



Ground Pattern Performance of the SEI Industries Bambi 324- Gallon Helibucket

Gregg Johnson, Project Leader, and Cammie Jordan, Project Assistant

The Wildland Fire Chemicals 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 Bambi 324-gallon helibucket is one of a family of helibuckets designed for use with a wide range of helicopters.

The Missoula Technology and Development Center tested the Bambi 324-gallon helibucket 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 helibucket is constructed of a heavy coated fabric mounted to a collapsible frame (Figure 1). The dump valve is

electrically actuated from the helicopter using 28 volts dc aircraft power. The volume of a given drop can be controlled by the rate at which the helibucket is lifted from the water (a faster lift produces more volume) or by adjusting a cinch strap inside the helibucket. During the MTDC tests, the rate that the helibucket was lifted from the retardant was not controlled, producing variations in the volume dropped. The drops in these tests were made with the cinch strap at its maximum opening (maximum volume of 324 gallons).

Tests covered airspeeds from 19 to 89 knots (22 to 102 mph). Drop heights ranged from 25 to 120 feet from the bottom of the helibucket to the ground. The drops were made with three different materials: water, foam and

gum-thickened retardant. Drop height and airspeed both have an effect on the drop pattern. Increasing drop height gradually widens the drop at the expense of higher coverage. This effect is modified by the ambient wind. Increasing wind speed widens the drop and decreases coverage levels. Airspeed has a much greater effect on the drop pattern. Figures 2, 3, and 4 show the effect of increasing the airspeed from 19 to 81 knots (22 to 93 mph). Drop heights are nearly identical, ranging from 42 to 47 feet.

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 using both the National Fire Danger Rating System and Fire Behavior Fuel Model.

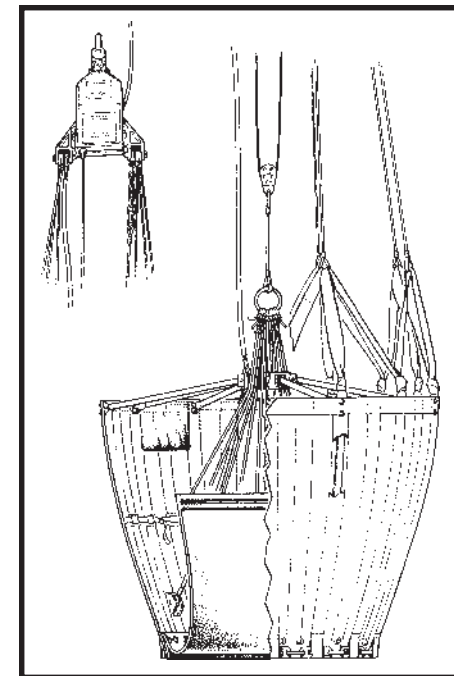


Figure 1 – Cutaway view of the Bambi helibucket.

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 |
| E,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 coverage levels.

| Coverage Level (gal/100 sq. ft) | Drop Speed (knots) | Line Length (feet) |
|------------------------------------|-----------------------|-----------------------|
| 0.5 | 78 | 362 |
| 1.0 | 78 | 342 |
| 2.0 | 64 | 298 |
| 3.0 | 64 | 215 |
| 4.0 | 65 | 185 |
| 6.0 | 37 | 136 |
| 8.0 | 37 | 91 |
| 10.0 | 19 | 68 |

Table 3—Foam tests producing the longest line at various levels of coverage.

| Coverage Level (gal/100 sq. ft) | Drop Speed (knots) | Line Length (feet) |
|------------------------------------|-----------------------|-----------------------|
| 0.5 | 84 | 388 |
| 1.0 | 84 | 363 |
| 2.0 | 62 | 249 |
| 3.0 | 43 | 215 |
| 4.0 | 43 | 164 |
| 6.0 | 19 | 98 |
| 8.0 | 19 | 82 |
| 10.0 | 19 | 61 |

The results of drop tests allow managers to estimate the air speed and height that provide the retardant coverage level required for a given fire intensity. Figure 5 or Table 2 can be used to estimate the air speed of a water drop to obtain the

longest line of the desired coverage level. Figure 6 or Table 3 can be used to estimate the airspeed of a foam drop to obtain the longest line of the desired coverage level. Figure 7 or Table 4 can be used to estimate the air speed of a gum-

thickened retardant drop to obtain the longest line of the desired coverage level. The line length graphs predict line length (in feet) as a function of airspeed (in knots). 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 airspeed required to produce the longest line for a given coverage level. The tables show an ideal case, while the graphs represent an average case.

