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Airtanker Drop Guides

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Forest Service
Technology & Development Program

Ground Pattern Performance of the Erickson Air Crane

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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 Sikorsky S-64 Skycrane (military version identified as Tarhe CH-54) owned, operated, and modified by Erickson Air Crane, Inc. is one of a family of helitankers designed for fire suppression. The Erickson Air Crane is designated as a Type I Helitanker.

The aluminum tank is a constant flow system. The door opening is actuated by an electrically operated hydraulic system using 28 volts dc aircraft power. The tank consists of one compartment that is certified by the Interagency Airtanker Board to drop 2000 gallons. The tank is divided into bays by bulkhead dividers to minimize fluid movement within the tank. The doors are controlled by an Erickson designed controller, which interprets fluid height information and adjusts door opening to produce a nearly constant rate of flow for a selected flow rate. Partial loads can be delivered by closing the doors before the tank has emptied. Tests included airspeeds from 35 to 91 knots (40 to 105 mph), drop heights from 144 to 262 feet (measured from the bottom of the tank to ground), and flow rates of 75, 300, and 700 gallons per second (gal/sec). The drops were made with three different materials: water, foam, and gum-thickened retardant.

The Missoula Technology and Development Center tested the Erickson Air Crane (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.

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

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 while decreasing coverage levels. Airspeed has a much greater effect on the drop pattern. Increased airspeed increases the line length while reducing the coverage level. Different flow rates affect the amount of retardant that is dropped over a given period of time from the tank. Variation in flow rate also has a great effect on 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–Test drops producing the longest line at various coverage levels using water.

Coverage Level (gal/100 sq. ft)	Door Opening (percent)	Line Length (feet)
0.5	75	2455
1.0	75	2112
2.0	300	1329
3.0	300	615
4.0	300	519
6.0	300	396
8.0	700	173
10.0	700	128

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

Coverage Level (gal/100 sq. ft)	Door Opening (percent)	Line Length (feet)
0.5	75	2341
1.0	75	1179
2.0	300	674
3.0	300	324
4.0	700	131
6.0	300	168
8.0	300	4
10.0	-	-

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 while decreasing coverage levels. Airspeed has a much greater effect on the drop pattern. Increased airspeed increases the line length while reducing the coverage level. Different flow rates affect the amount of retardant that is dropped over a given period of time from the tank. Variation in flow rate also has a great effect on drop pattern. Figures 2, 3, and 4 show the effect of increasing the flow rate from 75 to 700 gal/sec with airspeeds ranging from 47 to 68 knots (54 to 78 mph) and drop heights ranging from 177 to 199 feet.

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

Coverage Level (gal/100 sq. ft)	Flow Rate (gal/sec)	Line Length (feet)
0.5	75	2482
1.0	75	2315
2.0	75	1739
3.0	75	612
4.0	300	545
6.0	300	466
8.0	300	356
10.0	700	179

The proper amount of fire-retarding material (expressed as coverage levels in gallons per 100 square feet) depends 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 descriptions.

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 flow rate of a water drop required for the longest line of the desired coverage level. Table 3 or Figure 5 can be used to estimate the flow rate of a foam drop for the longest line of the desired coverage level. Table 4 or Figure 6 can be used to estimate the airspeed of a gum-thickened retardant drop to obtain the maximum line length of the desired coverage level.

