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Airtanker Drop Guides

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Forest Service
Technology & Development Program

Ground Pattern Performance of the Airspray Electra L-188 with Aero Union Constant Flow Tank

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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 Airspray Electra L-188 (similar to the Orion P-3A), with an Aero Union Corporation tank, is a Type I airtanker used for fire suppression.

The Airspray Electra L-188 contains a RADS II constant flow tank approved by the Interagency Airtanker Board (IAB) to hold 3000 gallons. The constant flow system distributes the retardant uniformly, minimizing the possibility of the fire burning through the applied retardant. The tank has a single compartment with bulkhead dividers to minimize fluid movement forward and backward and to provide structural integrity. Two opposing doors, which run the length of the tank, are used to control the fluid flow. The tank doors are mechanically linked. They open from the center and operate in unison. The doors operate with full or partial tank fluid levels. The controller senses the level of retardant and constantly adjusts the door opening to maintain selected flow rates. Flow rate is controlled by varying the angle of the door opening. The volume released depends on how long the doors are opened. The computerized digital control logic used to operate the doors enables the pilot to control coverage level and quantity, producing the desired drop pattern. Drop tests were conducted at airspeeds from 111 to 144 knots (128 to 166 mph) and drop heights from 133 to 229 feet (measured from the bottom of the tank to ground). The drops were made with two different materials: water and gum-thickened retardant. Due to limitations in the size of the grid and the number of assistants, the test matrix used volumes less than 1500 gallons. Smaller volumes were selected in combination with low flow rates.

Figure 1 —The Constant flow tank of the Airspray Electra L-188.

The Missoula Technology and Development Center tested the Airspray Electra L-188 (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.

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Table 1—Retardant coverage levels needed for specific fuel models.

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

Table 2–Water tests producing the longest line at various coverage level settings using a constant flow tank.

Coverage Level (gal/100 sq. ft)	Flow Rate (gal/sec)	Coverage Level (setting)	Line Length (feet)
0.5	1011	Max.	673
1.0	1011	Max.	566
2.0	1011	Max.	451
3.0	1011	Max.	371
4.0	1011	Max.	264
6.0	1011	Max.	186
8.0	1011	Max.	85
10.0	1011	Max.	39

Table 3–Gum-thickened retardant tests producing the longest line at various coverage level settings using a constant flow tank.

Coverage Level (gal/100 sq. ft)	Flow Rate (gal/sec)	Control Setting	Line Length (feet)
0.5	90	0.5	1684
1.0	261	1	1412
2.0	261	1	652
3.0	698	Max.	408
4.0	698	Max.	349
6.0	698	Max.	238
8.0	698	Max.	63
10.0*	318	Max.	39

*Drop used less gum-thickened retardant

Flow rate, drop height, and airspeed affect the drop pattern. Increasing drop height gradually widens the drop while decreasing coverage levels. This effect is modified by the ambient wind. Increasing windspeed widens the drop and decreases coverage levels. Airspeed also affects the drop pattern. Because this airtanker has eight selectable flow rate settings, it can produce specific coverage levels needed for effective drops. Figure 2 shows a 974-gallon water drop with a coverage level of 4, airspeed of 122 knots (140 mph), and drop height of 152 feet. Figure 3 shows a 995-gallon gum-thickened retardant drop with a coverage level of 4, airspeed of 129 knots (148 mph), and drop height of 162 feet.

The proper amount of fire-retarding material (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.

