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Airtanker Drop Guides

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Forest Service
Technology & Development Program

Ground Pattern Performance of the Neptune P2V-7 Airtanker

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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 ground pattern coverage over a wide range of fuel and fire conditions. The Neptune P2V-7 with a conventional tank, owned and operated by Neptune Aviation, is one of a family of multiengine airtankers designed for fire suppression as a Type II airtanker.

The conventional tank is constructed of aluminum. The door opening is actuated by an independent hydraulic system mechanically activated using 28 volts dc aircraft power using a Black Hills-type controller. The tank is certified to hold 2450 gallons. It includes six compartments and six doors arranged side by side, running the length of the tank with all doors hinged on the outboard side. Each compartment contains deployable flow restrictors to help control the flow rate. Restrictors serve as a physical barrier that lowers the flow rate as liquid is released from the tank (Figure 2). Tests included airspeeds from 109 to 144 knots (125 to 166 mph) and drop heights from 78 to 232 feet (measured from the bottom of the tank to ground). The drops were made with two different materials: water and gum-thickened retardant.

The Missoula Technology and Development Center tested the Neptune P2V-7 (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.

Flow rate, drop height, 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, 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. Because each compartment has restrictors, specific coverage levels can be produced by raising or lowering restrictors and releasing more than one compartment at a time. Figures 3 and 4 show the effect of using the restricted or unrestricted flow settings while dropping water from compartments 1 and 2 simultaneously. These drops included an airspeed of 122 knots (140 mph) and drop heights of from 171 to 196 feet (measured from the bottom of the tank to ground). The volume of the drops was 808 gallons.

Figure 1–A static test of the Neptune P2V-7..

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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

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.

The results of drop tests allow managers to estimate the length of line a specific airtanker produces at various coverage levels. With conventional airtankers, trail drops are performed to produce different line lengths of coverage level. Computer simulation and drop test data were used to determine the time intervals between simultaneous releases of the two compartments that produced the longest line of the desired coverage level. Drop height, airspeed, and windspeed also affect the drop pattern. Table 2 or Figure 5 demonstrates the restricted gum-thickened retardant test drops producing the longest line of the desired coverage level based on varying the time interval between three simultaneous releases of two compartments (2 X 3 trail drop).

Table 2–Maximum line-length intervals based on a drop of compartments 1 and 2, with a drop height of 196 feet, an airspeed of 122 knots, and a windspeed of 12.0 mph. The restrictors were deployed and 808 gallons of gum-thickened retardant were dropped.

Coverage Level (gal/100 sq. ft)	Time Interval Between Releases (seconds)	Line Length (feet)
0.5	1.80	1120
1.0	1.36	830
2.0	1.07	680
3.0	0.73	520
4.0	0.58	430
6.0	0.49	310
8.0	0.49	220
10.0	0.29	180

Table 3–Maximum line-length intervals based on a drop of compartments 1 and 2, with a drop height of 171 feet, an airspeed of 122 knots, and a windspeed of 14.5 mph. This drop was unrestricted and 808 gallons of gum-thickened retardant were dropped.

Coverage Level (gal/100 sq. ft)	Time Interval Between Releases (seconds)	Line Length (feet)
0.5	2.87	1740
1.0	1.89	1140
2.0	0.73	520
3.0	0.24	380
4.0	0.19	280
6.0	0.15	110
8.0	0.15	40
10.0	-	-