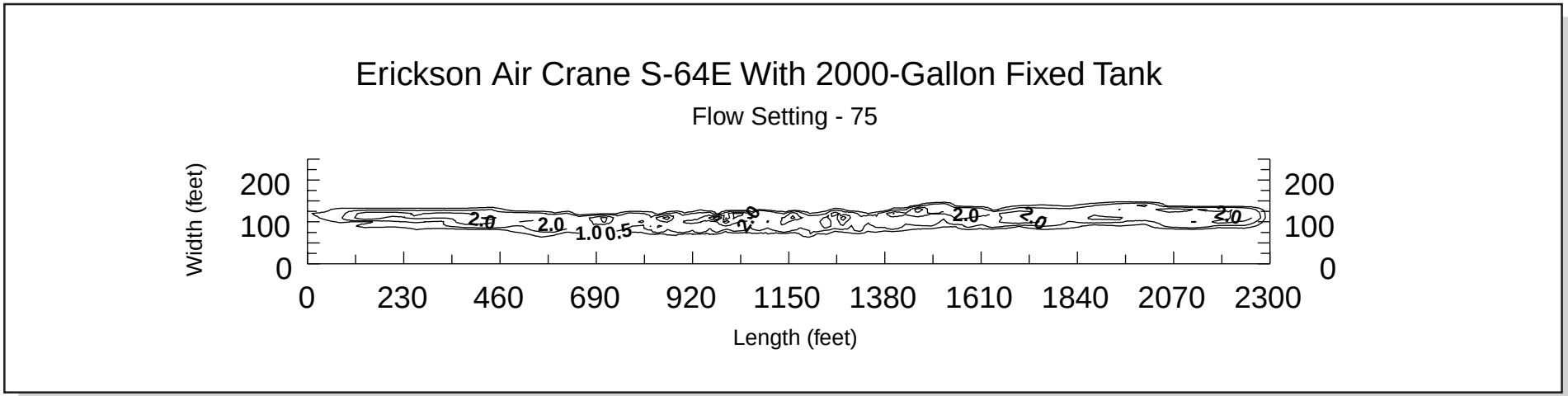

Figure 2–Drop pattern characteristics for the Erickson Air Crane using water with a constant flow system at a flow rate of 75 gal/sec, an airspeed of 47 knots (54 mph), and a drop height of 199 feet. The contour lines are at coverage levels of 0.5, 1, 2, 3, 4, 6, 8, and 10 gallons per square feet.

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. Either the graphs or 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 helitanker 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 C (Fire Behavior Model 2), represented by conifer with grass, a coverage level of 2 is required (Table 1). The graph for water shows that for coverage level 2, a flow rate of 300 produces the longest line (1329 feet).

The ground drop characteristics for the Erickson Air Crane were derived through controlled drop test procedures on flat ground (Figure 8). 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, foam, or gum-thickened retardant. Actual coverage may vary depending on terrain, wind, weather, and pilot proficiency.

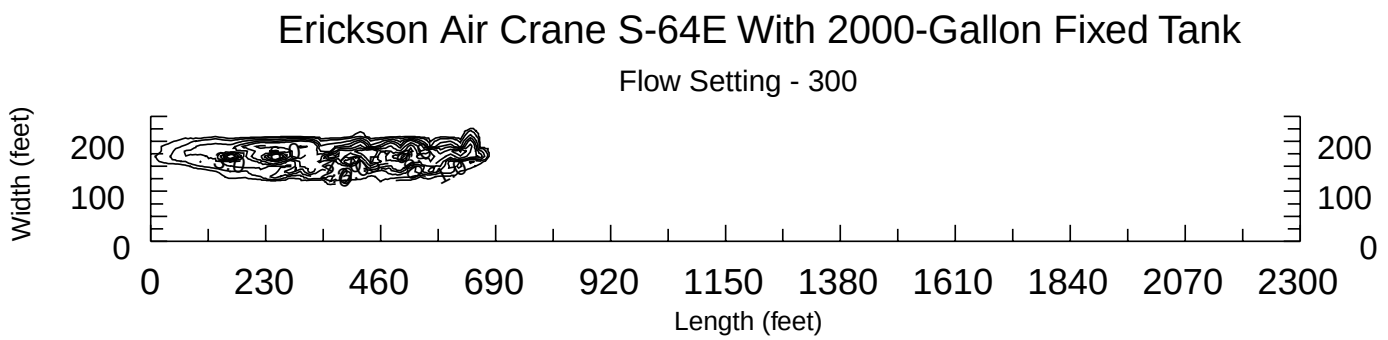

Figure 3–Drop pattern characteristics for the Erickson Air Crane using foam with a constant flow system at a flow rate of 300 gal/sec, an airspeed of 59 knots (68 mph), and a drop height of 184 feet. The contour lines are at coverage levels of 0.5, 1, 2, 3, 4, 6, 8, and 10 gallons per square feet.

