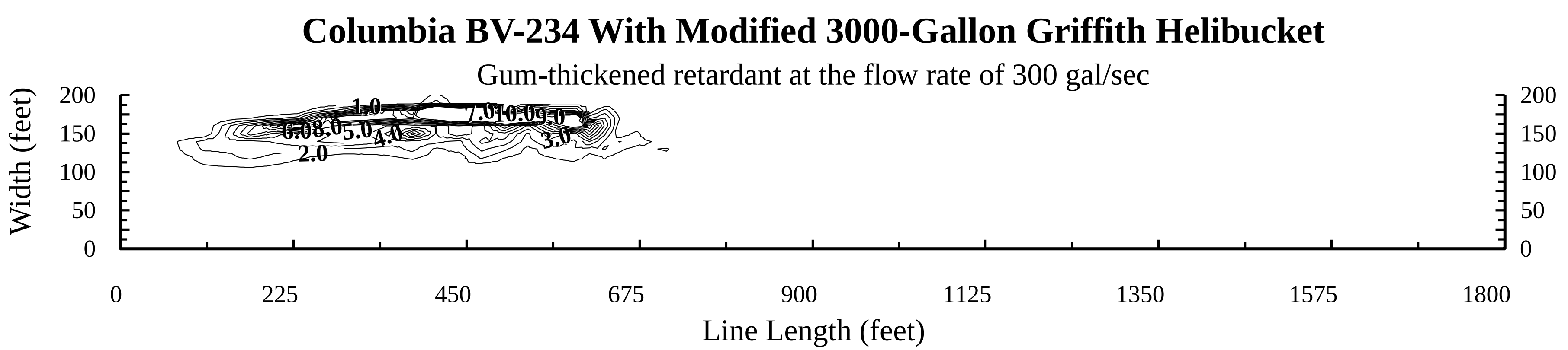

Figure 4—Drop pattern characteristics for the Columbia BV-234 using the modified 3000-gallon Griffith helibucket with gum-thickened retardant at an airspeed of 33 knots (38 mph), drop height of 88 feet, and flow rate of 300 gallons per second. The contour lines are at coverage levels of 0.5, 1, 2, 3, 4, 6, 8, and 10 gallons per 100 square feet.

per second with airspeeds of 33 to 53 knots (38 to 61 mph) and drop heights ranging from 73 to 88 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 modified 3000-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 modified 3000-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 modified 3000-gallon Griffith helibucket.

The length-of-line graphs predict line length (in feet) as a function of flow rate (in gallons per second). 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 flow rate 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 flow rate, 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 flow rate can be found. Use the graph for the material dropped (water, foam, or gum-thickened retardant) to find the flow rate 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 O (Fire Behavior Model 4), represented by southern rough, Table 1 shows that a coverage level of 6 is required. The table for water shows that for coverage level 6, a flow rate of about 200 gallons per second produces the longest line (699 feet) when applied at an airspeed of 71 knots (82 mph).

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

The ground drop characteristics for the Columbia BV-234 with the modified 3000-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 2—Water tests producing the longest line at various coverage levels.

Coverage Level (gal/100 sq. ft)	Flow Rate (gal/sec)	Line Length (feet)	Speed (knots)
0.5	100	1664	52
1	100	1607	52
2	100	1495	52
3	100	1416	52
4	100	1222	52
6	200	699	71
8	300	423	33
10	300	338	33