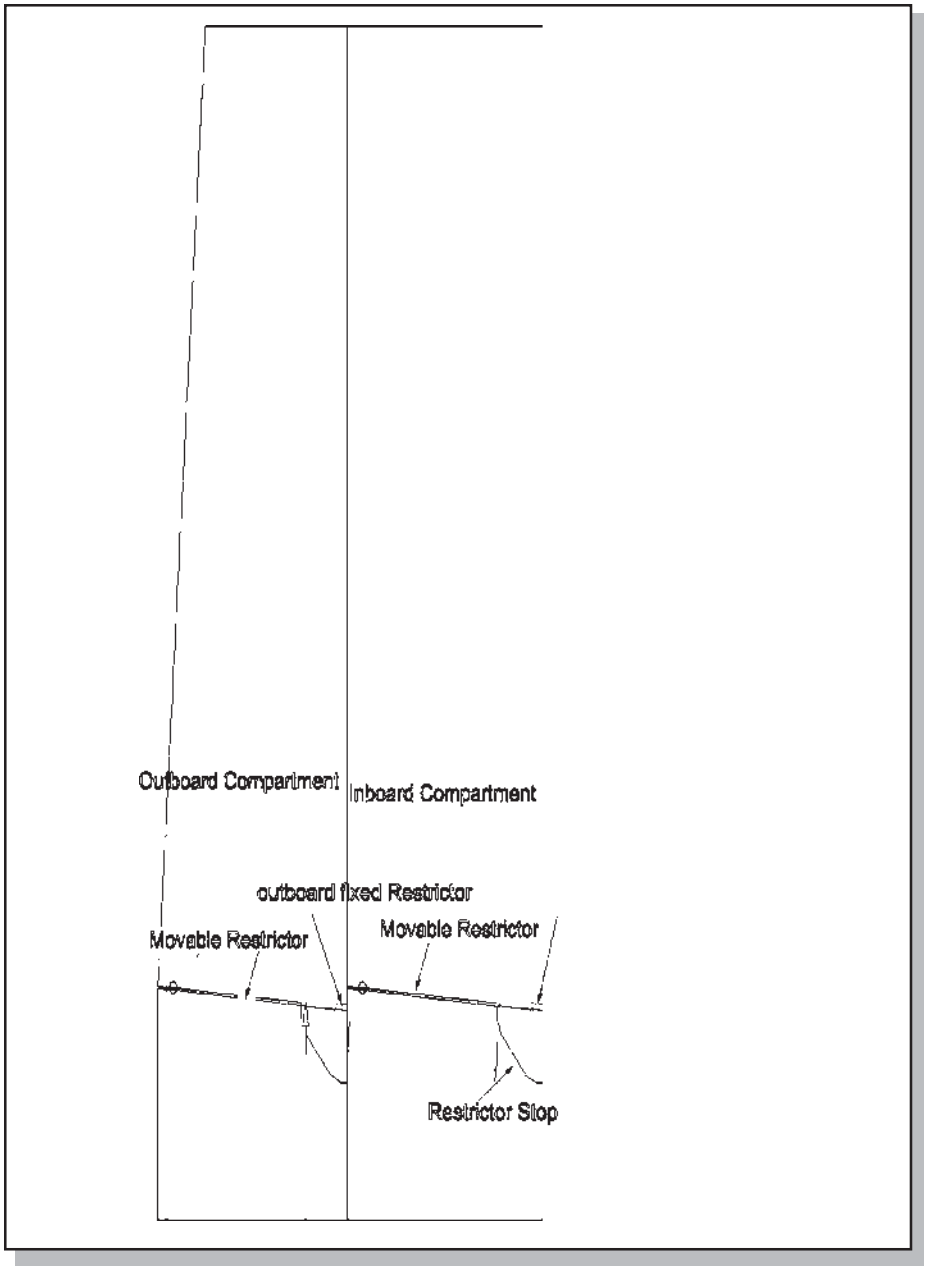

Figure 2–Drawing of the restrictors in the Neptune P2V-7 tank.

Table 3 or Figure 6 demonstrates the unrestricted gum-thickened retardant test drops producing the longest line of the desired coverage level based on varying the time interval between three simultaneous releases of two compartments (2 X 3 trail drop). The graphs predict line length (in feet) as a function of time interval (in seconds). 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 volume required to produce the longest line for a given coverage level.

To select the proper airtanker time interval, 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 the 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 time interval can be found. Use the table for the material dropped (water or gum-thickened retardant) to find the time interval that produces the longest line for the desired coverage level.

