Field Comparisons for Drift Reducing/Deposition Aid Tank Mixes

Presented at

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Objective:

The objective of this study was to evaluate the influence of selected drift control products/deposition aids on horizontal and vertical spray drift and droplet spectra characteristics during two selected fixed wing aerial application scenarios.

Materials and Methods:

- ✓ Goodland Airport, Goodland, KS
- ✓ Sept. 25 and 26, 2002
- ✓ Design 2 x 3 x 21 (126 treatments)
- ✓ Products and airplanes completely randomized and blocked over both days
- ✓ All treatments in near 90 degree crosswind
- ✓ Flat, open desert-like canopy 15-25cm (6-10 inches)
- ✓ Application Height 3-3.7m (10-12 feet)
- ✓ Application Conditions:
  - 12.7C (55F) average temperature
  - 50% average relative humidity
  - Crosswind averages:
    - 11.9 km/h (7.4 mph) average-average
    - 17.1 km/h (10.6 mph) maximum average
- ✓ 3 reps

Materials and Methods:

- ✓ AT 502A (Hawkeye Flying Service)
  - Drop booms
  - CP-09 nozzles w/5° deflection
  - Combination of .078 and .125 orifice settings
  - 276 kPa (40 psi)
  - 241 km/h (150 mph ground speed by radar)
- ✓ Cessna 188 Ag Husky (Rucker Flying Service)
  - Ag Tips
  - CP-03 w/30 degree deflection
  - Combination of .078 and .125 orifice settings
  - 179 kPa (26 psi)
  - 185 km/h (115 mph ground speed by radar)
- ✓ Aircraft calibrated for 28 L/ha (3 GPA)

Materials and Methods:

- ✓ 8 Companies participated
- ✓ 19 Drift Reduction/Deposition Aids
- ✓ Water used as a check both days
- ✓ Spray mixes containing 560 L (60 gal)
  - X-77 @ .25% v/v
  - Tap water
  - Required amount of product per label
- ✓ Application volume – 28 L/ha (3 GPA)
- ✓ Hot water-high pressure cleaner used to rinse each treatment

Participants in the Study: Appendix A in the paper.

Companies

- ✓ United Suppliers
- ✓ Helena Chemical
- ✓ Garrco
- ✓ Loveland
- ✓ Wilber-Ellis
- ✓ Rosen's
- ✓ Precision Labs
- ✓ SanAg

Products

1. 41-A
2. Formula One
3. AMS 20/10
4. Border EG 250
5. Control
6. INT VWZ
7. Inplace
8. Garrco Exp-3
9. INT YAR
10. Border XTRA 8L
11. HM2005-C
12. HM0226
13. Liberate
14. Target LC
15. HM2052
16. INT HLA
17. HM 0230
18. Valid
19. Double Down

20 & 21. water

Grouped by Chemistry: Appendix B

- ✓ Polyacrylamide:
  - A, C, L, T, N, Q
- ✓ Guar
  - D, F, J, I, P, K
- ✓ Oils
  - G, B
- ✓ Non-traditional/Combination:
  - E, H, M, R, O

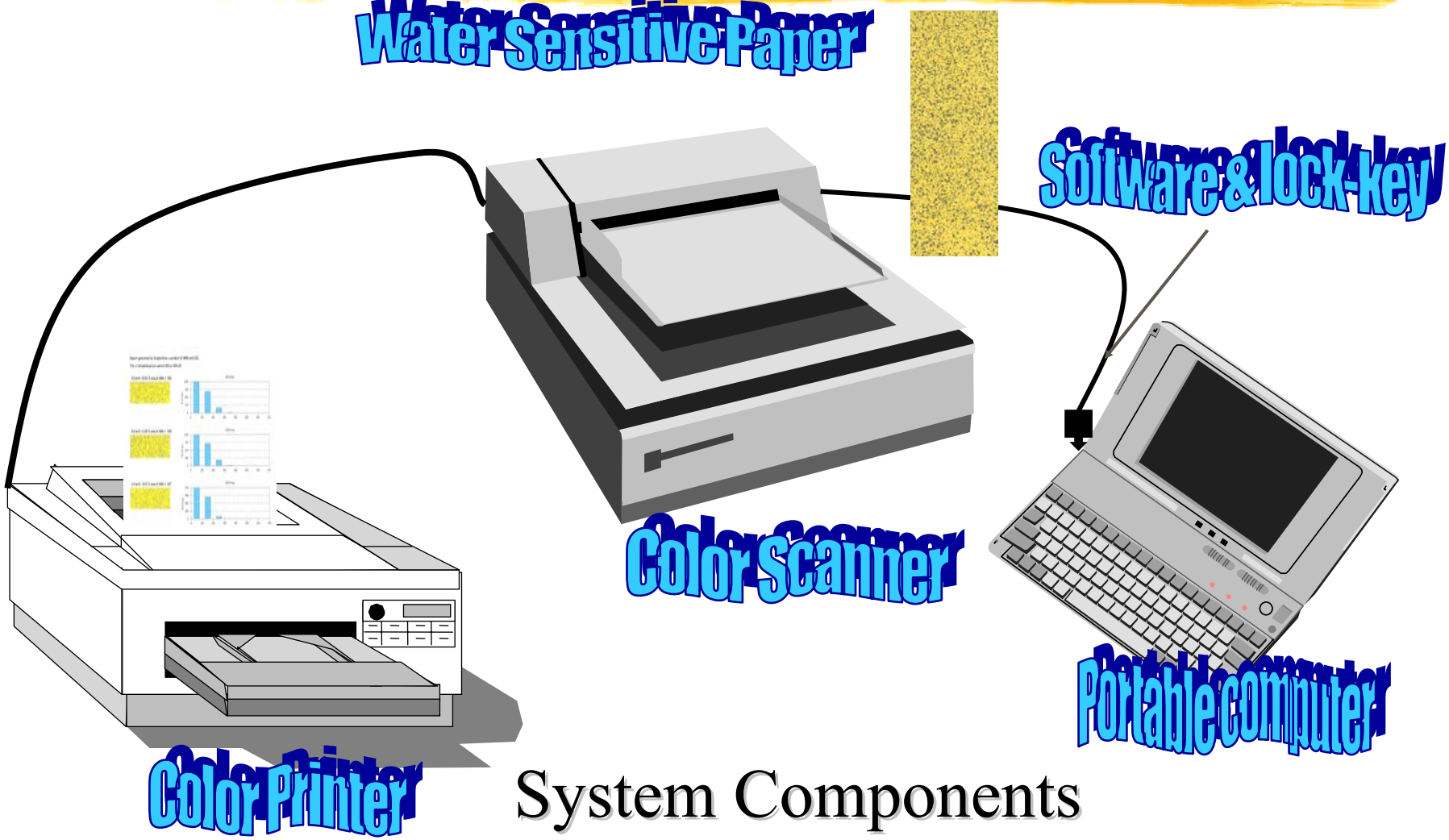
Collection Procedure for drift: Appendix C

Volunteers critical!!!!

Collection Procedure for canopy: Appendix D

- ✓ 1 pass over an 18-20 inch canopy into headwind
- ✓ 11 wsp evenly spaced across the swath width in top of canopy
- ✓ 21 treatments
- ✓ 2 airplanes
- ✓ 462 total wsp

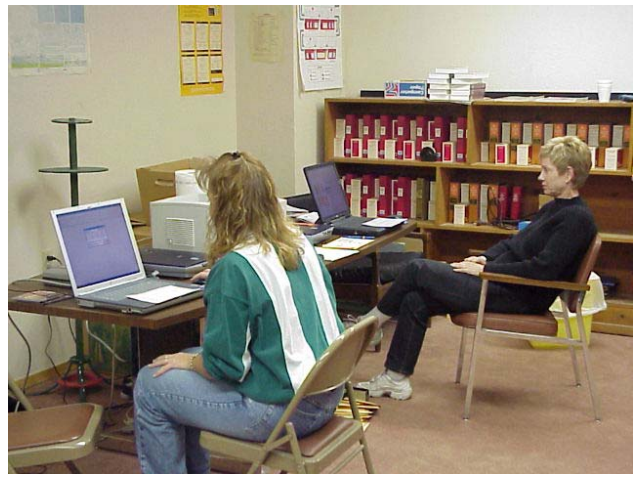
DropletScan™ used to analyze droplets:

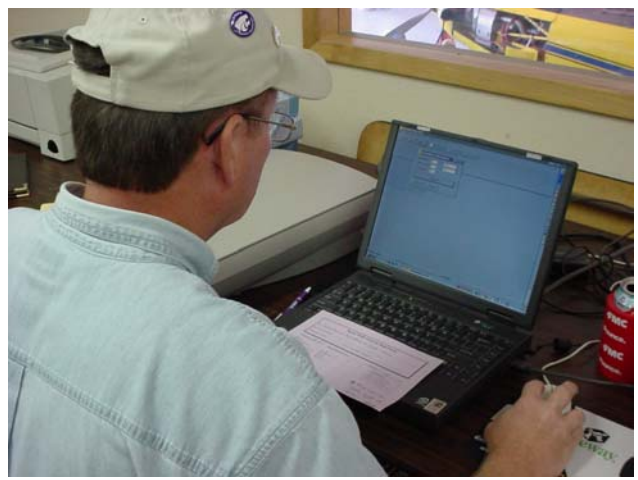


System Components

Analysis Procedure:

- ✓ Drift - Scanned and recorded
  - 2,016 cards (2 x 3 x 21 x 16 = 2016)
    - 7 horizontal collectors
    - 9 vertical collectors
  - Percent area coverage
  - Equation based spread factors were used for drift cards
- ✓ Canopy - Scanned and recorded
  - 462 cards (2 x 21 x 11)
    - 11 wsp across top of canopy
  - VMD, VD0.1, VD0.9, % Area Coverage
  - Laboratory based spread factors were used for canopy scans
- ✓ Statistical analysis with SAS Proc GLM and covariate-adjusted least square means were computed to factor out variability in the wind
- ✓ 3 wind profiles (4.2, 7.0. and 11.5 MPH)
- ✓ Alpha = .10





Spread factor determination:

- ✓ Each sample duplicated in laboratory
- ✓ Used water from Goodland
- ✓ Procedure done at LPCAT in Wooster, OH
- ✓ Coefficients were determined for 15 of the treatments
- ✓ SF coefficients were inserted into DropletScan™ and used to calculate VMD, VD 0.1, and VD 0.9

Spread factor coefficients: Appendix E

Treatment*	Spread factor where intercept is computed	R^2 (squared)
S (Water)	$y = 2E\text{-}05x^2 + 0.3949x + 29.533$	$R^2 = 0.9847$
A	$y = -7E\text{-}05x^2 + 0.6477x - 3.3723$	$R^2 = 0.8885$
C	$y = 2E\text{-}05x^2 + 0.3986x + 10.42$	$R^2 = 0.9481$
D	$y = -2E\text{-}05x^2 + 0.5421x - 31.266$	$R^2 = 0.9853$
E	$y = 3E\text{-}05x^2 + 0.3078x + 96.556$	$R^2 = 0.9197$
F	$y = -1E\text{-}05x^2 + 0.4606x + 5.0232$	$R^2 = 0.9829$
G	$y = -4E\text{-}07x^2 + 0.4368x - 4.7645$	$R^2 = 0.9769$
H	$y = 2E\text{-}06x^2 + 0.5036x - 0.5712$	$R^2 = 0.9599$
I	$y = -1E\text{-}06x^2 + 0.4389x + 7.0701$	$R^2 = 0.9834$
J	$y = 5E\text{-}06x^2 + 0.3916x + 19.257$	$R^2 = 0.9803$
L	$y = -2E\text{-}05x^2 + 0.548x - 12.349$	$R^2 = 0.9733$
M	$y = 7E\text{-}06x^2 + 0.4694x - 1.8849$	$R^2 = 0.9852$
N	$y = 6E\text{-}05x^2 + 0.3316x + 52.725$	$R^2 = 0.9393$
P	$y = 2E\text{-}05x^2 + 0.4424x - 7.1237$	$R^2 = 0.9815$
R	$y = -3E\text{-}05x^2 + 0.4852x - 14.638$	$R^2 = 0.9752$
T	$y = 2E\text{-}05x^2 + 0.4193x + 27.949$	$R^2 = 0.9485$

*All treatments included .25% v/v of X-77 to simulate a pesticide

Sample DropletScan™ printout:

Report generated by DropletScan, a product of WRK and DSI.

File: c:\dropscan\data\air-venturi-99\xr-80h.dlf

Comments
Air Induction/Venturi Drift Study
Biological & Agricultural Engineering Dept.
Ashland Bottoms Research Station
Oct. 27, 1999

Material:	water
Number of Nozzles:	4
Nozzle Pres. (PSI):	80
Nozzle Type:	XR Flat-fan
Flow Rate at 40 PSI (GPM):	.56

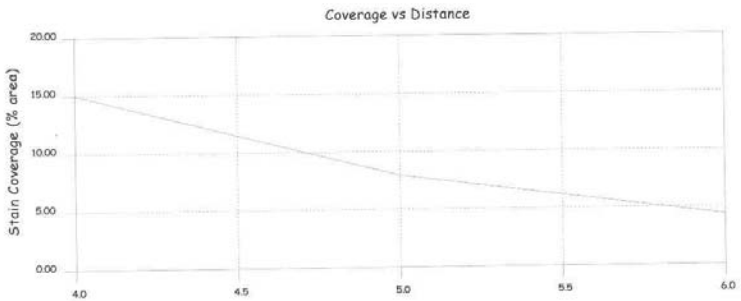
Spread Factors Equation
SF = 1.6333 + 0.0009*D + 0.0000*D*D

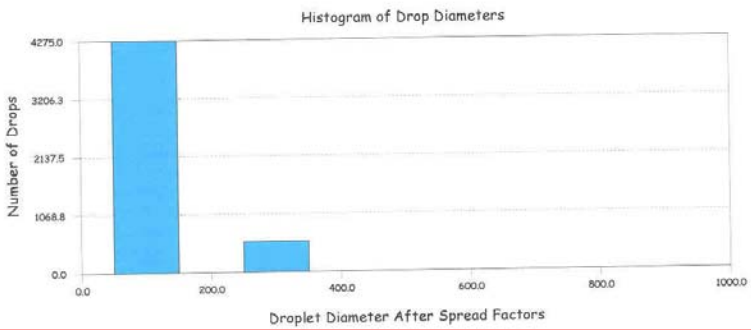
Defect Rejection: 0.9050

Scanned on Dec 05 1999
at 13:22

Composite results
VMD = 221
VD(0.1) = 125
VD(0.9) = 328
% Area Coverage = 9.1

Run Number:	1
Time:	1:00
Target Rate (GPA):	20
Target Swath (Ft):	10
Application Height (Ft):	.6
Number of Passes:	2
Ground Speed (MPH):	5.5
Wind Velocity (MPH):	10
Wind Direction(deg.):	190
Cross Wind (MPH):	0
Temperature (F):	85
Humidity (%):	40

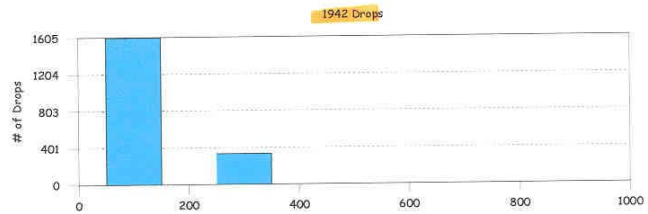




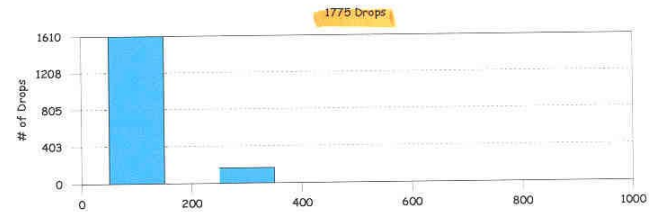
Report generated by DropletScan, a product of WRK and DSI.

File: c:\dropscan\data\air-venturi-99\xr-80h.dlf

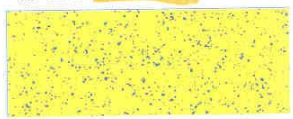
4.0 with 14.99 % area & VMD = 249

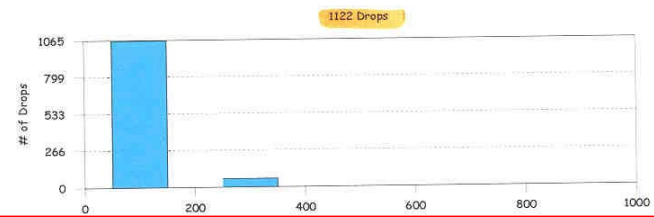


5.0 with 7.93 % area & VMD = 198



6.0 with 4.38 % area & VMD = 174





Results and Discussion

- ✓ Tables 1-3 (Horizontal data)
  - LS Means for all collector positions
  - 3 wind profiles (4.2, 7.0, 11.5 MPH)
- ✓ Tables 4-6 (Vertical data)
  - LS Means for all collector positions
  - 3 wind profiles (4.2, 7.0, 11.5 MPH)
- ✓ Figure 1-3 (Horizontal graphs)
- ✓ Figures 4-6 (Vertical graphs)
- ✓ Table 7 (Canopy - Droplet Spectra)
- ✓ Figure 7 (Graphics for Droplet Spectra)