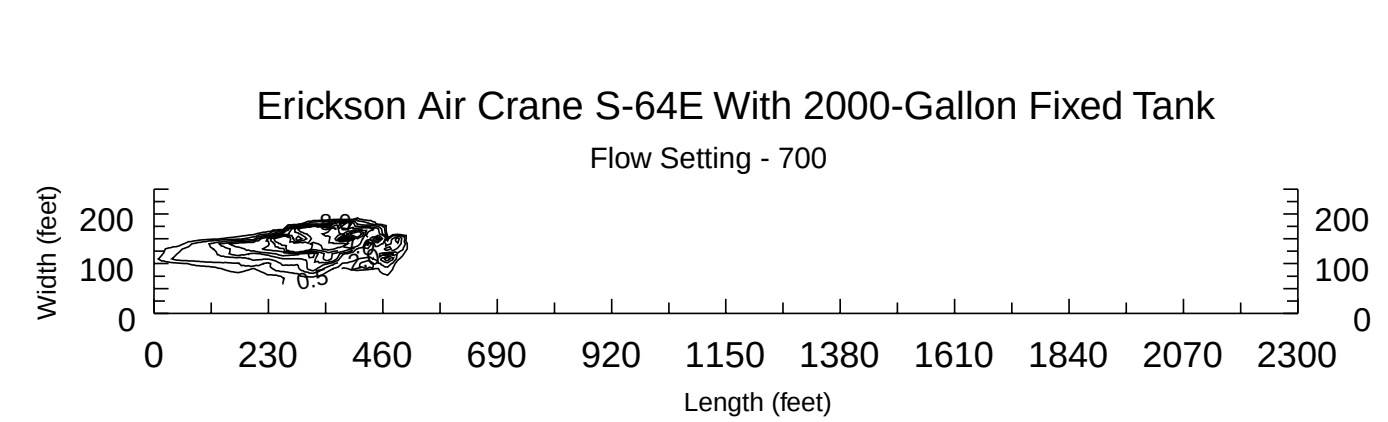

Figure 4–Drop pattern characteristics for the Erickson Air Crane using gum-thickened retardant with a constant flow system, a flow rate of 700 gal/sec, an airspeed of 68 knots (78 mph), and a drop height of 177 feet. The contour lines are at coverage levels of 0.5, 1, 2, 3, 4, 6, 8, and 10 gallons per square feet.

