0057-2849-MTDC
September 2000
5100/5700

Airtanker Drop Guides

United States Department of Agriculture
Forest Service
Technology & Development Program

Ground Pattern Performance of the Aero Union SP-2H

Paul Solarz, Project Leader, and Cammie Jordan, Project Assistant

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 Aero Union Corporation SP-2H is one of a family of airtankers that are used for initial attack fire suppression and defined as a Type II airtanker.

The Aero Union SP-2H constant flow system contains a single compartment that is certified by the Interagency Airtanker Board to carry 2000 gallons. The tank contains bulkhead dividers to minimize fluid movement from front to back and to provide structural integrity. Two opposing doors, which run the length of the tank, are used to control the fluid flow. The doors are controlled by a servo controller with a MOOG valve, which interprets fluid height information from sensors in the forward and aft compartments and adjusts the door opening to produce a constant rate of flow from the tank. The flow rate and volume for any individual drop can be adjusted to meet Interagency Airtanker Board criteria by programming the controller. Any fraction of the load can be released by holding down the drop button. When the operator lets go of the button, the doors will close. Tests included airspeeds from 112 to 134 knots (90 to 100 mph) and drop heights from 112 to 315 feet (measured from the bottom of the tank to ground). The drops were made with water and with gum-thickened retardant.

The Missoula Technology and Development Center (MTDC) tested the Aero Union SP-2H (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 for the AeroUnion SP-2H.

Flow rate, drop height, volume, and airspeed affect the drop pattern. Increasing drop height gradually widens the drop while decreasing the coverage levels. This effect is modified by the ambient wind. Increasing windspeed widens the drop, decreasing coverage levels. Increasing airspeed increases the line length while reducing the coverage level. Because this airtanker has variable volume and flow rates, it can use specific coverage levels needed for accurate drops. Figures 2 and 3 show the effect of using water and gum-thickened retardant at a coverage level setting of 3. These drops were made at speeds of 125 and 126 knots (144 and 145 mph) and drop heights of 162 and 164 feet.

For additional Information contact: *Greg Lovellette, Project Leader; Missoula Technology & Development Center; 5785 Highway 10 West; Missoula, MT 59808. Phone: 406-329-4815; Fax: 406-329-4811; E-mail: glovellette@fs.fed.us; Lotus Notes: Greg Lovellette/WO/USDAFS*

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 flow rate settings using the constant flow tank.

Coverage Level (gal/100 sq. ft)	Flow Rate (gal/sec)	Coverage Level (setting)	Drop Length (feet)
0.5	234	2	2244
1.0	225	2	1970
2.0	225	2	870
3.0	607	6	372
4.0	607	6	114
6.0	476	4	13
8.0	476	4	1
10.0	-	-	-

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

Coverage Level (gal/100 sq. ft)	Flow Rate (gal/sec)	Coverage Level (setting)	Drop Length (feet)
0.5	221	2	1816
1.0	221	2	1478
2.0	353	3	1184
3.0	476	4	755
4.0	585	5	545
6.0	607	6	273
8.0	607	6	74
10.0	607	6	28

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 Models.

The results of drop tests allow managers to estimate the airspeed, drop height, and flow rate 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 flow rate of a water drop for the longest line of the desired coverage level. Table 3 or Figure 5 can be used to estimate the flow rate of a gum-thickened retardant drop for the longest line of the desired coverage level.