Table 1 (Horizontal drift - 4.2 MPH) p.11

Product	Airplane	50ft.	100ft.	150ft.	200ft.	250ft.	300ft.	350ft.
A	AT	12.54	1.35	1.38	0.73	0.34	0.17	0.07
A	C	10.01	1.51	1.32	0.33	0.22	0.13	0.05
B	AT	14.66	3.10	0.81	0.62	0.32	0.13	0.00
B	C	12.98	2.00	1.85	0.82	0.52	0.24	0.35
C	AT	6.51	0.84	0.17	0.09	0.02	0.00	0.00
C	C	14.52	2.41	0.80	0.45	0.48	0.14	0.17
D	AT	11.42	6.10	0.53	0.97	0.42	0.53	0.44
D	C	7.46	2.17	0.78	0.34	0.09	0.10	0.14
E	AT	10.48	2.21	0.40	0.17	0.16	0.01	0.00
E	C	7.06	1.94	0.48	0.27	0.14	0.00	0.00
F	AT	21.84	5.20	1.25	0.45	0.27	0.21	0.19
F	C	9.12	0.99	1.33	0.19	0.09	0.06	0.02
G	AT	19.11	4.16	1.74	0.96	0.32	0.21	0.00
G	C	16.61	4.48	2.17	1.46	0.27	0.04	0.10
H	AT	11.28	1.63	0.76	0.20	0.13	0.00	0.00
H	C	6.95	0.71	0.23	0.17	0.08	0.07	0.03
I	AT	12.22	3.21	0.43	0.24	0.11	0.22	0.15
I	C	12.27	2.63	1.32	0.34	0.19	0.22	0.15

Figure 1: p. 18

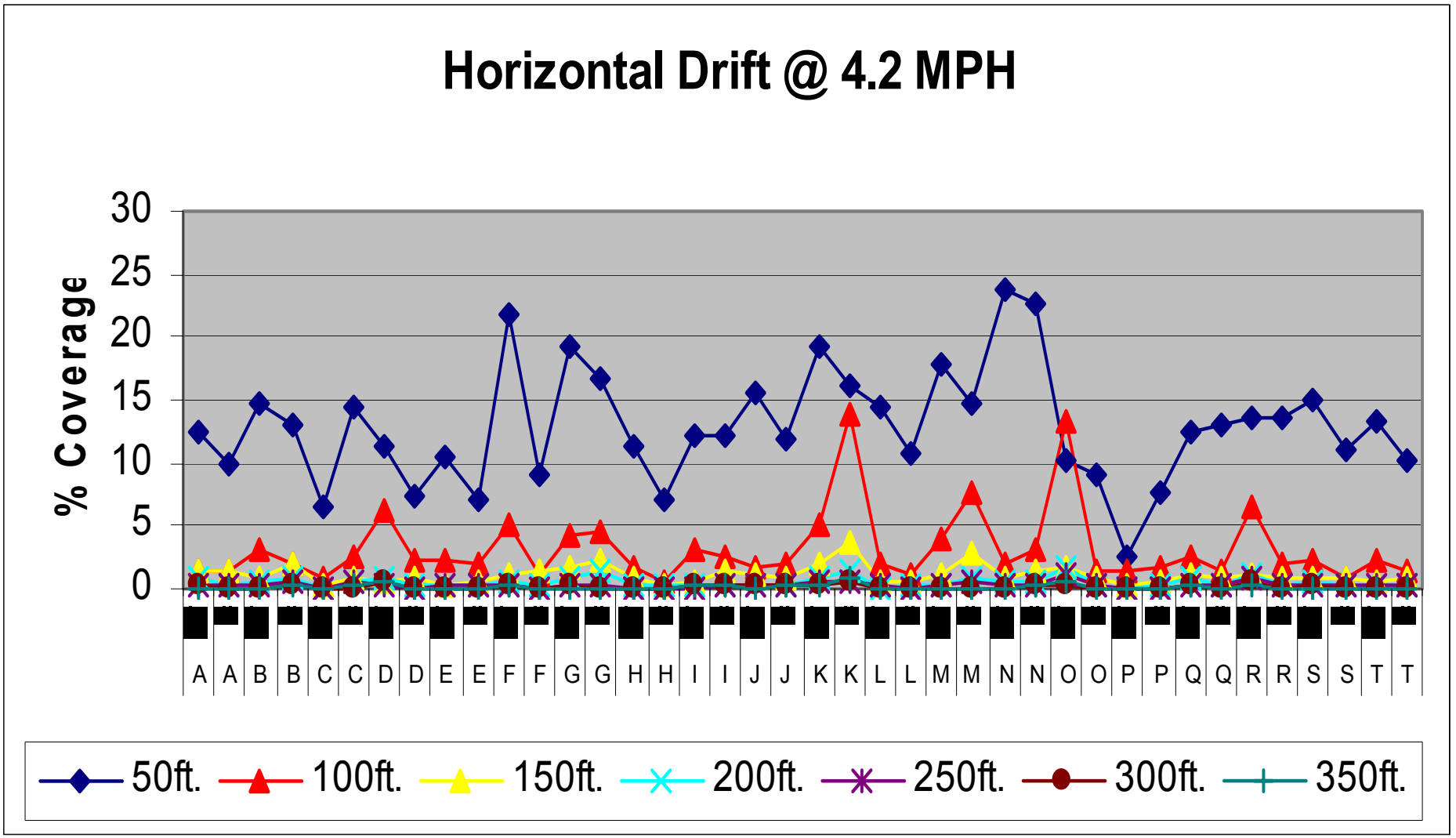
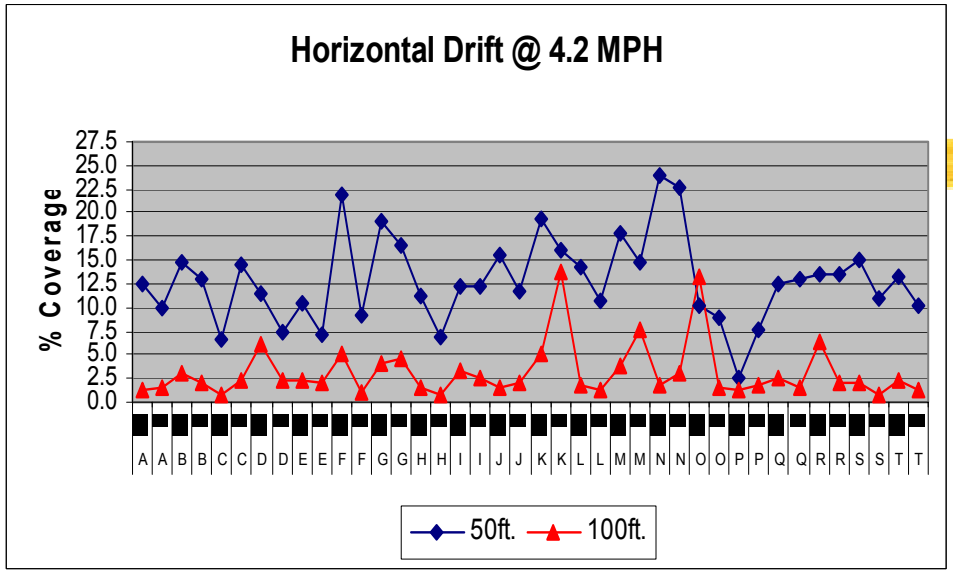
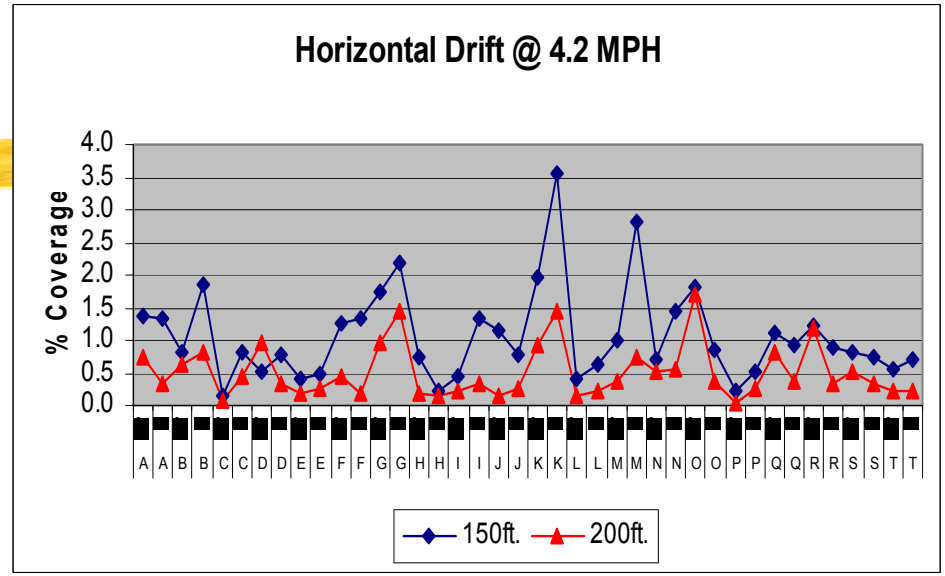
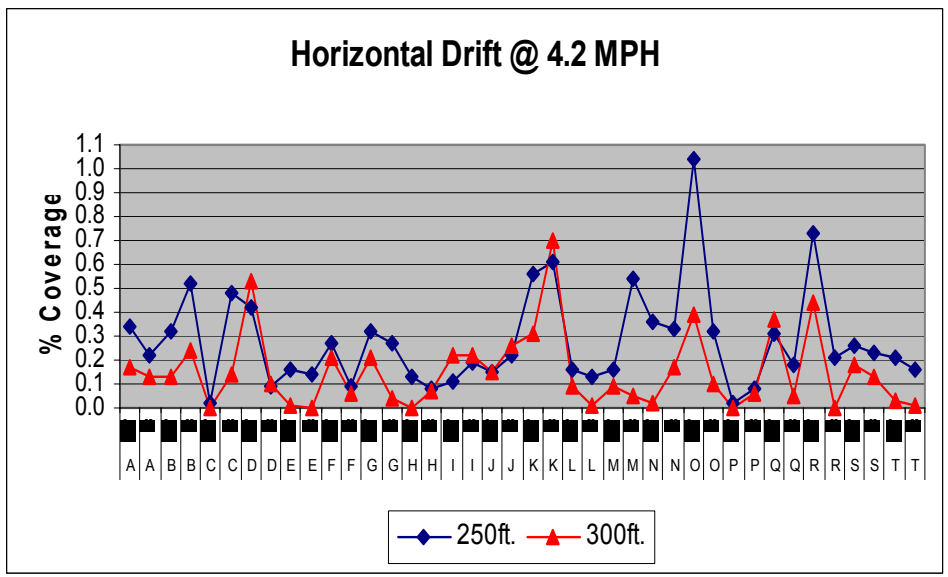
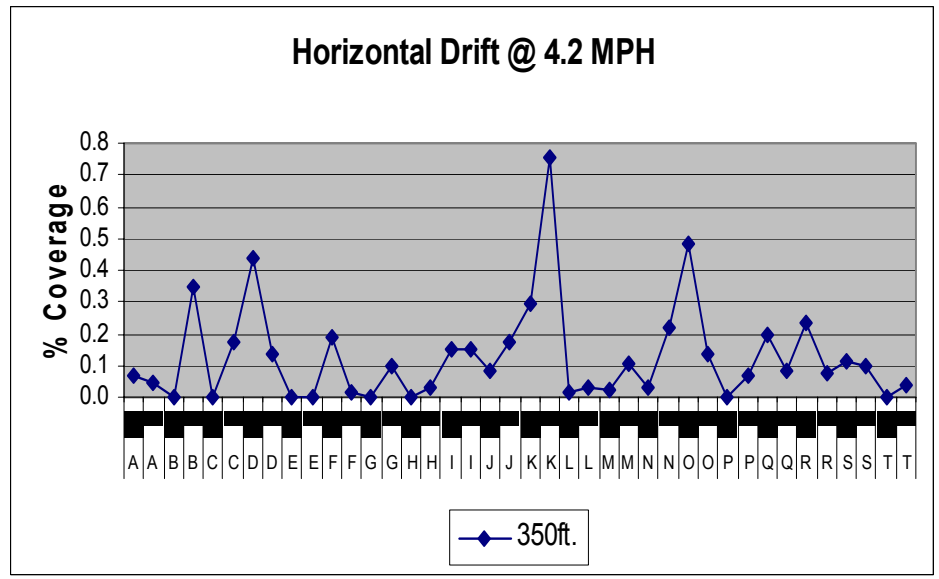