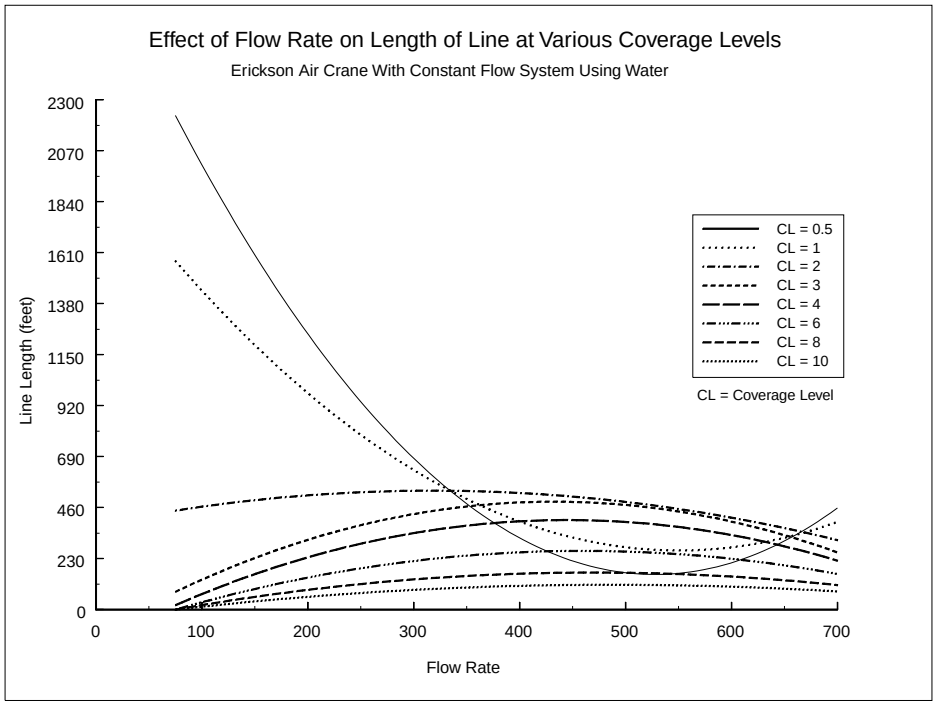

Figure 5–Use this graph to estimate the flow rate needed to produce the longest line of water at various coverage levels.

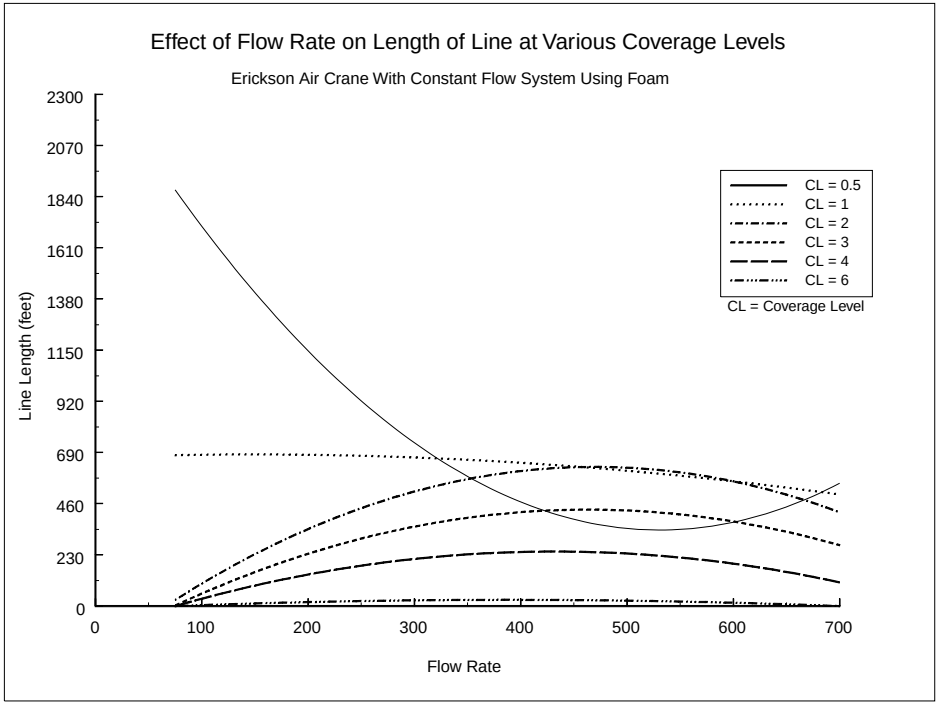

Figure 6–Use this graph to estimate the flow rate needed to produce the longest line of foam at various coverage levels.