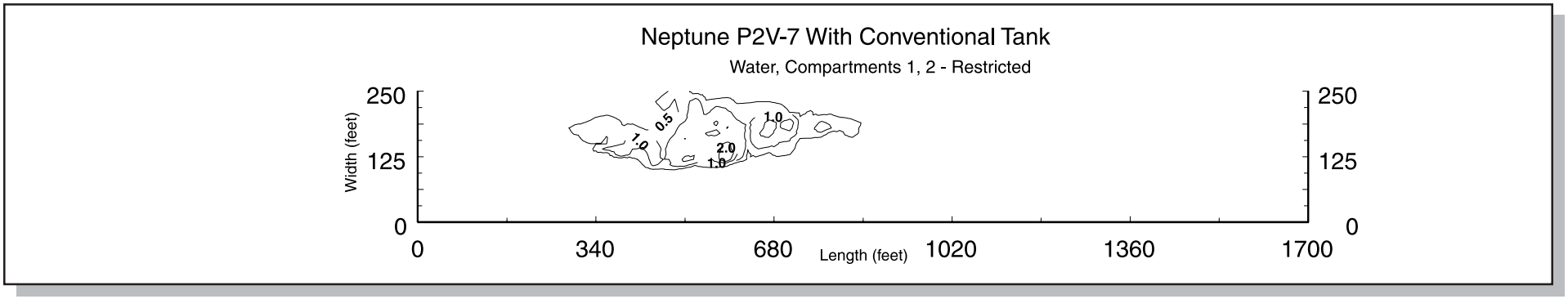

Figure 3–Drop pattern characteristics for the Neptune P2V-7 with a restricted conventional tank using compartments 1 and 2 with an airspeed of 122 knots (140 mph) and a drop height of 196 feet. The contour lines are at coverage levels of 0.5, 1, 2, 3, 4, 6, 8, and 10 gallons per 100 square feet.

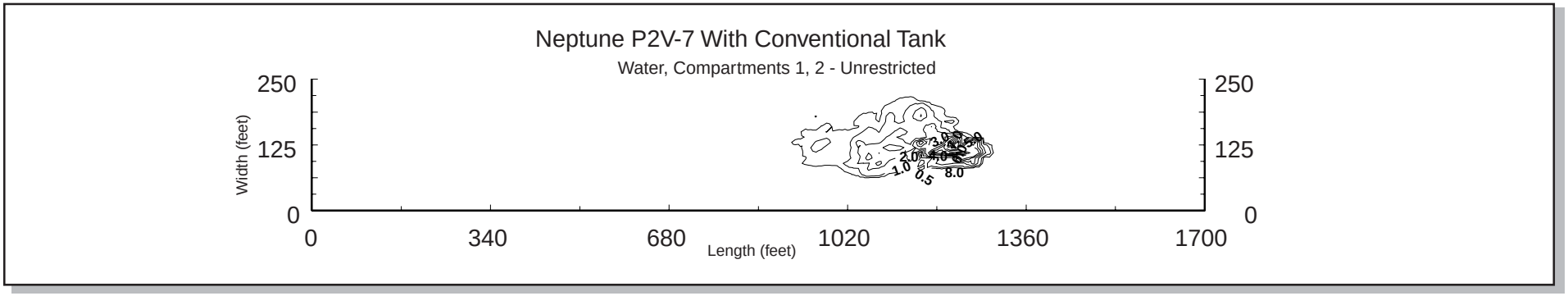

Figure 4–Drop pattern characteristics for the Neptune P2V-7 with an unrestricted conventional tank using compartments 1 and 2 with an airspeed of 122 knots (140 mph) and a drop height of 171 feet. The contour lines are at coverage levels of 0.5, 1, 2, 3, 4, 6, 8, and 10 gallons per 100 square feet.

