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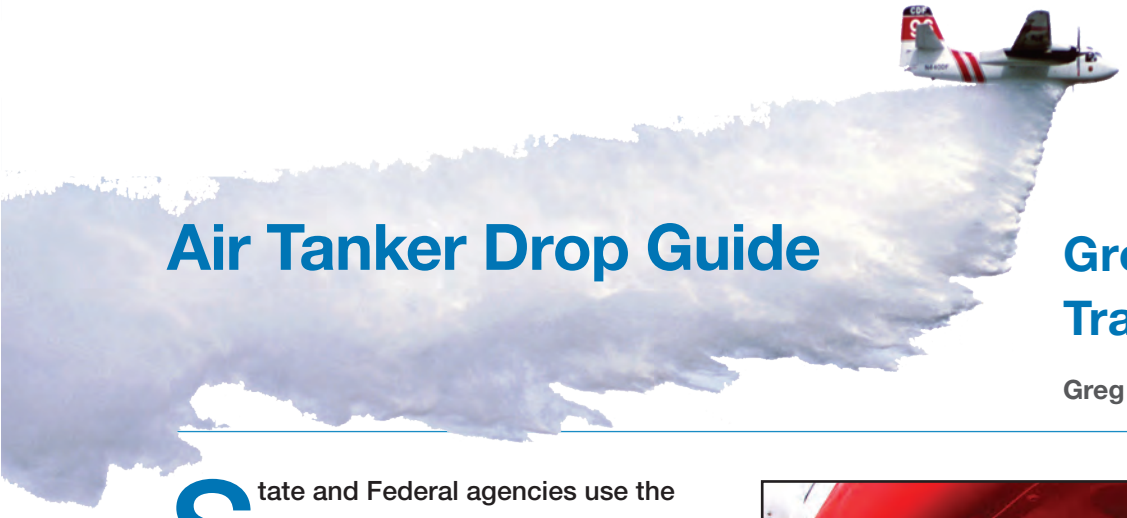

Air Tanker Drop Guide

Ground Pattern Performance of the Air Tractor AT-802 With Hydromax Fire Gate

Greg Lovellette, Physical Scientist

State and Federal agencies use the Air Tractor 802 (AT-802) with the Hydromax fire gate (figure 1) as a type III, single-engine airtanker (SEAT) resource for wildland fire suppression. Alaska Aviation Services, LLC, designed the fire gate and controller system. The Interagency Airtanker Board certified this constant flow system to carry 800 gallons of retardant. The SEAT pilot can select flow rate and volume for any individual drop using a touchscreen control panel in the cockpit. The pilot can also release any fraction of the load by holding down the drop button. When the pilot releases the button, the doors close.

Figure 1—A Hydromax fire gate installed on an Air Tractor AT-802.

The U.S. Department of Agriculture, Forest Service, National Technology and Development Program, Aerial Delivery Project (Aerial Delivery), drop tested this system during the fall of 2009. The aircraft performed all drops with gum-thickened retardant over an array of 4-inch-wide by 2-inch-deep plastic bowls. After each drop, grid crews collected the bowls and measured the quantity of material in each bowl to generate drop deposition patterns. Figures 2 and 3 display the ground deposition response from two different flow rates.

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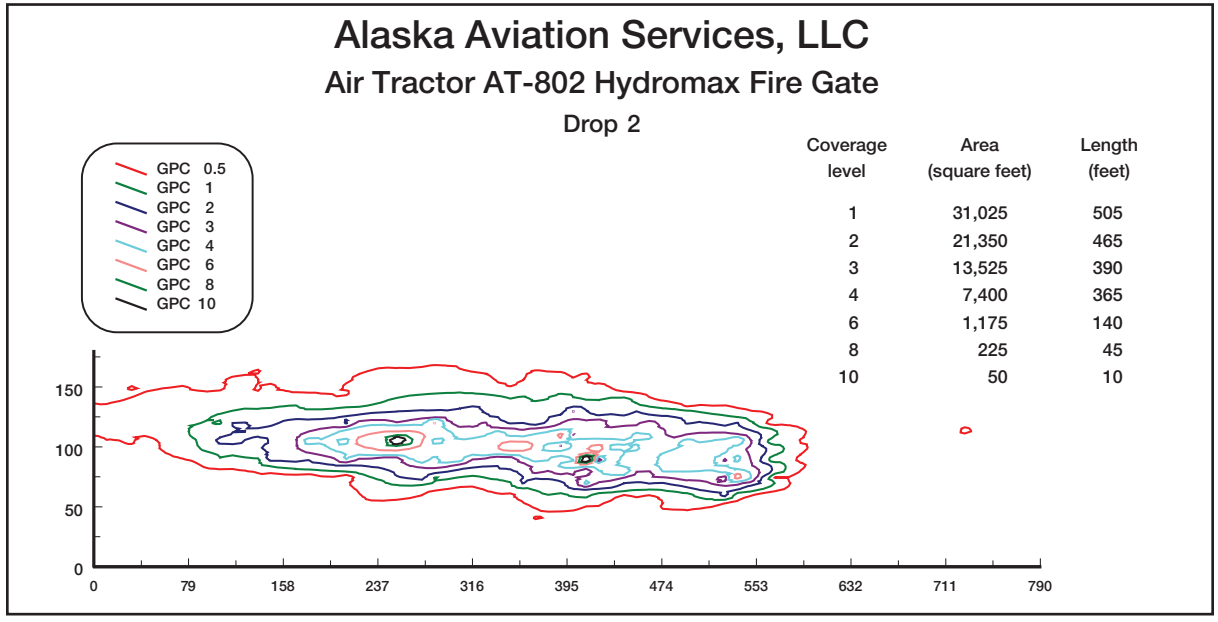