Table 4—Gum-thickened retardant test producing the longest line at various coverage levels.

| Coverage Level (gal/100 sq. ft) | Airspeed (knots) | Line Length (feet) |
|------------------------------------|---------------------|-----------------------|
| 0.5 | 82 | 403 |
| 1.0 | 82 | 361 |
| 2.0 | 64 | 303 |
| 3.0 | 64 | 270 |
| 4.0 | 44 | 225 |
| 6.0 | 44 | 188 |
| 8.0 | 44 | 128 |
| 10.0 | 24 | 113 |

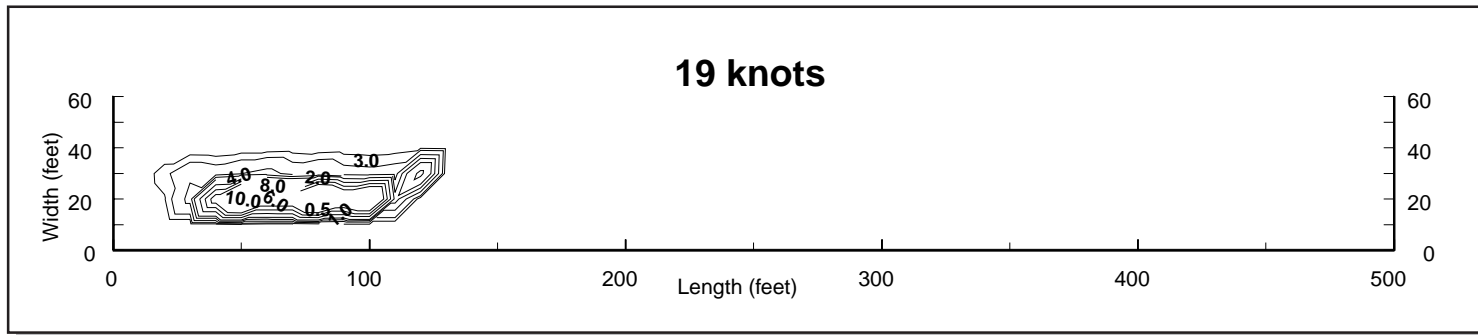


Figure 2— Drop pattern characteristics for the Bambi 324-gallon helibucket with an airspeed of 19 knots and a drop height of 42 feet. The contour lines are at 0.5, 1, 2, 3, 4, 6, 8, and 10 gallons per 100 square feet.

To select the proper helicopter speed, 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 an 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 airspeed can be found. Use the graph for the material dropped (water, foam, or gum-thickened retardant) to find the speed 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 F (Fire Behavior Model 5), represented by intermediate brush (green), Table 1 shows that a coverage level of 3 is required. The graph for water shows that for coverage level 3, a speed of about 64 knots produces the longest line. The ground drop characteristics for the Bambi 324-gallon

helibucket were derived through controlled test drop procedures on flat ground (Figure 8). This information is to serve only as a guide in assisting field personnel to determine the proper drop height and airspeed for delivering water, foam, or gum-thickened retardant. Actual coverage may vary depending on terrain, wind, weather, and pilot proficiency.