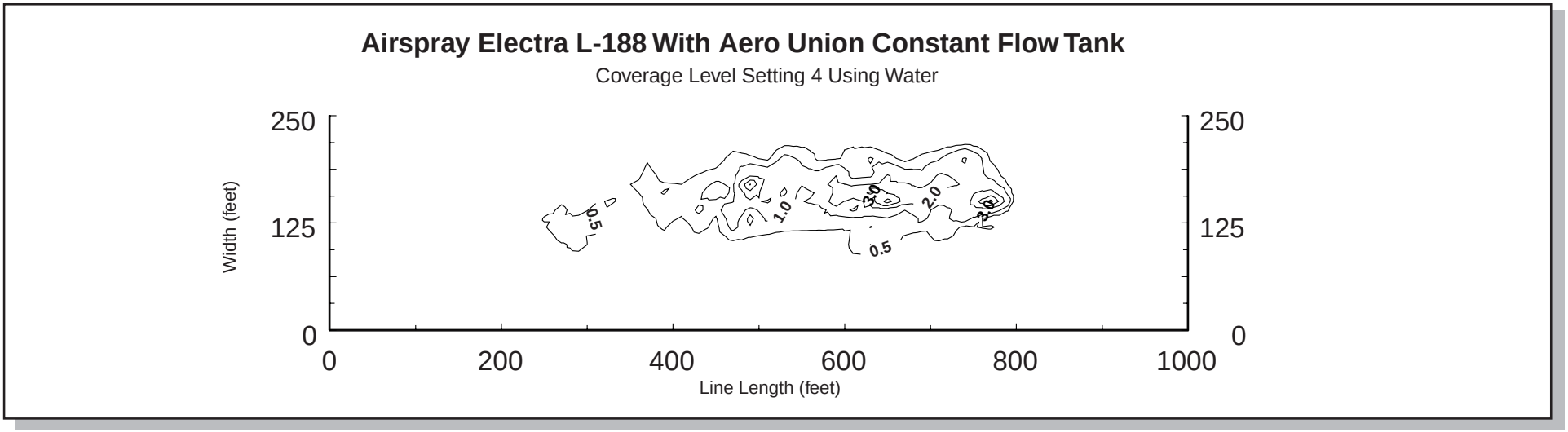

Figure 2–Drop pattern characteristics for the Airspray Electra L-188 with a coverage level setting of 4, carrying 995 gallons with an airspeed of 122 knots (140 mph) and a drop height of 152 feet. The contour lines are at coverage levels of 0.5, 1, 2, 3, 4, 6, 8, and 10 gallons per 100 square feet.

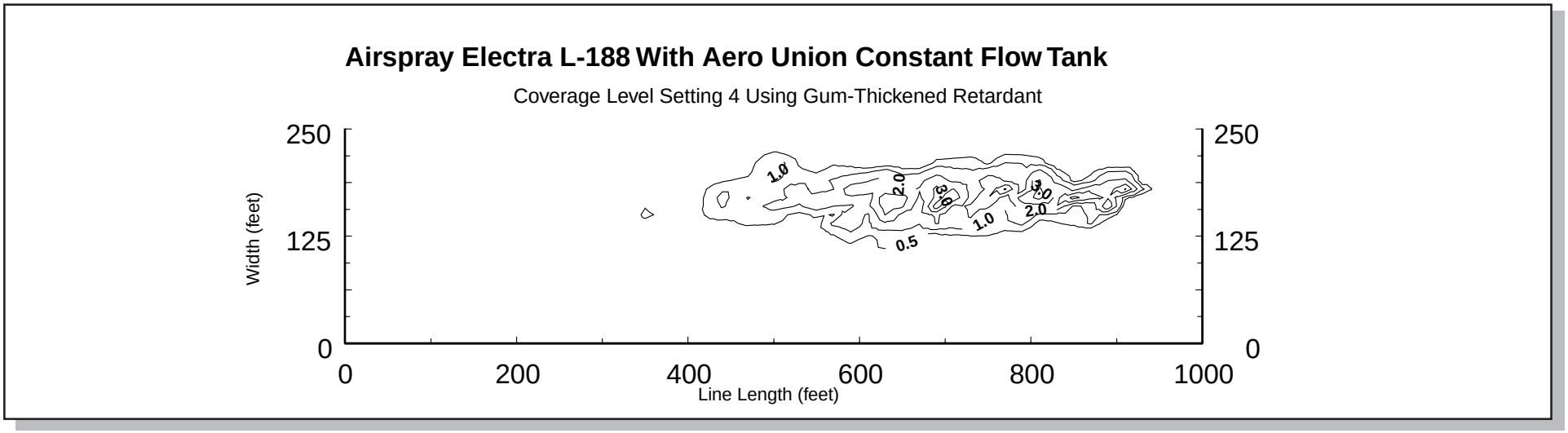

Figure 3–Drop pattern characteristics for the Airspray Electra L-188 with a coverage level setting of 4, carrying 974 gallons with an airspeed of 129 knots (148 mph) and a drop height of 162 feet. The contour lines are at coverage levels of 0.5, 1, 2, 3, 4, 6, 8, and 10 gallons per 100 square feet.