Horizontal Drift @ 4.2 MPH
% Coverage
30
25
20
15
10
5
0
A A B B C C D D E E F F G G H H I I J J K K L L M M N N O O P P Q Q R R S S T T
50ft.
100ft.
150ft.
200ft.
250ft.
300ft.
350ft.

Figure 1 continued:









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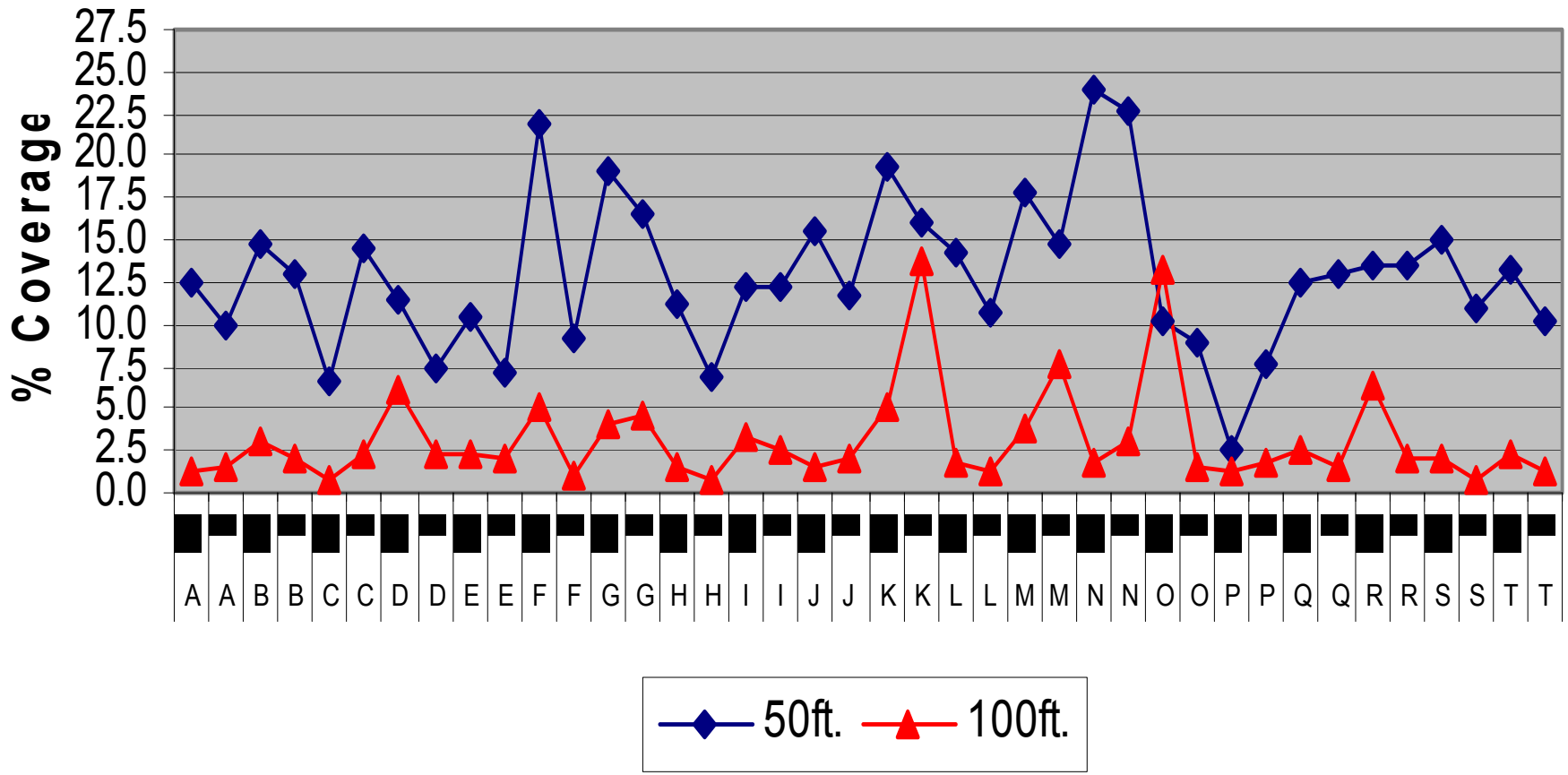


Figure 1 continued:

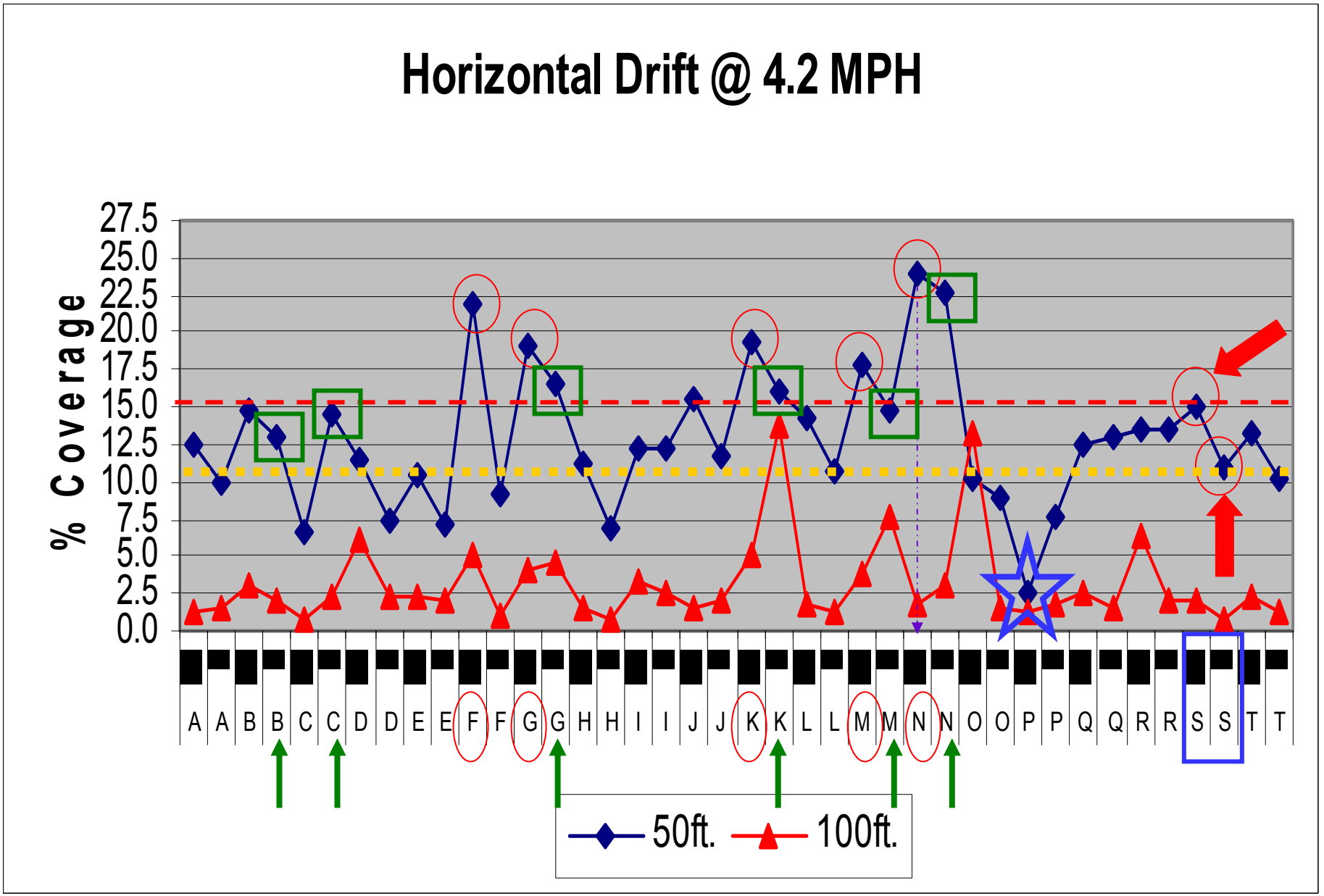


Figure 2:

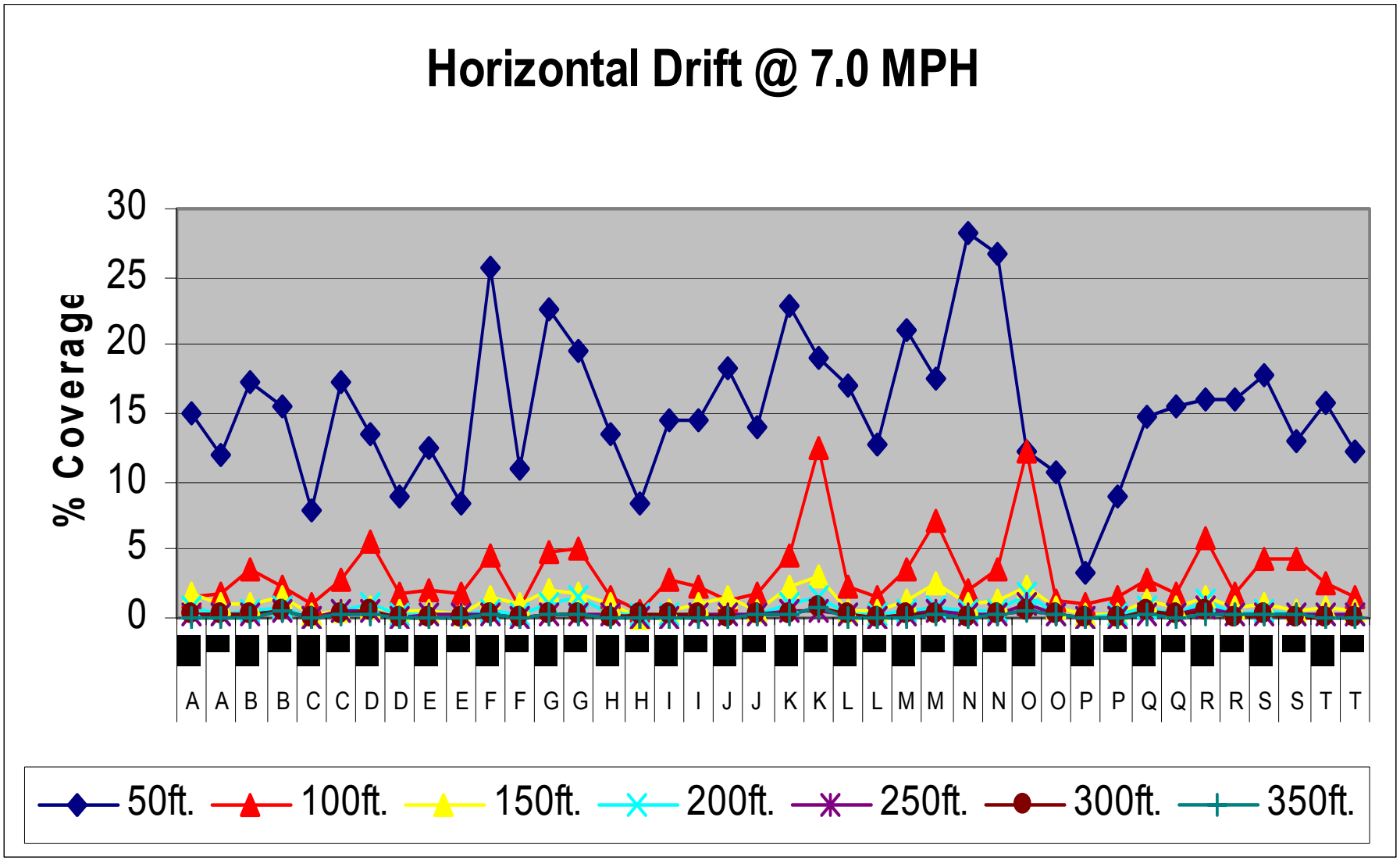
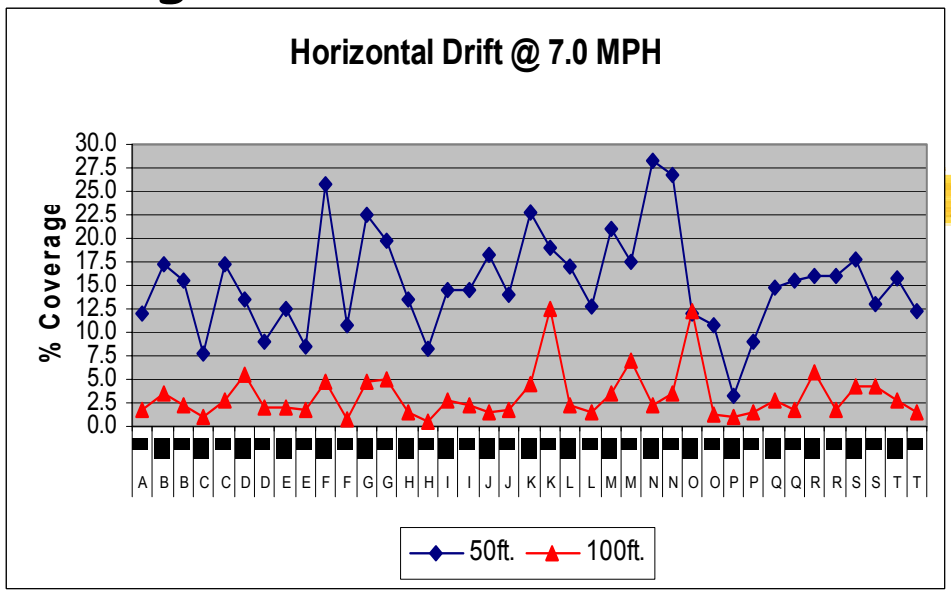
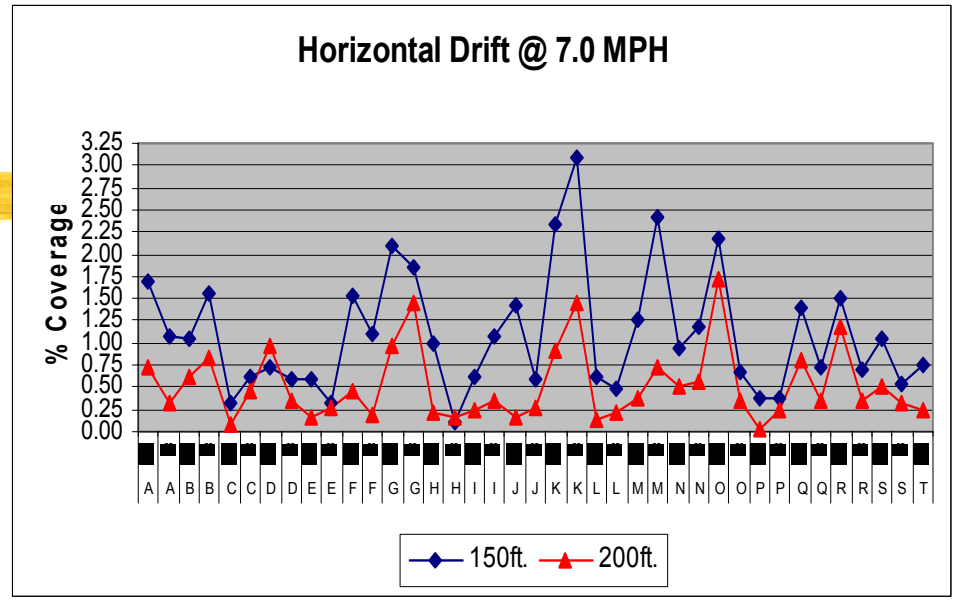
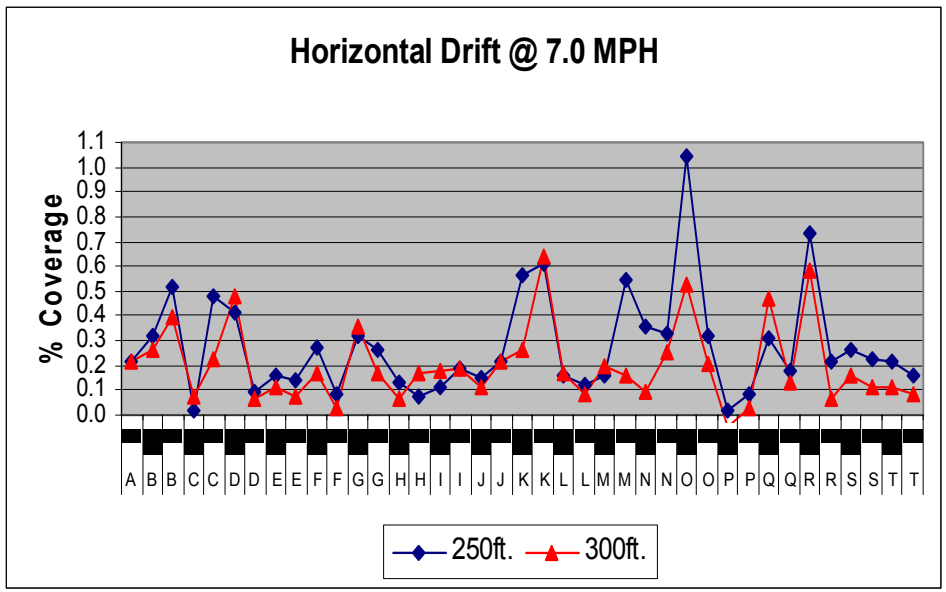