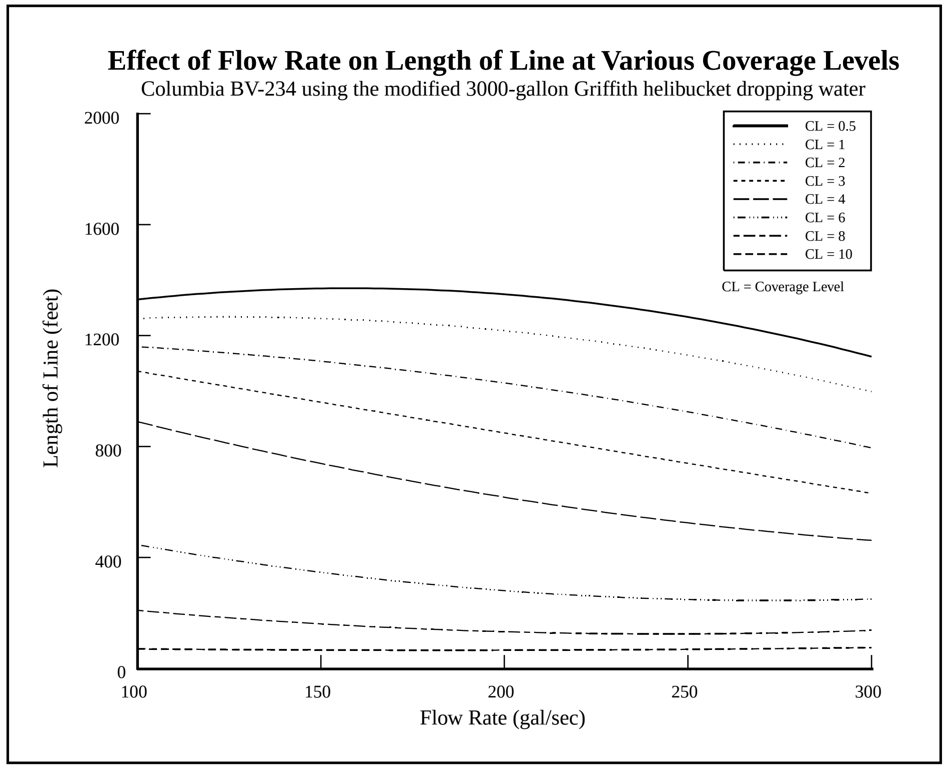

Figure 5—Use this graph to estimate the flow rate needed to produce the maximum line length of water at various coverage levels.

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

Coverage Level (gal/100 sq. ft)	Flow Rate (gal/sec)	Line Length (feet)	Speed (knots)
0.5	100	2113	69
1	100	2009	69
2	100	1299	69
3	100	1035	51
4	300	703	45
6	300	540	45
8	300	155	45
10	300	19	47

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

Coverage Level (gal/100 sq. ft)	Flow Rate (gal/sec)	Line Length (feet)	Speed (knots)
0.5	100	2182	77
1	100	2075	77
2	100	1444	64
3	100	916	64
4	300	623	76
6	300	453	77
8	300	287	77
10	300	169	77

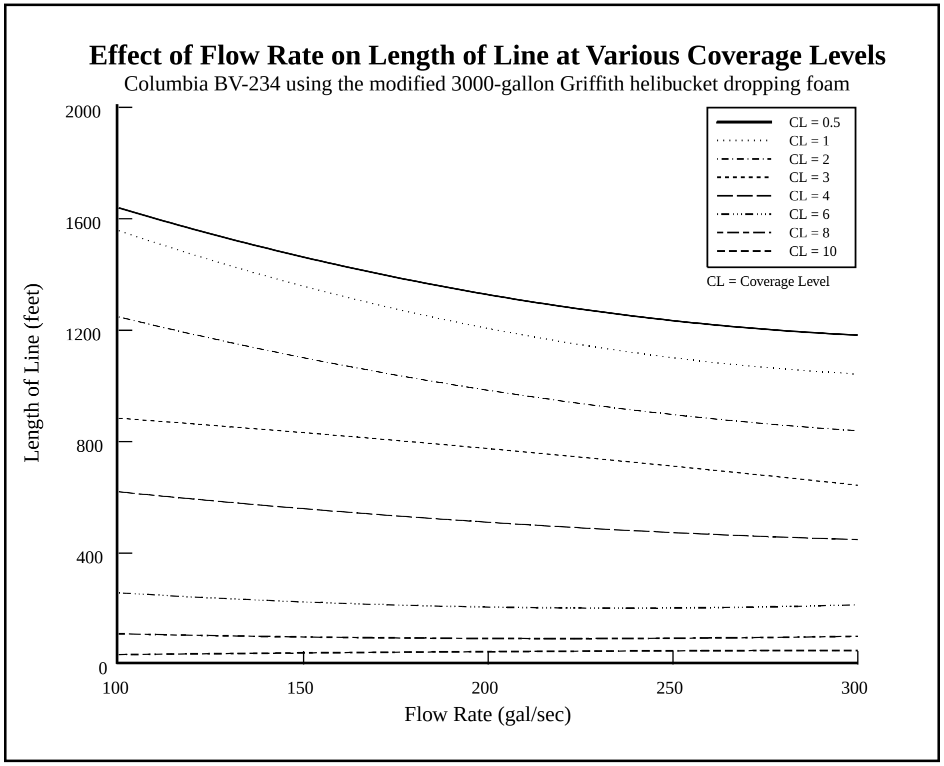

Figure 6—Use this graph to estimate the flow rate needed to produce the maximum line length of foam at various coverage levels.