Figure 2—A full load drop with a flow rate of 350 gallons per second.

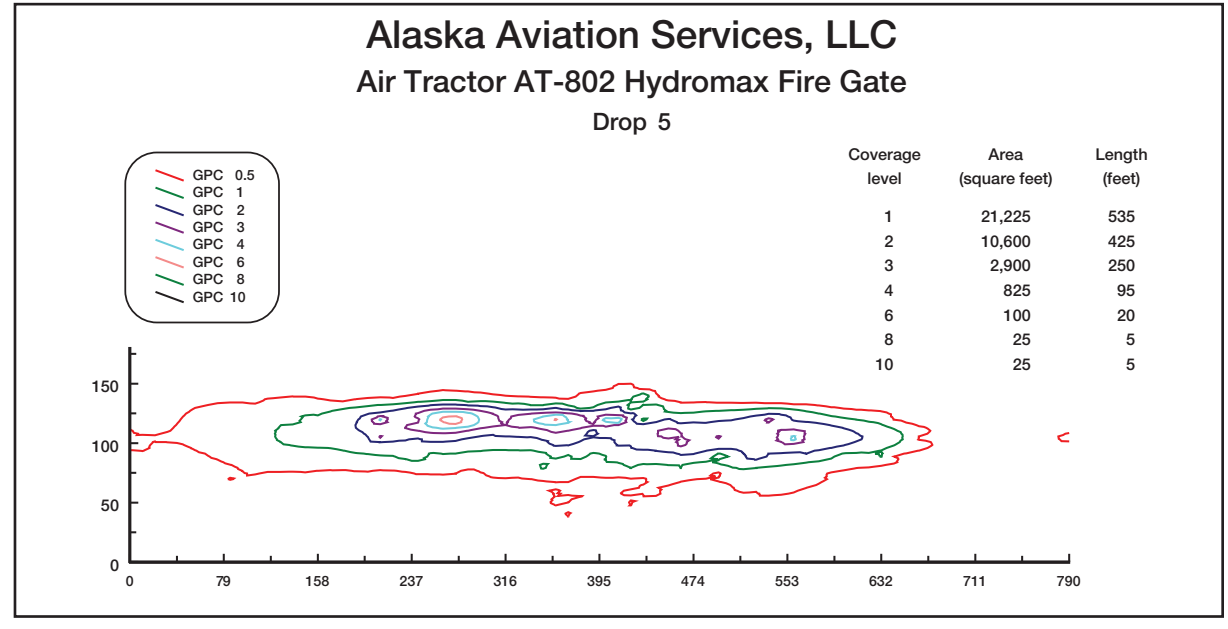

Figure 3—A half load drop with a flow rate of 130 gallons per second.

The results of drop tests allow managers to estimate the line length of the most effective coverage level required for a given fire intensity based on flow rate, volume, drop height, and groundspeed. In general, increasing flow rate creates higher coverage levels within the pattern, but reduces overall pattern length. Increasing volume creates longer patterns. Increasing drop height widens the drop pattern and increases wind drift effect while decreasing the coverage levels. Increasing airspeed increases the pattern length, but reduces coverage levels.

The pilot uses the drop controller to adjust flow rate and volume to compensate for the effects of drop height and speed variation, and to produce coverage levels and line lengths needed for various fire suppression missions. The optimum ground deposition of fire-retarding material, expressed in gallons per 100 square feet (GPC), differs depending on the fuel type and fire intensity. Table 1 shows the coverage needed for specific fuel types using both the National Fire Danger Rating System (NFDRS) and the fire behavior fuel models.