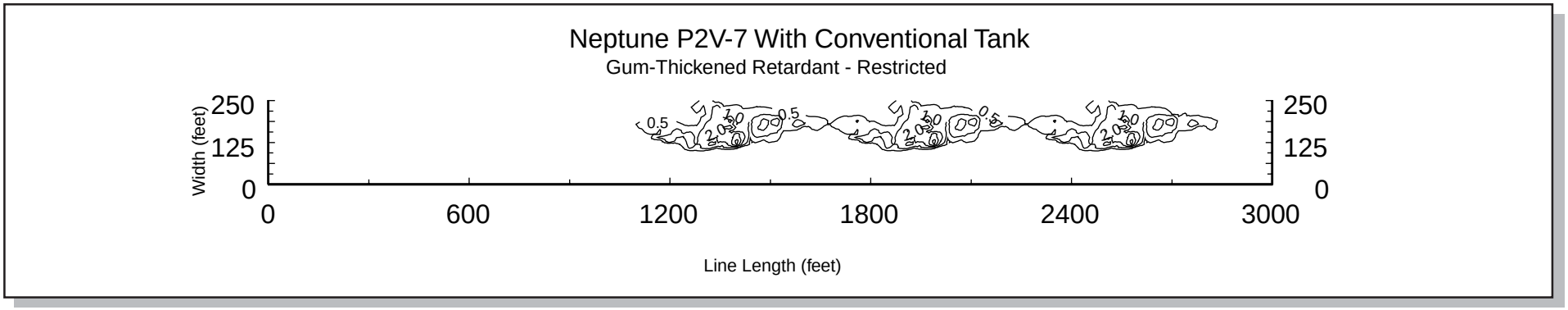

Figure 5–Drop pattern characteristics for the Neptune P2V-7 using gum-thickened retardant with a restricted conventional tank using compartments 1 and 2 at a 2.87-second time interval with a computer-simulated, restricted 2 X 3 trail drop (both compartments released simultaneously three different times).

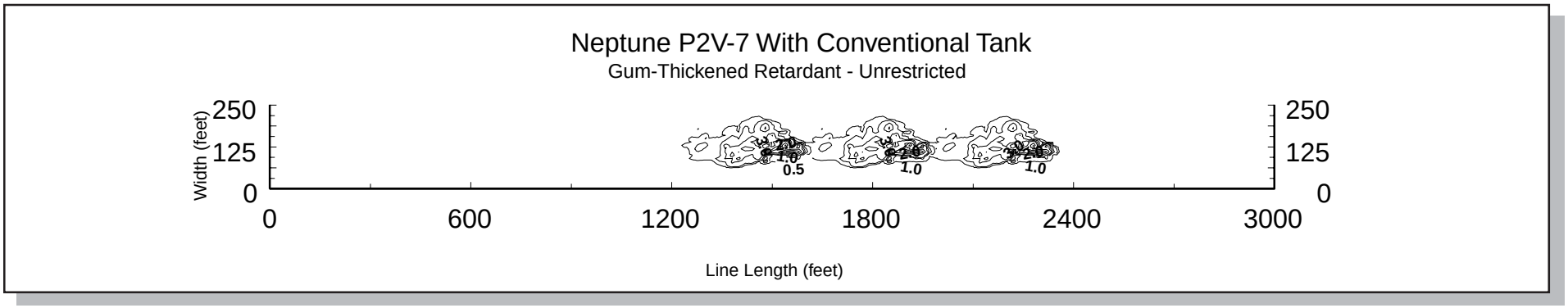

Figure 6–Drop pattern characteristics for the Neptune P2V-7 using gum-thickened retardant with an unrestricted conventional tank using compartments 1 and 2 at a 1.80-second time interval with a computer-simulated, restricted 2 X 3 trail drop (both compartments released simultaneously three different times).

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 table for gum-thickened retardant shows that for coverage level 3, an unrestricted 2 x 3 trail drop (three simultaneous releases of both compartments), produces the longest line (520 feet) when the interval between releases is 0.24 seconds.

The ground drop characteristics for the Neptune P2V-7 were derived through controlled drop test procedures on flat ground (Figure 7). The time intervals were derived through computer simulation by overlaying the drop pattern produced from simultaneous release of compartments 1 and 2. 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 7–Gum-thickened retardant being dropped by the Neptune P2V-7.

About the Authors

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