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Airtanker Drop Guides

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Ground Pattern Performance of the Sims Rainmaker 2000-Gallon 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 coverage over a wide range of fuel and fire conditions. The Sims Rainmaker 2000-gallon Helibucket Model SF 2000 is one of a family of helibuckets designed for use with a variety of helicopters. The Sims 2000-gallon helibucket is designed for use with Type I helicopters.

MTDC tested the Sims 2000-gallon helibucket (Figure 1) 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.

The helibucket is constructed of fiberglass. The door opening is actuated by a electric hydraulic system using 28 volts dc aircraft power. A series of holes with removable covers are arranged around the upper part of the bucket. These holes, when uncovered, allow for reduced loads. The drop tests were made with a volume of 1750 gallons.

The standard Sims 2000-gallon helibucket and a modified version were tested. The modified version had a door that opened faster, allowing a higher flow rate. Tests included air speeds from 19 to 98 knots (22 to 113 mph) and drop heights from 15 to 148 feet (measured from the bottom of the bucket to ground). The drops were made with three different materials: water, foam, and gum-thickened retardant.

Drop height and drop speed both have an effect on the drop pattern.

Figure 1—Sims 2000-gallon helibucket with the Sikorsky CH-54 “Tarhe.” The civilian version is the S-64 “Skycrane.”

Increasing drop height gradually widens the drop at the expense of higher coverage levels. This effect is modified by the ambient wind. Increasing wind speed widens the drop and decreases coverage levels.

Drop speed has a much greater effect on the drop pattern. Figures 2 and 3 show the effect of increasing the drop speed from 25 to 86 knots (29 to 99 mph). Drop heights are nearly identical, ranging from 106 to 119 feet.

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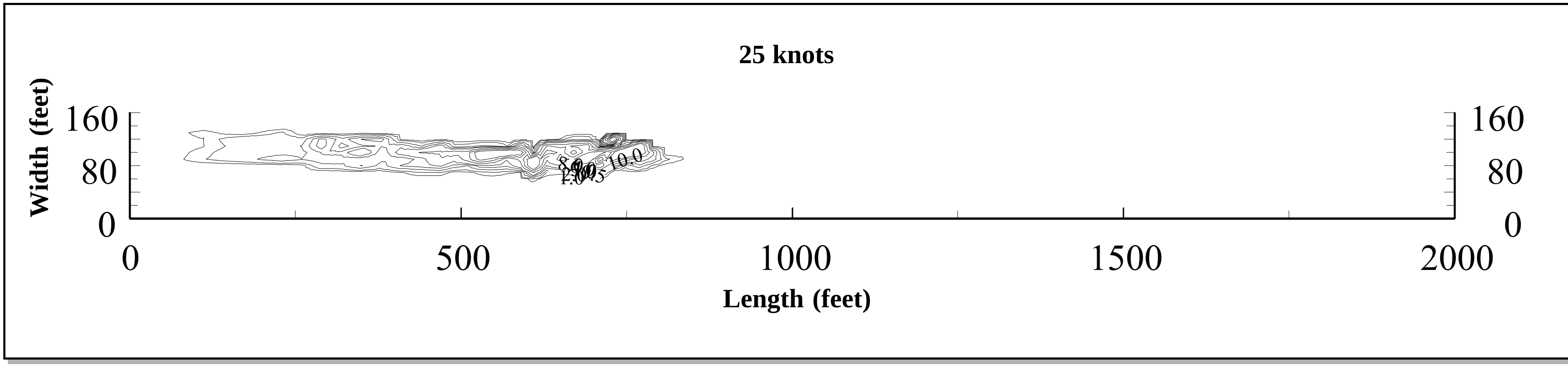

Figure 2—Drop pattern characteristics for the Sims 2000-gallon helibucket with a drop speed of 25 knots and a drop height of 106 feet. The contour lines are at coverage levels of 0.5, 1, 2, 3, 4, 6, 8 and 10 gallons per 100 square feet.