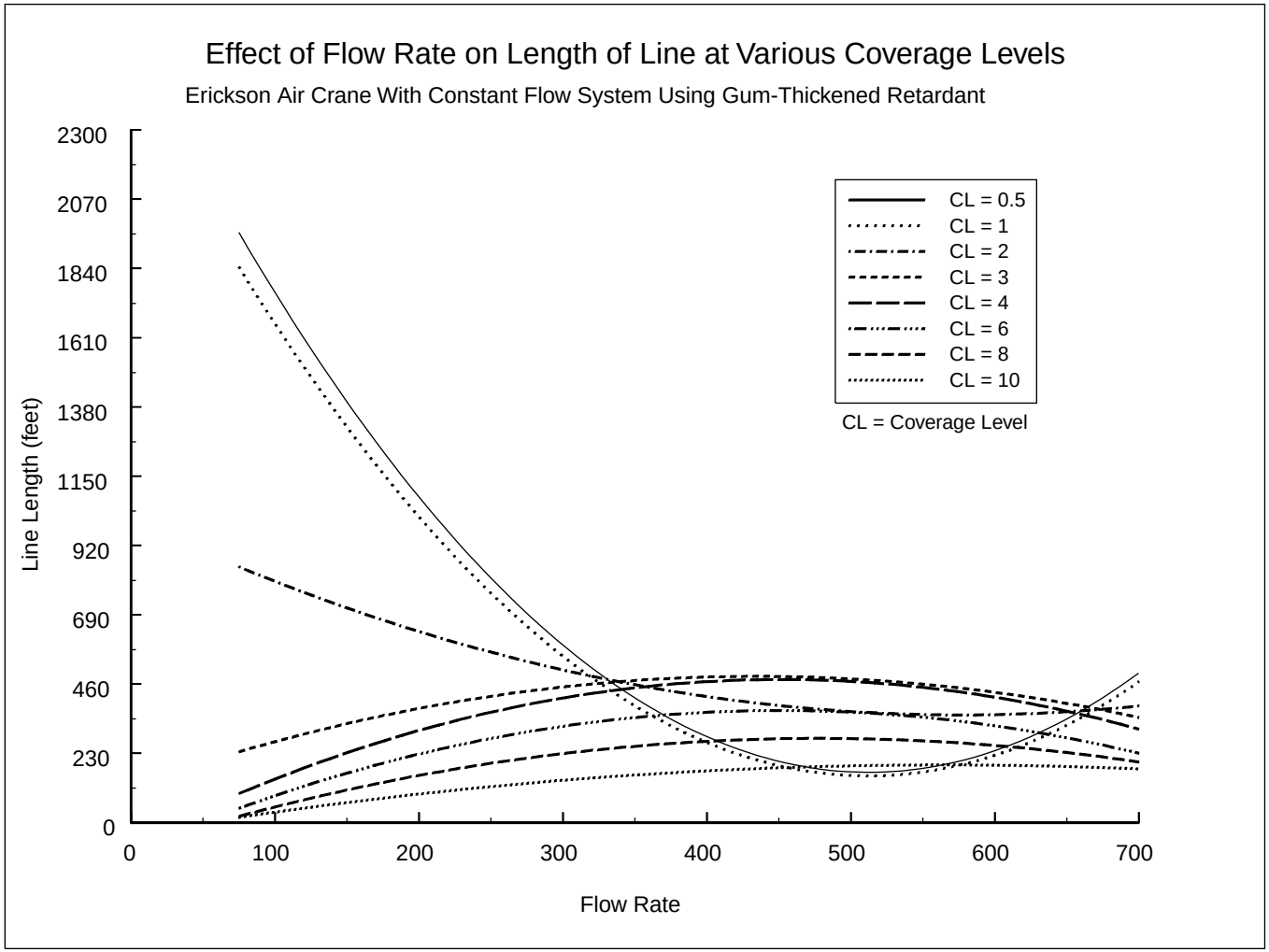

Figure 7–Use this graph to estimate the flow rate needed to produce the longest line of gum-thickened retardant at various coverage levels.

Figure 8–An Erickson Air Crane drops foam from the constant flow tank.

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