Horizontal Drift @ 7.0 MPH
% Coverage
30
25
20
15
10
5
0
A A B B C C D D E E F F G G H H I I J J K K L L M M N N O O P P Q Q R R S S T T
50ft.
100ft.
150ft.
200ft.
250ft.
300ft.
350ft.

Figure 2 continued:







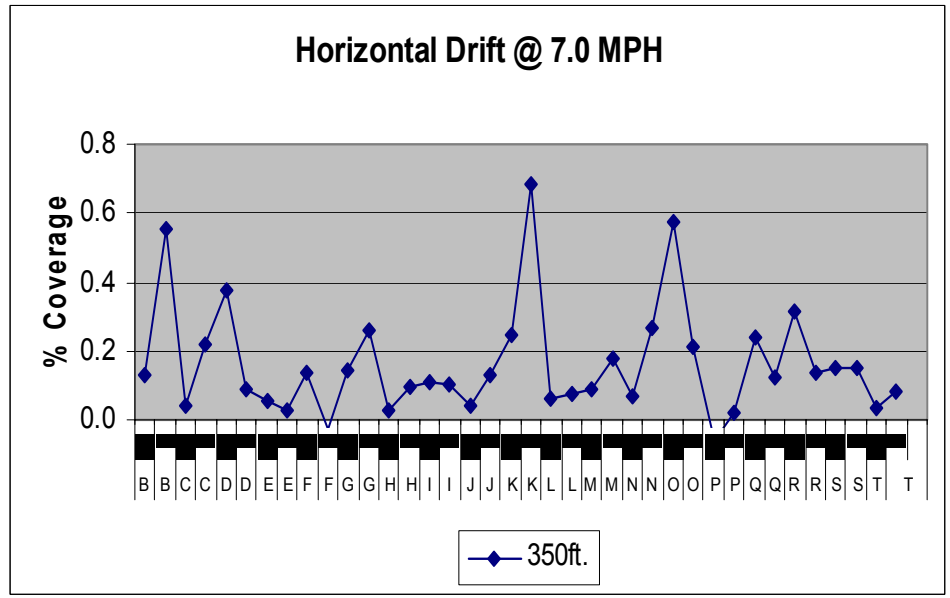


Figure 3:

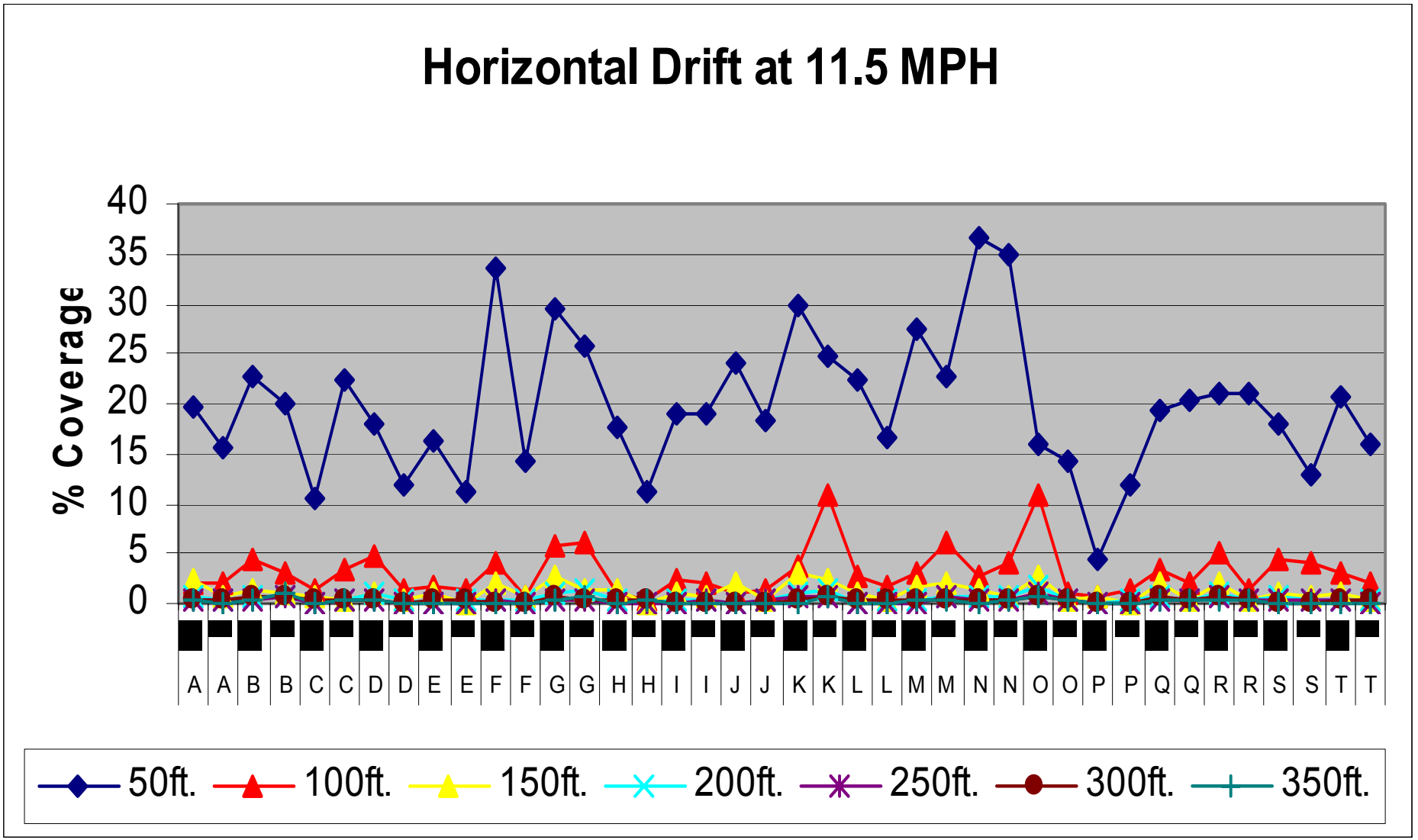
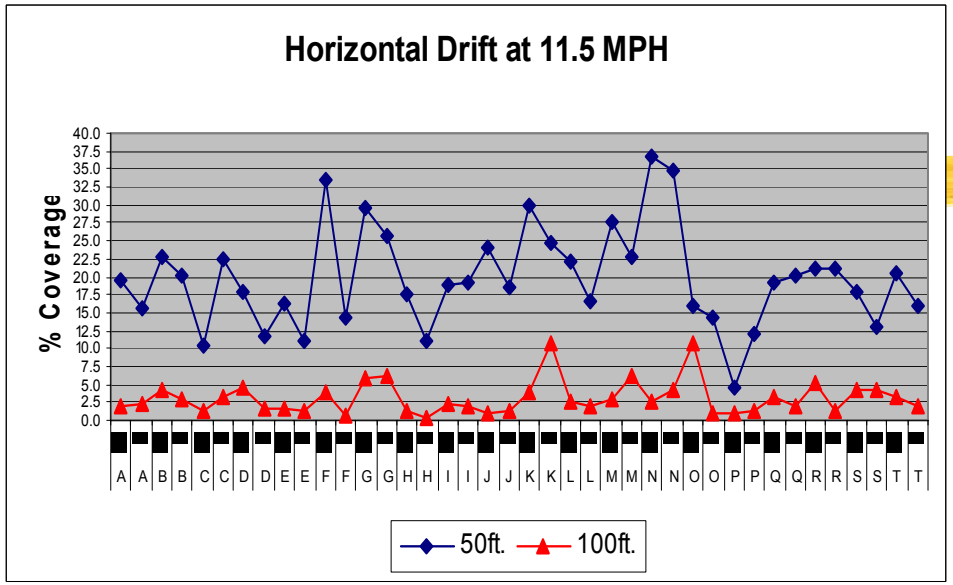
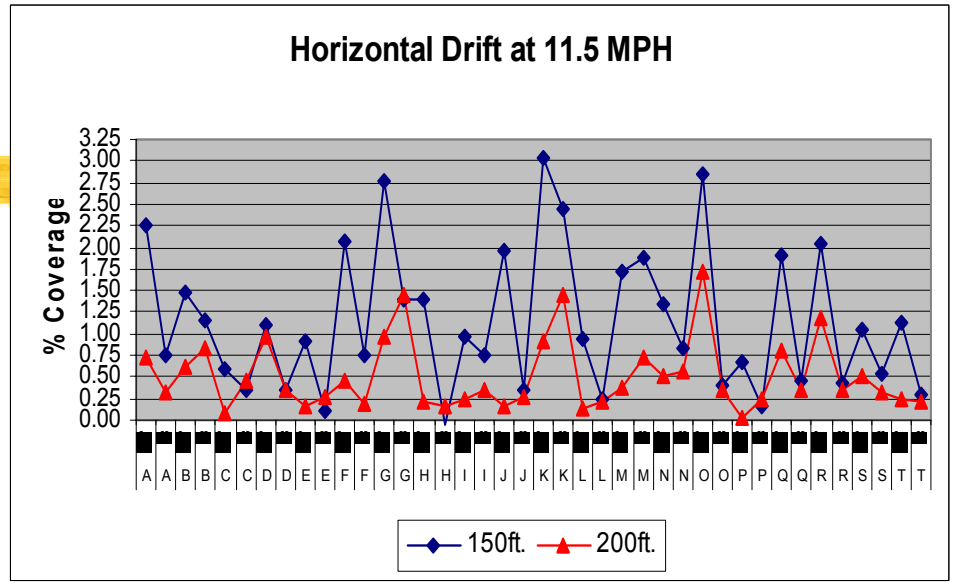
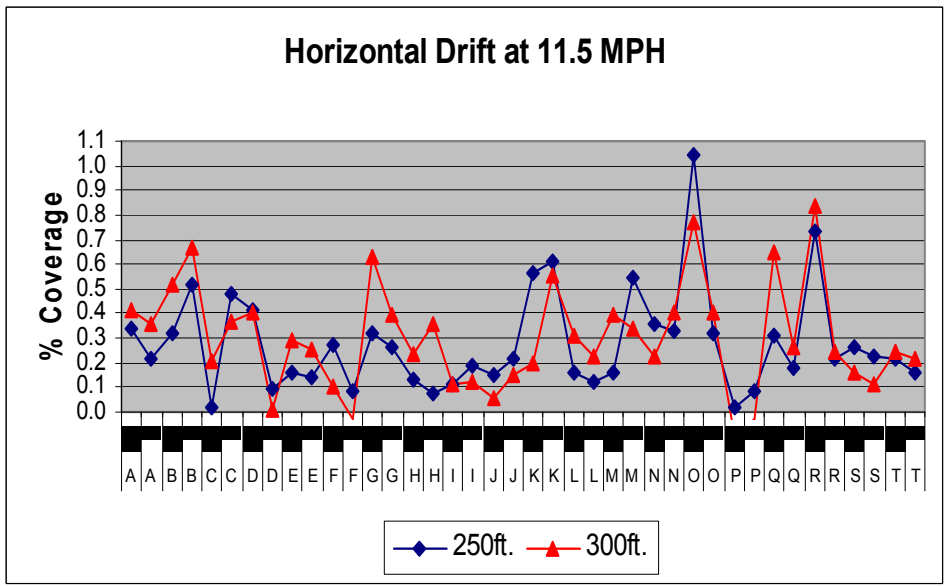