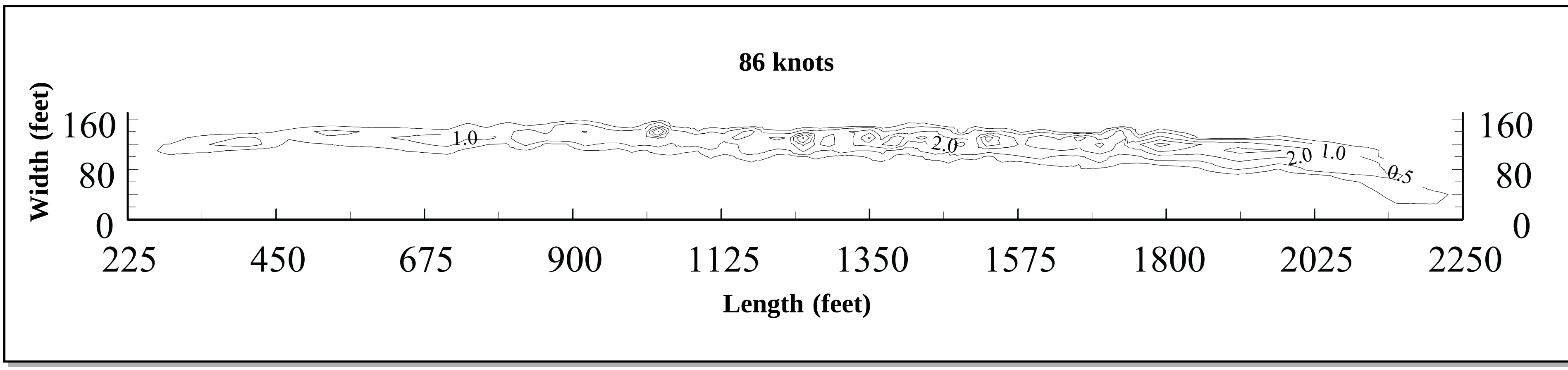

Figure 3—Drop pattern characteristics for the Sims 2000-gallon helibucket with a drop speed of 86 knots and a drop height of 119 feet. The contour lines are at coverage levels of 0.5, 1, 2, 3, 4, 6, 8 and 10 gallons per 100 square feet.

The proper amount of gum-thickened retardant (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 the Fire Behavior Fuel Model.

The results of drop tests allow managers to estimate the drop speed and height that provide the retardant coverage level required for a given fire intensity represented by the applicable fuel model. Table 2 or Figure 4 can be used to estimate the air speed of a water drop required to obtain the maximum line length of the desired coverage level. Table 3 or Figure 5 can be used to estimate the air speed of a foam drop to obtain the maximum line length of the desired coverage level. Table 4 or Figure 6 can be used to estimate the air speed of a gum-thickened retardant drop to obtain the maximum line length of the desired coverage level.

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 line length graphs predict line length (in feet) as a function of drop speed (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 drop speed required to produce the maximum length of line for a given coverage level. The tables show an ideal case, while the graphs represent an average.

Table 2—Test drops producing the longest line at various coverage levels using water.

Coverage Level (gal/100 sq. ft)	Drop Speed (knots)	Line Length (feet)
0.5	80	2008
1.0	86	1659
2.0	72	1189
3.0	58	1046
4.0	58	791
6.0	39	457
8.0	39	265
10.0	25	229