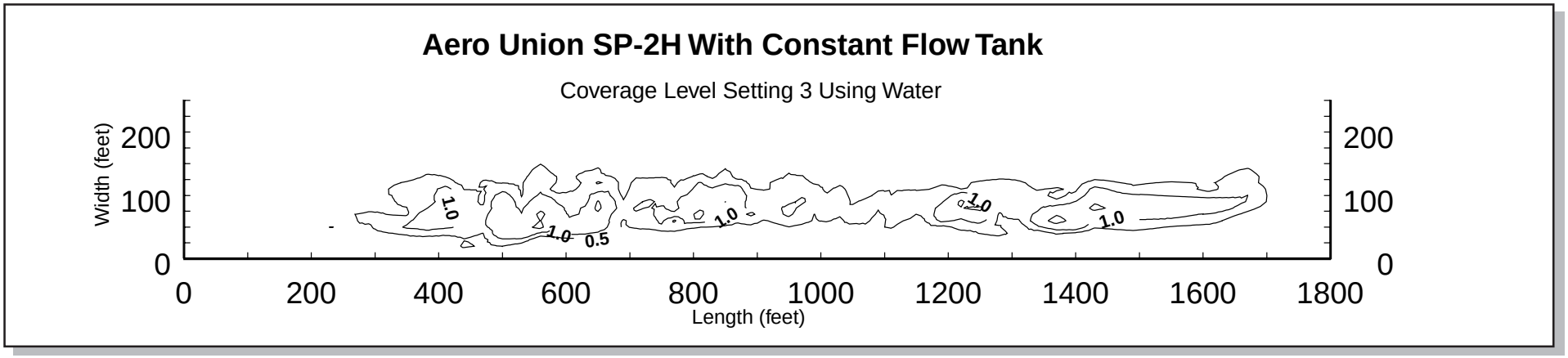

Figure 2–Drop pattern characteristics for the Aero Union SP-2H using water with a coverage level setting of 3, an airspeed of 85 knots (98 mph), and a drop height of 46 feet. The contour lines are at coverage levels of 0.5, 1, 2, 3, 4, 6, 8, and 10 gallons per 100 square feet.

The graphs predict line length (in feet) as a function of flow rate. 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 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 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.

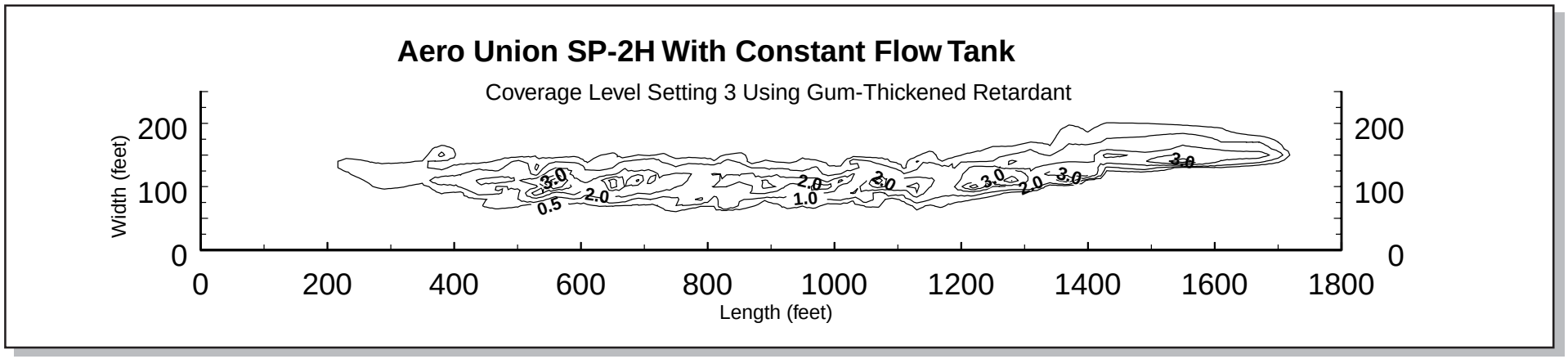

Figure 3–Drop pattern characteristics for the Aero Union SP-2H using gum-thickened retardant with a coverage level setting of 3, an airspeed of 85 knots (98 mph), and a drop height of 90 feet. The contour lines are at coverage levels of 0.5, 1, 2, 3, 4, 6, 8, and 10 gallons per 100 square feet.

For example, if a fire is burning in NFDRS Fuel Model F (Fire Behavior Model 5), represented by intermediate brush (green), a coverage level of 3 is required (Table 1). The graph for gum-thickened retardant shows that for coverage level 3, a coverage level setting of 4 produces the longest line (755 feet).

The ground drop characteristics for the Aero Union SP-2H 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 airspeed, drop height, and flow rate for delivering water or gum-thickened retardant. Actual coverage may vary depending on terrain, wind, weather, and pilot proficiency.