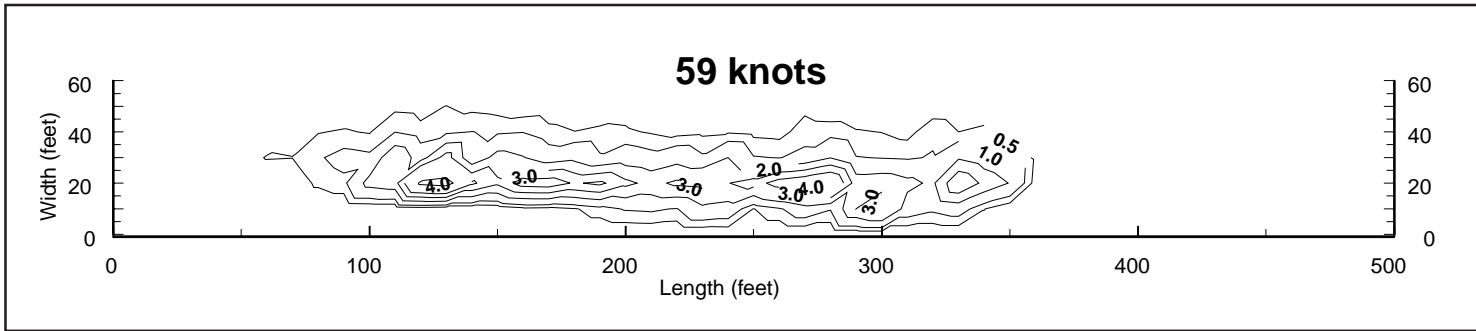


Figure 3– Drop pattern characteristics for the Bambi 324-gallon helibucket with an airspeed of 59 knots and a drop height of 47 feet. The contour lines are at 0.5, 1, 2, 3, 4, 6, 8, and 10 gallons per 100 square feet.

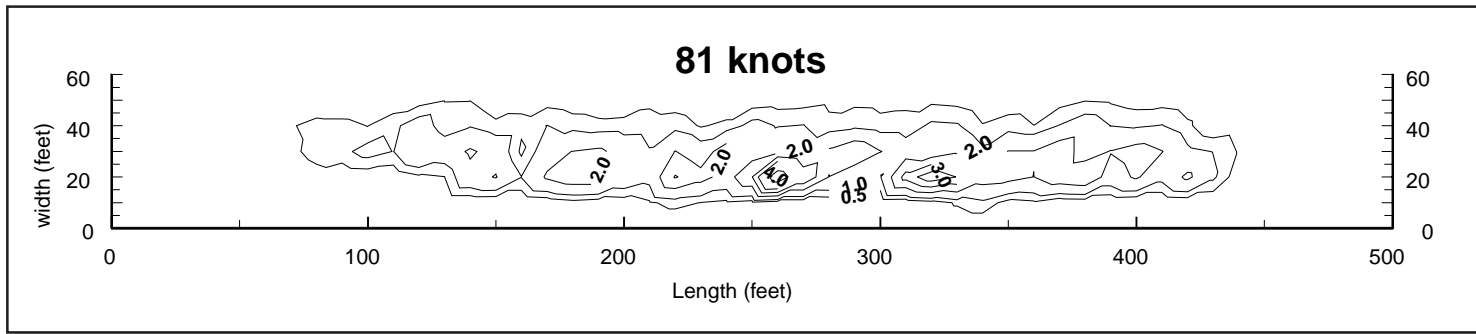


Figure 4– Drop pattern characteristics for the Bambi 324-gallon helibucket with an airspeed of 19 knots and a drop height of 47 feet. The contour lines are at 0.5, 1, 2, 3, 4, 6, 8, and 10 gallons per 100 square feet.



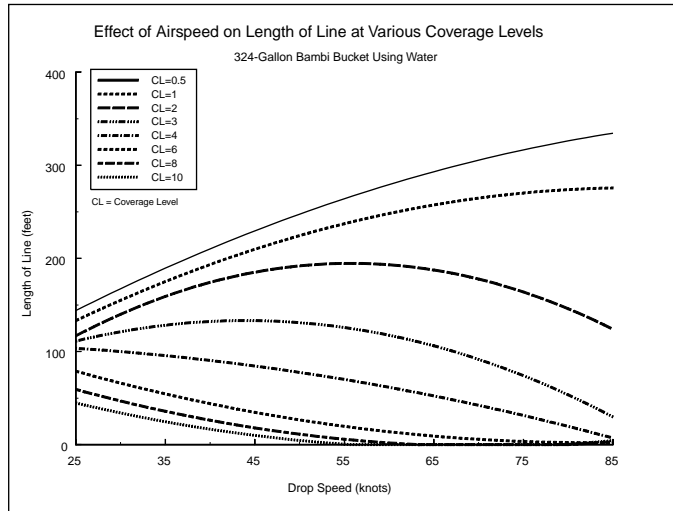


Figure 5– Use the graph to estimate the speed needed to produce the longest line of water at various coverage levels.