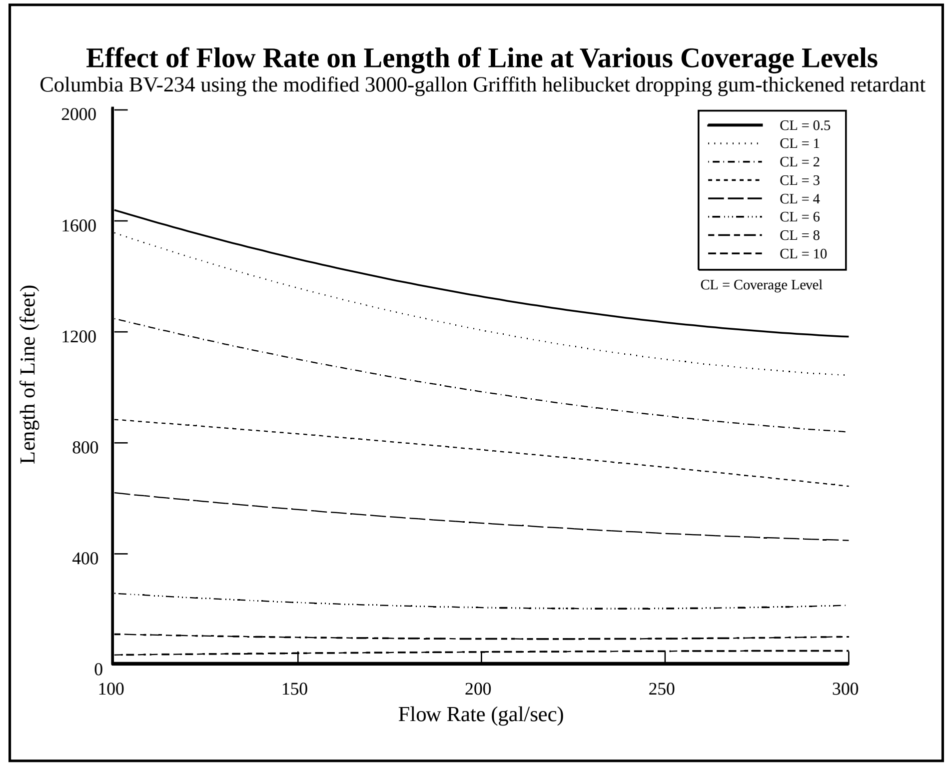

Figure 7—Use this graph to estimate the flow rate needed to produce the maximum line length of gum-thickened retardant at various coverage levels.

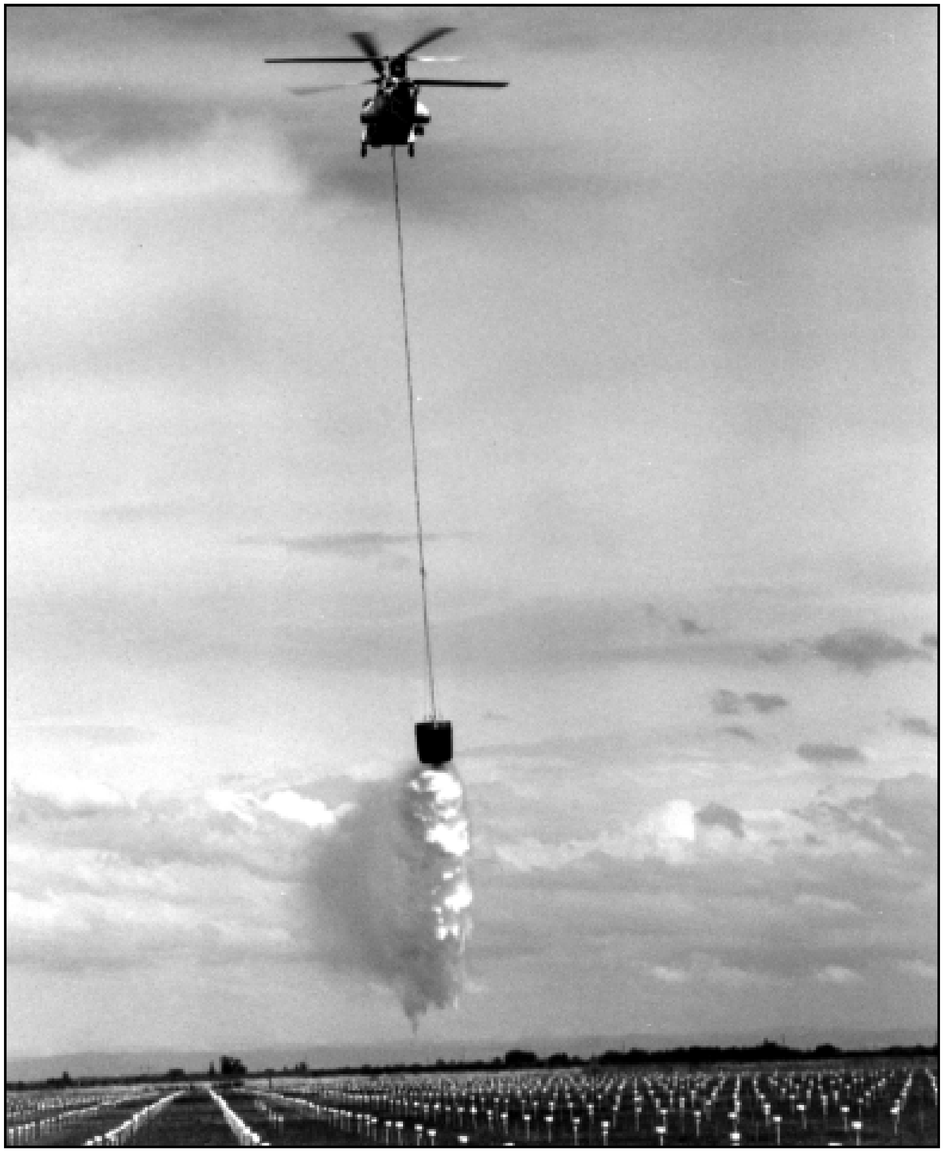

Figure 8—Drop test of the Columbia BV-234 using the modified 3000-gallon Griffith helibucket dropping gum-thickened retardant.

About the Authors...

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