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

Fuel model		Coverage level (gallons per 100 square feet)	Description
National Fire Danger Rating System (NFDRS)*	Fire behavior		
A, L, S	1	1	Annual and perennial western grasses, tundra
C	2	2	Conifer with grass
H, R	8	2	Shortneedle closed conifer, fall hardwood
E, P, U	9	2	Longneedle conifer, fall hardwood
T	2	3	Sagebrush with grass
N	3	3	Sawgrass
F	5	3	Intermediate brush (green)
K	11	3	Light slash
G	10	4	Shortneedle conifer (heavy dead litter)
D	4	6	Southern rough
F, Q	6	6	Intermediate brush (cured), Alaska black spruce
B, O	4	Greater than 6	California mixed chaparral, high pocosin
J	12	Greater than 6	Medium slash
I	13	Greater than 6	Heavy slash

* Find National Fire Danger Rating System codes in: Cohen, J.D.; Deeming, J.E. 1985. The National Fire Danger Rating System: basic equations. Gen. Tech. Rep. PSW–82. Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station. 16 p. <http://ftp.fs.fed.us/psw/publications/documents/psw_gtr082/psw_gtr082.pdf>.

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Aerial Delivery constructed table 2 from actual drop test data. It lists the longest observed line length (on the ground) of each coverage level using gum-thickened retardant when dropping full and half loads. The table also includes the total deposition pattern length and the percent of that overall pattern containing the selected coverage level. For example, a half load with a flow controller setting of 2 produced 576 cumulative feet of 1 GPC coverage level. The overall pattern length was 712 feet, of which 81 percent was at 1 GPC or higher.

Table 2—Gum-thickened retardant tests producing the most line of coverage levels from the Hydromax fire gate with Air Tractor AT-802.

Coverage level (gallons per 100 square feet)	Flow rate (gallons per second)	Flow controller setting	Coverage level line length (feet)	Total deposition pattern length (feet)	Coverage level to total length (percent)
Half loads					
0.5	80	1	777	777	100
1	130	2	576	712	81
2	130	2	468	712	66
3	250	3	212	452	47
4	250	3	148	452	33
6	325	4	44	388	11
8	325	4	16	388	4
Full loads					
0.5	80	1	1554*	1554*	100
1	130	2	1152*	1424*	81
2	130	2	936*	1424*	66
3	240	3	495	744	67
4	240	3	370	744	50
4	350	4	365	600	61
6	350	4	140	600	23
8	350	4	45	600	8

* Values estimated from half load drops.

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. Depending on experience or a recommendation, the pilot can adjust the target coverage level up or down based on the actual fire intensity.

Use table 2 to find the corresponding coverage level setting on the aircraft drop controller, volume dropped, and longest line produced. For example, a coverage level of 3 GPC is required for a fire burning in light slash (NFDRS fuel model K/fire behavior fuel model 11—see table 1). Table 2 shows that a controller setting of 3 produces the most line (495 feet) of 3 GPC when dropping a full 800-gallon load. Aerial Delivery derived the values in table 2 through controlled drop test procedures on flat ground.

This information serves only as a guide to help field personnel estimate line length production of desired or required coverage levels. Actual line length may vary depending on terrain, wind, weather, and pilot proficiency.

About NTDP

The U.S. Department of Agriculture, Forest Service, National Technology and Development Program, provides Forest Service employees and partners with practical, science-based solutions to resource management challenges. We evaluate, design, and develop new technologies, products, and systems to solve problems and deliver solutions.

About the Author

Greg Lovellette is a physical scientist for the U.S. Department of Agriculture, Forest Service, National Technology and Development Program, Aerial Delivery Project. He has worked with the technical tank and gating aspects of aerial retardant delivery systems since joining the Forest Service in 1989.

Library Card

Lovellette, G. 2019. Ground pattern performance of the Air Tractor AT-802 with Hydromax fire gate. 1751–2802P–NTDP. Tech. Rep. Missoula, MT: U.S. Department of Agriculture, Forest Service, National Technology and Development Program. 6 p.

This report describes the results of tests to determine the optimal ground pattern coverage of gum-thickened retardant dropped from the Air Tractor AT-802 with Hydromax fire gate. The results of drop tests allow managers to estimate the line length of the most effective coverage level required for a given fire intensity based on airspeed, drop height, and flow rate. Two graphs with contour lines at 0.5, 1, 2, 3, 4, 6, 8, and 10 gallons per 100 square feet compare the drop pattern characteristics for the Air Tractor AT-802 with Hydromax fire gate at two different flow rates but at similar drop heights and speeds. A table shows the coverage of fire-retarding material needed for specific fuel types and fire behavior. Another table lists the predicted line lengths, based on actual drop test measurements, of selected coverage levels.

Keywords: chemicals, drop guides, retardants, single engine airtanker, wildland fires, wild land fires, wildfires

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