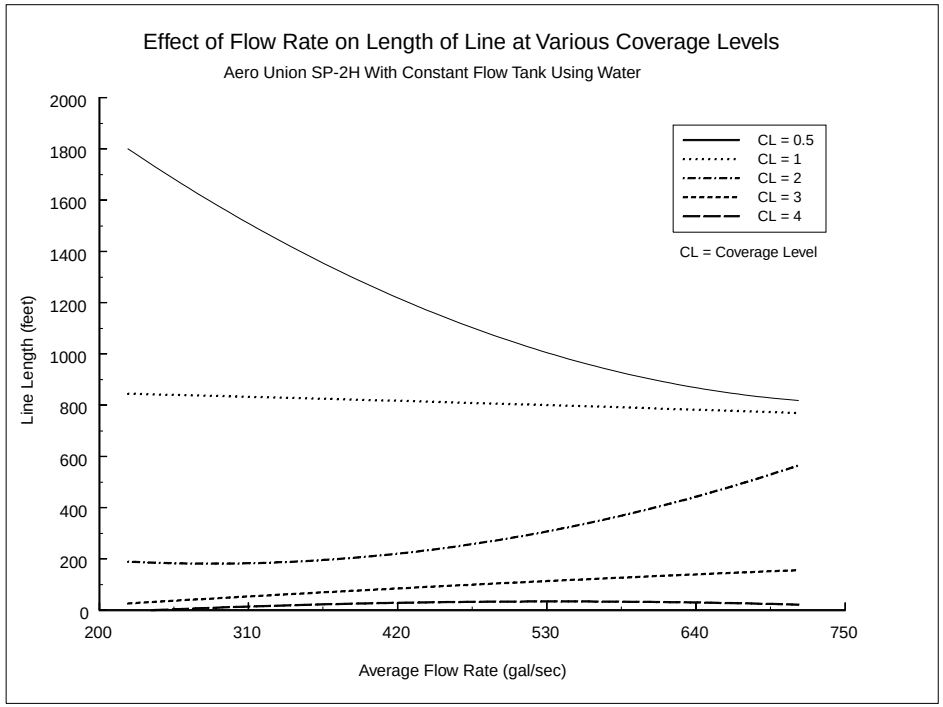

Figure 4–Use this graph to estimate the flow rate needed to produce the longest line of water at various coverage levels.

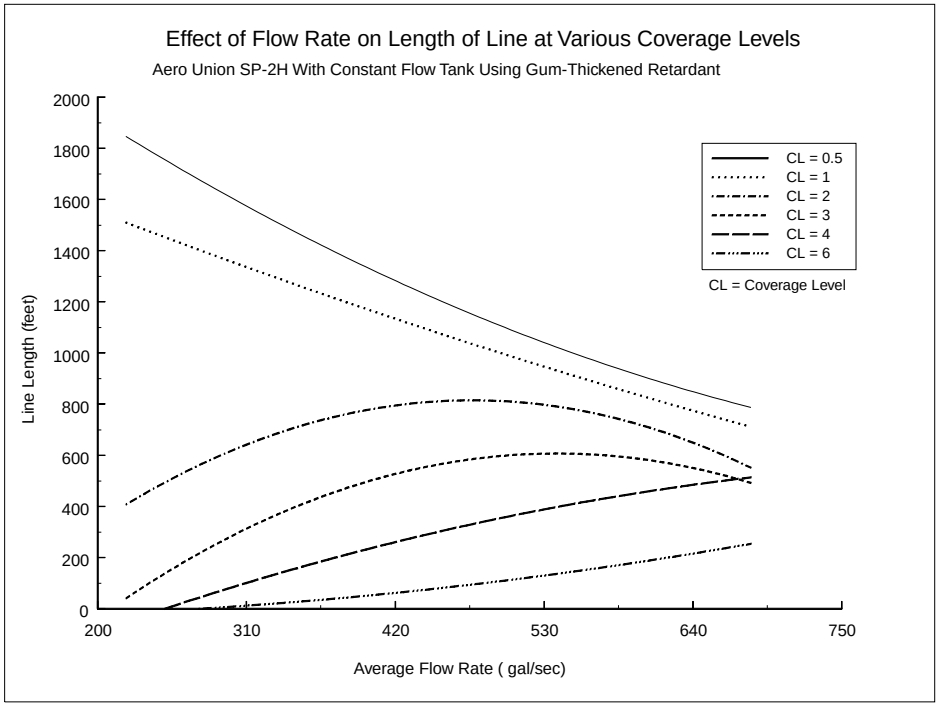

Figure 5–Use this graph to estimate the flow rate needed to produce the longest line of gum-thickened retardant at various coverage levels.

Figure 6–Drop test of the Aero Union SP-2H.

About the Authors

Cammie Jordan is a Project Assistant for the Wildland Fire Chemical Systems Program at MTDC. She is currently enrolled at the University pursuing a bachelorís degree in Elementary Education with a Special Education Endorsement. She has worked for MTDC in Missoula since 1998.

Paul Solarz is Program Leader for the Wildland Fire Chemical Systems Group. He received his bachelor's degree from Eastern Oregon State College in 1986. Paul has worked in Aviation and Fire Management since 1973, serving at seven Ranger Districts and in two Forest Supervisor's offices. He has an extensive operational background in fire, fuels, and aviation.

Additional single copies of this document may be ordered from:

USDA Forest Service
Missoula Technology and Development Center
5785 Highway 10 West
Missoula, MT 59808
Phone: (406) 329-3978
Fax: (406) 329-3719
Internet: wo_mtdc_pubs@fs.fed.us

For additional technical information, contact Greg Lovellette at the address above.

Phone: (406) 329-4815
Fax: (406) 329-4811
Lotus Notes:Greg Lovellette/USDAFS/WO
Internet: glovellette@fs.fed.us

An electronic copy of this document is available on the Forest Service s FSWeb Intranet at:

http://fsweb.mtdc.wo.fs.fed.us