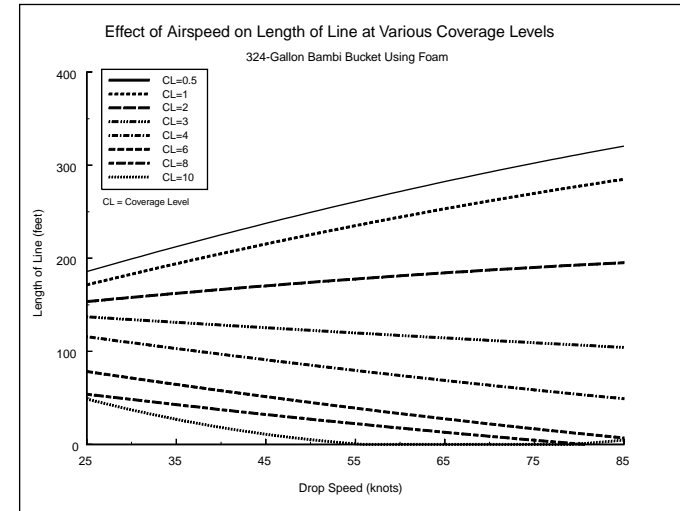


Figure 6– Use the graph to estimate the speed needed to produce the longest line of foam at various coverage levels.

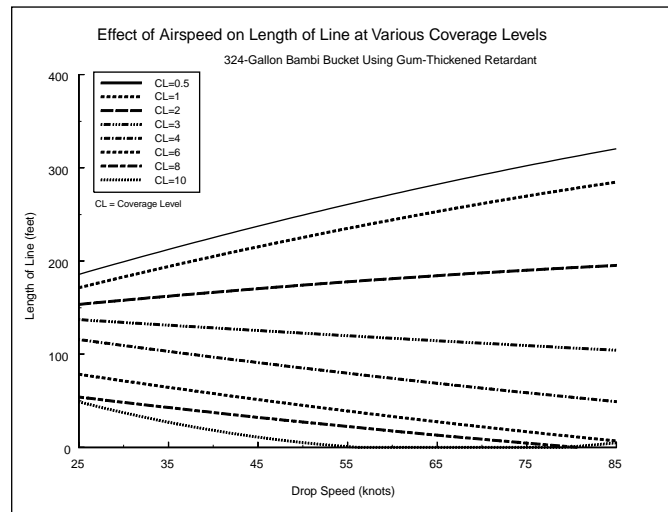


Figure 7– Use the graph to estimate the speed needed to produce the longest line of gum-thickened retardant at various coverage levels.





Figure 8— Drop test of the Bambi 324-gallon helibucket.

About the Authors...

Gregg Johnson is Project Leader of the Aerial Delivery Systems Project for the Wildland Fire Chemical Systems Program at MTDC. He received his bachelor's degree in chemistry from the University of Montana in 1969 and has more than 30 years experience in retardant chemical and aerial delivery systems research. He has worked for the Rocky Mountain Research Station's Fire Sciences Laboratory in Missoula and for MTDC.

Cammie Jordan is a Project Assistant for the Wildland Fire Chemical Systems Program at MTDC. She is an elementary education student at the University of Montana and has worked for MTDC since 1998.

Additional single copies of this document may be ordered from:

USDA Forest Service
Missoula Technology and
Development Center
Building 1, Fort Missoula
Missoula, MT 59804-7294
Phone: (406) 329-3978
Fax: (406) 329-3719

For additional technical information, contact Paul Solarz at the address above.

Phone: (406) 329-4719
Fax: (406) 329-4811
Internet: psolarz@fs.fed.us
Lotus Notes: Paul Solarz/WO/USDAFS

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

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

The Forest Service, United States Department of Agriculture, has developed this information for the guidance of its employees, its contractors, and its cooperating Federal and State agencies, and is not responsible for the interpretation or use of this information by anyone except its own employees. The use of trade, firm, or corporation

names in this publication is for the information and convenience of the reader, and does not constitute an endorsement by the Department of any product or service to the exclusion of others that may be suitable. The United States Department of Agriculture (USDA), prohibits discrimination in all its programs and activities on the basis of race,

color, national origin, gender, religion, age, disability, political beliefs, sexual orientation, and marital or family status. (Not all prohibited bases apply to all programs.) Persons with disabilities who require alternative means for communication of program information (Braille, large print, audiotape, and so forth) should phone USDA's TARGET

Center at (202) 720-2600 (voice and TDD). To file a complaint of discrimination, write: USDA, Director, Office of Civil Rights, Room 326-W, Whitten Building, 14th and Independence Avenue SW, Washington, DC 20250-9410, or call (202) 720-5964 (voice or TDD). USDA is an equal opportunity provider and employer.