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Airtanker Drop Guides

United States Department of Agriculture
Forest Service
Technology & Development Program

Ground Pattern Performance of the Marsh Turbo Thrush

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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 Marsh Turbo Thrush, owned and operated by the Marsh Aviation Company, is an aircraft designed for use as an agricultural sprayer. It is converted for fire suppression by adding a fire door.

The Missoula Technology and Development Center tested the Marsh Turbo Thrush (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.

The standard fire door was replaced by the Marsh 60/40 fire door. The Marsh 60/40 door is designed with two adjacent doors, one opening 40 percent and the other opening 60 percent of the available area. The system provides three flow rates by opening either the 40 percent door, the 60 percent door, or both. The doors are hydraulically controlled. The aircraft's tank holds 380 gallons. Tests were conducted at airspeeds from 80 to 86 knots (92 to 99 mph) and drop heights from 24 to 31 feet from the bottom of the door to ground. The drops were made with three different materials: water, foam, and gum-thickened retardant.

Flow rate, drop height, and air speed all have an effect on the drop pattern. Since this type of airtanker is normally used over a narrow range of height and speeds, only the effect of flow rate is considered here. Figures 2, 3, and 4 show the drop patterns resulting from flow rates produced by using the 40-percent, 60-percent, or 100-percent door opening. The proper amount of retardant (expressed as coverage level in gallons per 100 square feet) differs depending on the fuel model. Table 1 shows the coverage needed for specific fuel models. It is cross referenced to both the National Fire Danger Rating System (NFDRS) and Fire Behavior Fuel Model descriptions.

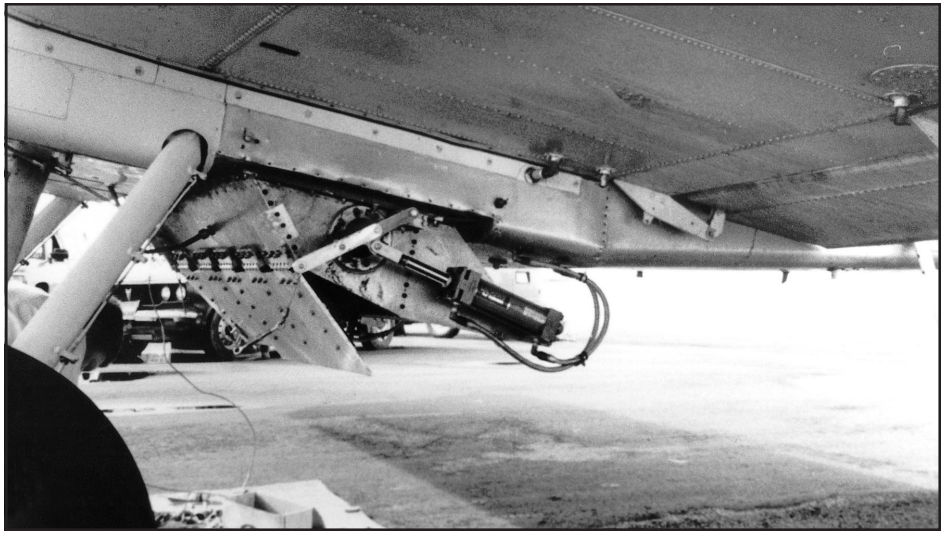

Figure 1–View of the gate of the Marsh Turbo Thrush.

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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 door openings.

Coverage Level (gal/100 sq. ft)	Door Opening (percent)	Line Length (feet)
0.5	40	1074
1.0	60	471
2.0	60	319
3.0	60	215
4.0	100	145
6.0	100	56
8.0	100	13
10.0		0

Table 3–Foam tests producing the longest line at various door openings.

Coverage Level (gal/100 sq. ft)	Door Opening (percent)	Line Length (feet)
0.5	40	966
1.0	40	449
2.0	60	279
3.0	100	184
4.0	100	78
6.0	100	5
8.0		0
10.0		0

The results of drop tests allow managers to estimate the length of line a specific airtanker produces at various coverage levels. Table 2 can be used to determine the maximum line length for water at each coverage level.

Table 3 can be used to determine the maximum line length for foam at each coverage level. Table 4 can be used to determine the maximum line length for gum-thickened retardant at each coverage level.

The ground drop characteristics for the Marsh Turbo Thrush were derived through controlled test drop procedures on flat ground (Figure 3).
This information is to serve only as a guide in assisting field personnel to determine the proper drop height, air speed, and door opening for delivering water, foam, or gum-thickened retardant. Actual coverage may vary depending on terrain, wind, weather, and pilot proficiency.

Table 4–Gum-thickened retardant tests producing the longest line at various door openings.