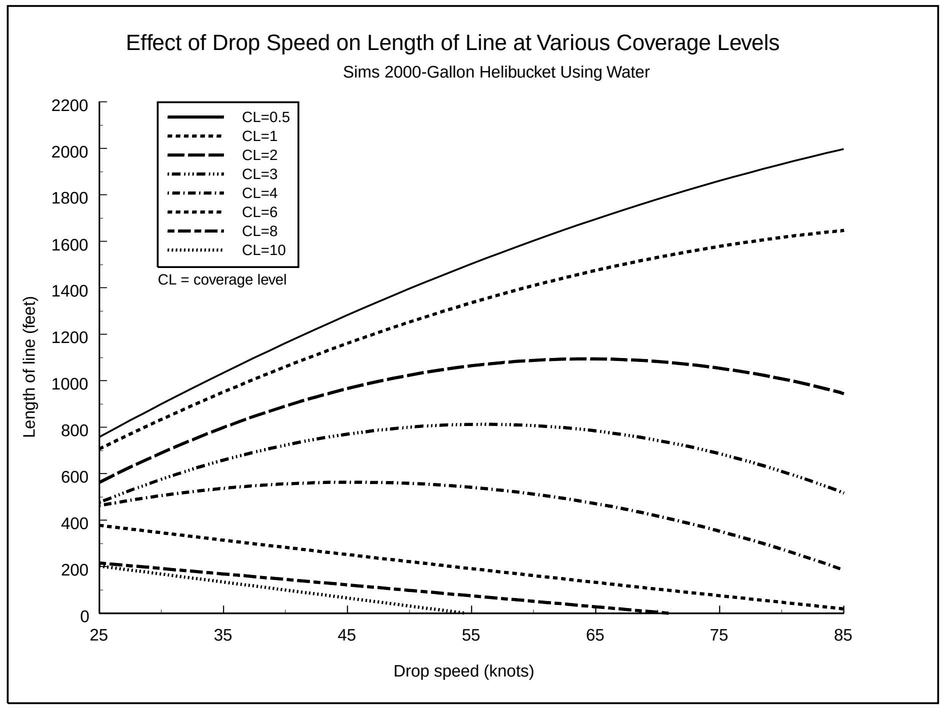

Figure 4—Use this graph to estimate the drop speed needed to produce the maximum line length of water at various coverage levels.

Table 3—Test drops producing the longest line at various coverage levels using foam.

Coverage Level (gal/100 sq. ft)	Drop Speed (knots)	Line Length (feet)
0.5	80	2031
1.0	80	1764
2.0	80	1268
3.0	45	926
4.0	45	638
6.0	19	352
8.0	19	305
10.0	19	237

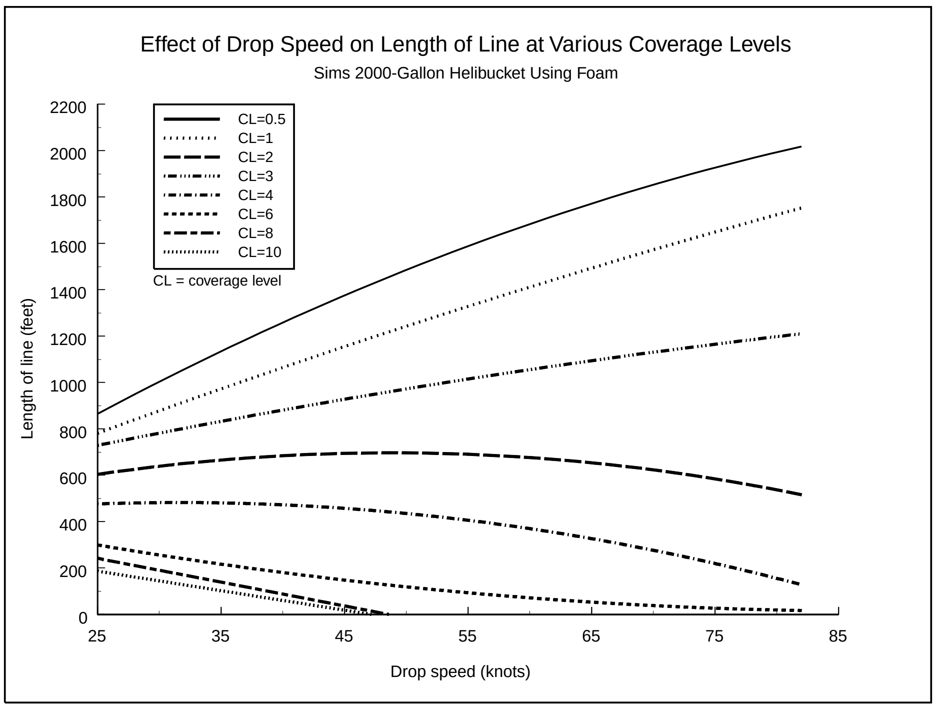

Figure 5— Use this graph to estimate the drop speed needed to produce the maximum line length of foam at various coverage levels.