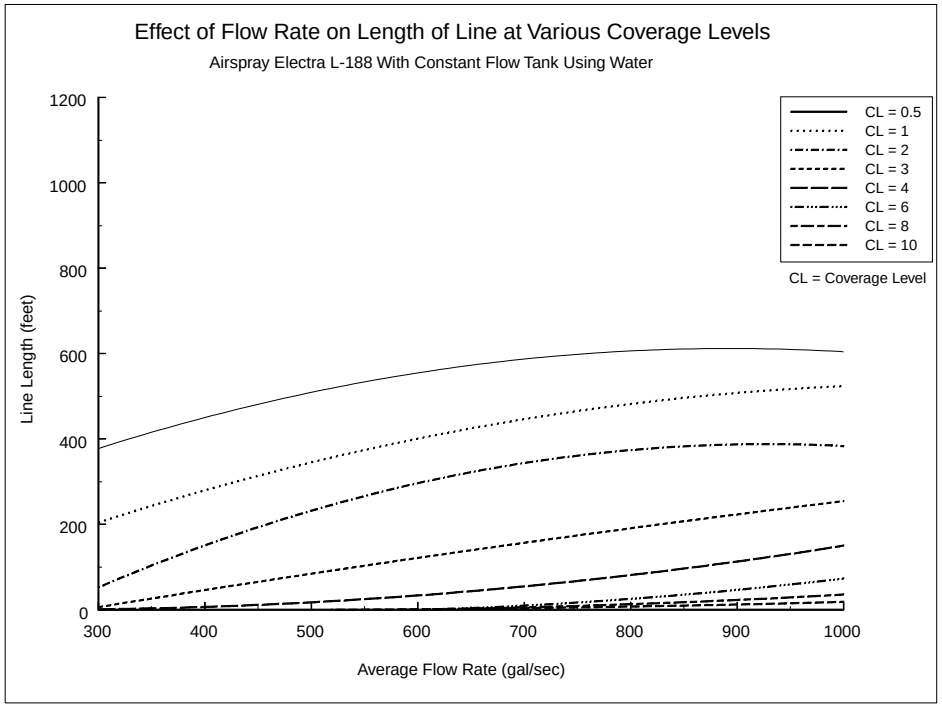

Figure 4–Use this graph to estimate the flow rate needed to produce the longest line of water at various coverage levels while dropping 1500 gallons.

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 4 can be used to estimate the coverage level setting of a water drop for the longest line at the desired coverage level. Table 3 or Figure 5 can be used to estimate the coverage level setting of a gum-thickened retardant drop for the longest line at the desired coverage level. The 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 line (on the ground) at each coverage level. The tables may be used to estimate the flow rate required to produce the longest line for a given coverage level. The tables show an ideal case, while the graphs represent an 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.

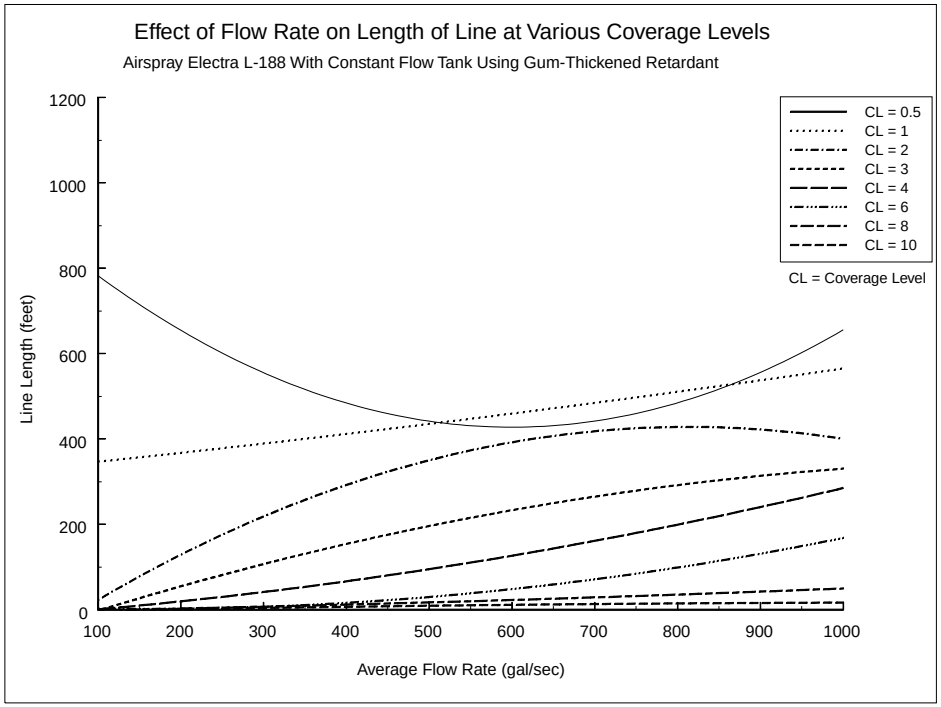

Figure 5–Use this graph to estimate the flow rate needed to produce the longest line of gum-thickened retardant at various coverage levels while dropping 1500 gallons.

Once the required coverage level is determined, the flow rate can be found. Use the graph for the material dropped (water 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 G (Fire Behavior Model 10), represented by shortneedle conifer (heavy dead litter), a coverage level of 4 is required (Table 1). The graph for gum-thickened retardant shows that for coverage level 4, a flow rate of 698 gal/sec, using 1500 gallons produces the longest line (349 feet).

The ground drop characteristics for the Airspray Electra L-188 were derived through controlled drop test procedures on flat ground (Figure 6). This information is to serve only as a guide to help field personnel determine the proper drop height, airspeed, and door opening for delivering water or gum-thickened retardant. Actual coverage may vary depending on terrain, wind, weather, and pilot proficiency.

Figure 6–Drop test of the Airspray Electra L-188.

About the Authors

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