Coverage Level (gal/100 sq. ft)	Door Opening (percent)	Line Length (feet)
0.5	40	1153
1.0	40	657
2.0	100	326
3.0	100	249
4.0	100	219
6.0	100	74
8.0	100	16
10.0	100	4

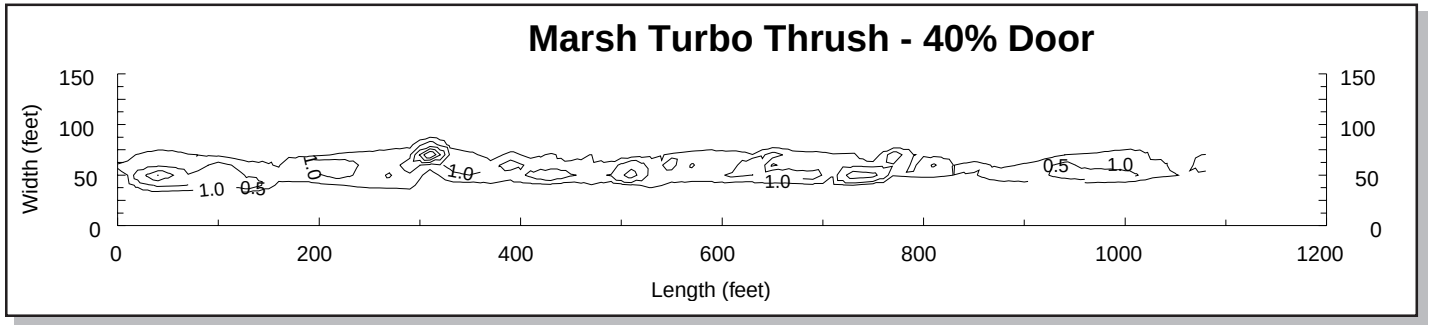

Figure 2–Drop pattern characteristics for the Marsh Turbo Thrush with an air speed of 86 knots (99 mph) and a drop height of 24 feet. The contour lines are at coverage levels of 0.5, 1, 2, 3, 4, 6, 8, and 10 gallons per 100 square feet.

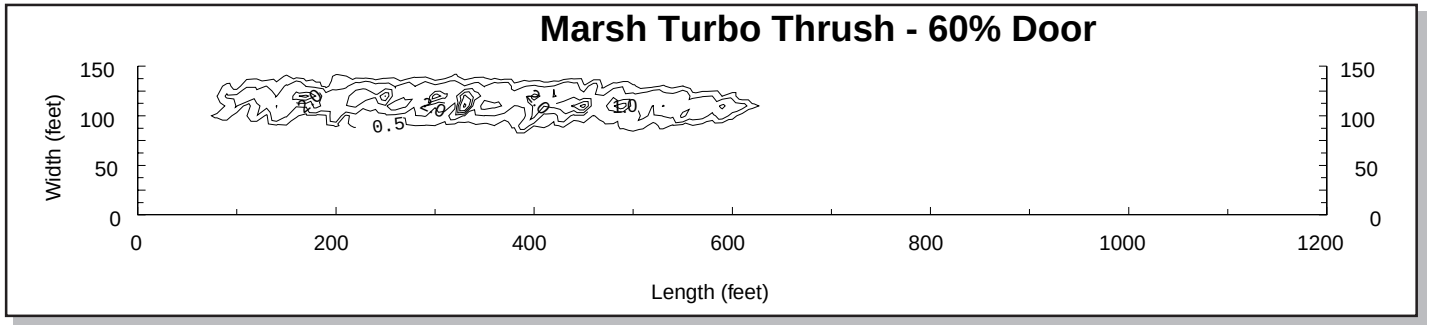

Figure 3–Drop pattern characteristics for the Marsh Turbo Thrush with an airspeed of 83 knots (95 mph) and a drop height of 28 feet. The contour lines are at coverage levels of 0.5, 1, 2, 3, 4, 6, 8, and 10 gallons per 100 square feet.

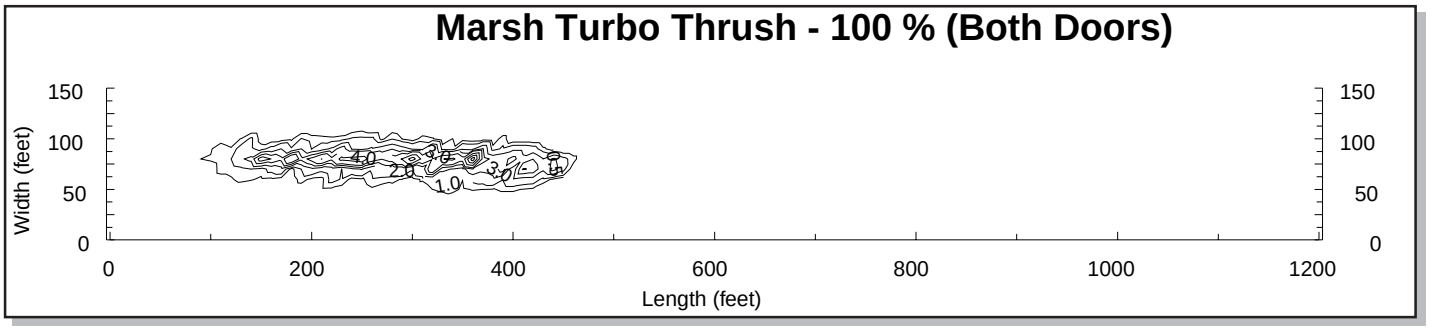

Figure 4–Drop pattern characteristics for the Marsh Turbo Thrush with an airspeed of 80 knots (92 mph) and a drop height of 31 feet. The contour lines are at coverage levels of 0.5, 1, 2, 3, 4, 6, 8, and 10 gallons per 100 square feet.

The tables are constructed by selecting the drop producing the longest length of line (on the ground) at each coverage level from the drop tests. The tables may be used to estimate the door opening required to produce the maximum length of line for a given coverage level.

To select the proper door opening, 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 ideal door opening can be found.

Use the table for the material dropped (water, foam, or gum-thickened retardant) to find the door opening that produces the longest line for the desired coverage level.

Figure 3—Drop test of the Marsh Turbo Thrush.

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