Table 4—Test drops producing the longest line at various coverage levels using gum-thickened retardant.

Coverage Level (gal/100 sq. ft)	Drop Speed (knots)	Line Length (feet)
0.5	64	1803
1.0	53	1556
2.0	53	1160
3.0	53	1023
4.0	36	790
6.0	42	438
8.0	42	188
10.0	42	71

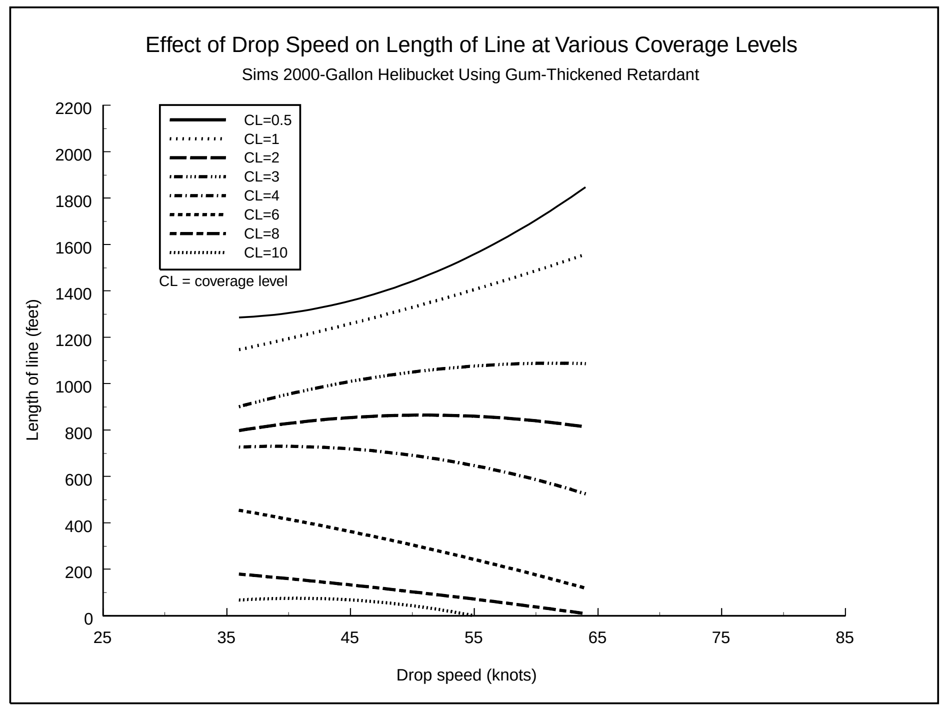

Figure 6— Use this graph to estimate the drop speed needed to produce the maximum line length of gum-thickened retardant at various coverage levels.

To select the proper helicopter speed, 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 drop speed can be found. Use the graph for the material dropped (water, foam, or gum-thickened retardant) to find the speed 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 F (Fire Behavior Model 5), represented by intermediate brush (green), 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 55 knots produces the longest line.

The ground drop characteristics for the Sims 2000-gallon helibucket were derived through controlled drop test procedures on flat ground (Figure 7). This information is to serve only as a guide in assisting field personnel to determine the proper drop height and air speed for delivering water, foam, or gum-thickened retardant. Actual coverage may vary depending on terrain, wind, weather, and pilot proficiency.

Figure 7—Sims 2000-gallon helibucket dropping retardant over the test grid.

About the Author...

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