Horizontal Drift at 11.5 MPH
% Coverage
40
35
30
25
20
15
10
5
0
A A B B C C D D E E F F G G H H I I J J K K L L M M N N O O P P Q Q R R S S T T
50ft.
100ft.
150ft.
200ft.
250ft.
300ft.
350ft.

Figure 3 continued:







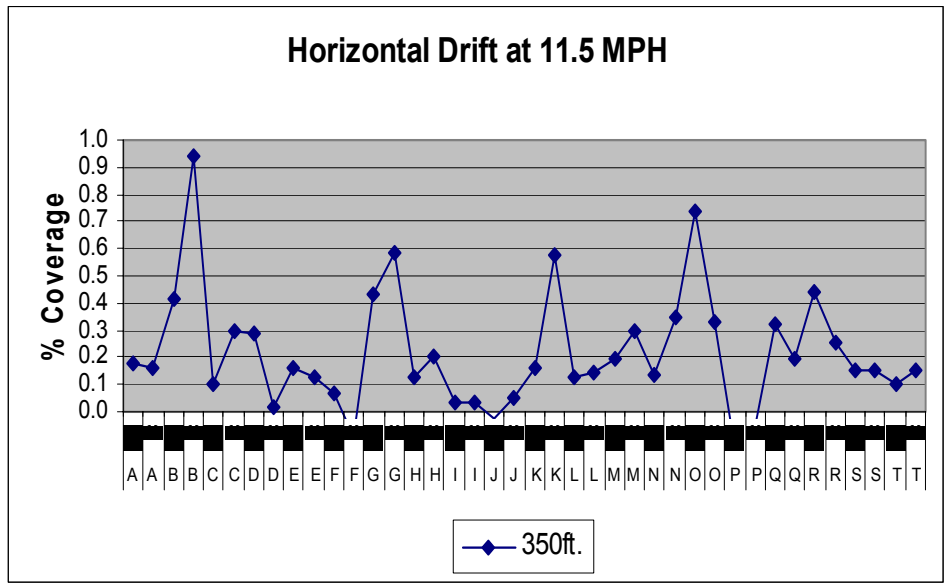


Table 4 (Vertical drift – 4.2 MPH) p. 14

Product	Airplane	0ft.	5ft.	10ft.	15ft.	20ft.	25ft.	30ft.	35ft.	40ft.
A	AT	-0.01	0.28	-0.04	0.07	-0.13	0.44	0.01	0.14	0.21
A	C	-0.04	0.17	0.26	0.11	0.19	0.33	0.16	0.36	0.05
B	AT	0.02	0.17	0.19	0.22	0.01	0.60	0.00	0.21	0.05
B	C	0.19	0.36	0.56	0.30	0.34	0.74	0.45	0.25	0.43
C	AT	-0.01	-0.01	-0.03	-0.02	-0.03	0.02	-0.02	0.01	0.00
C	C	0.13	0.67	0.77	0.77	0.73	0.64	0.65	0.82	0.43
D	AT	0.34	1.43	1.58	1.47	0.71	0.59	0.12	0.27	0.01
D	C	0.10	0.24	0.50	0.22	0.46	0.19	0.52	0.35	0.29
E	AT	0.00	0.07	0.08	0.21	0.28	0.24	0.50	0.42	0.43
E	C	-0.01	0.01	0.19	0.17	0.36	0.41	-0.20	-0.17	-0.26
F	AT	0.09	0.31	0.49	0.45	0.33	0.34	0.18	0.18	0.13
F	C	0.02	0.11	0.12	0.07	0.14	0.11	0.12	0.11	0.07
G	AT	0.00	0.14	0.16	0.18	0.06	0.68	0.16	0.31	0.16
G	C	-0.08	0.00	0.35	0.24	0.49	0.95	0.43	0.60	0.89
H	AT	-0.05	-0.07	-0.05	0.05	0.09	0.05	0.24	0.25	0.36
H	C	0.05	0.10	0.05	0.09	0.02	0.07	0.25	0.17	0.19
I	AT	0.15	0.39	0.41	0.41	0.30	0.32	0.12	0.21	0.11
I	C	0.10	0.41	0.68	0.35	0.49	0.29	0.51	0.38	0.36

Figure 4:

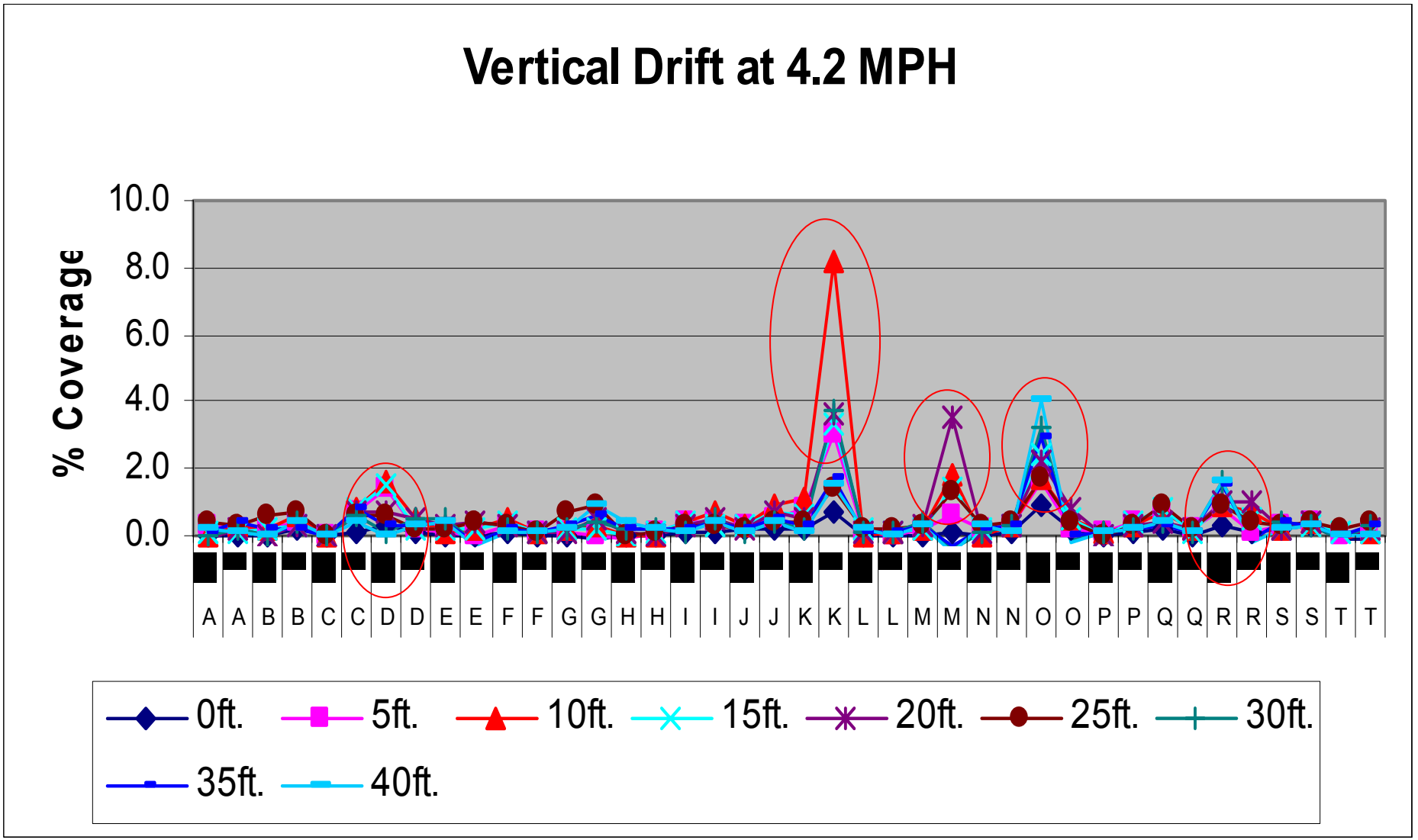
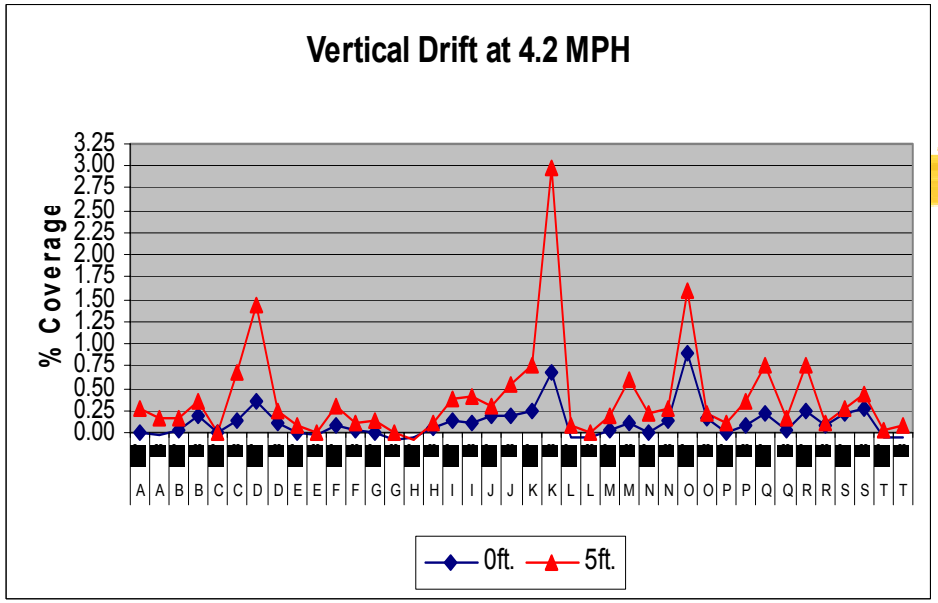
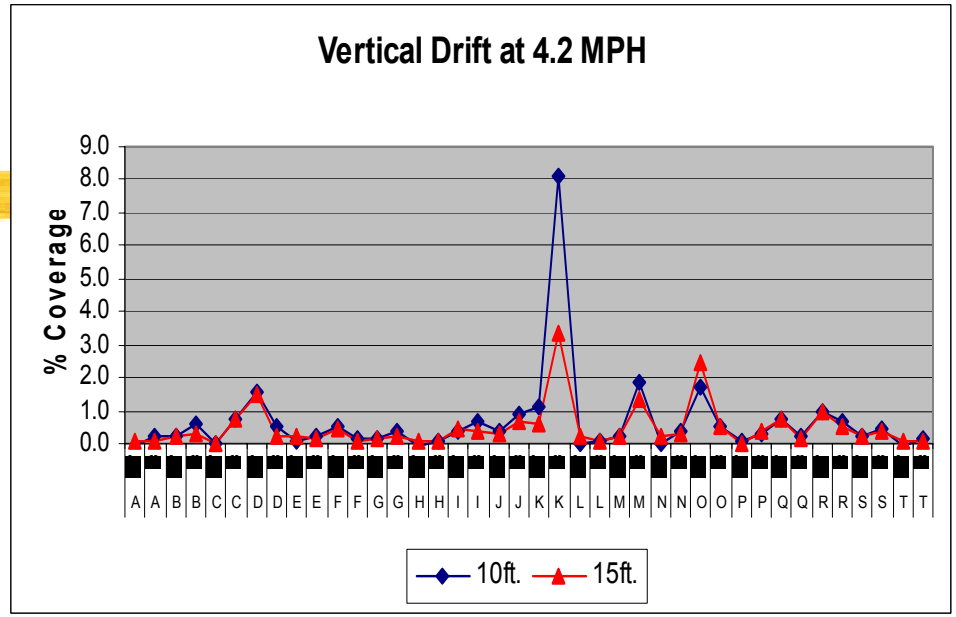
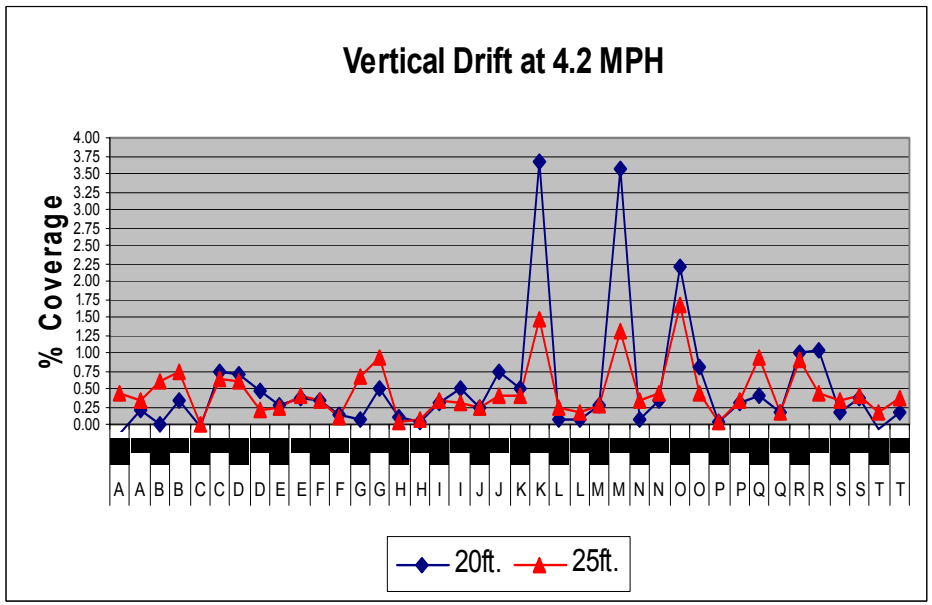

Vertical Drift at 4.2 MPH
% Coverage
10.0
8.0
6.0
4.0
2.0
0.0
A A B B C C D D E E F F G G H H I I J J K K L L M M N N O O P P Q Q R R S S T T
0ft.
5ft.
10ft.
15ft.
20ft.
25ft.
30ft.
35ft.
40ft.

Figure 4 continued:







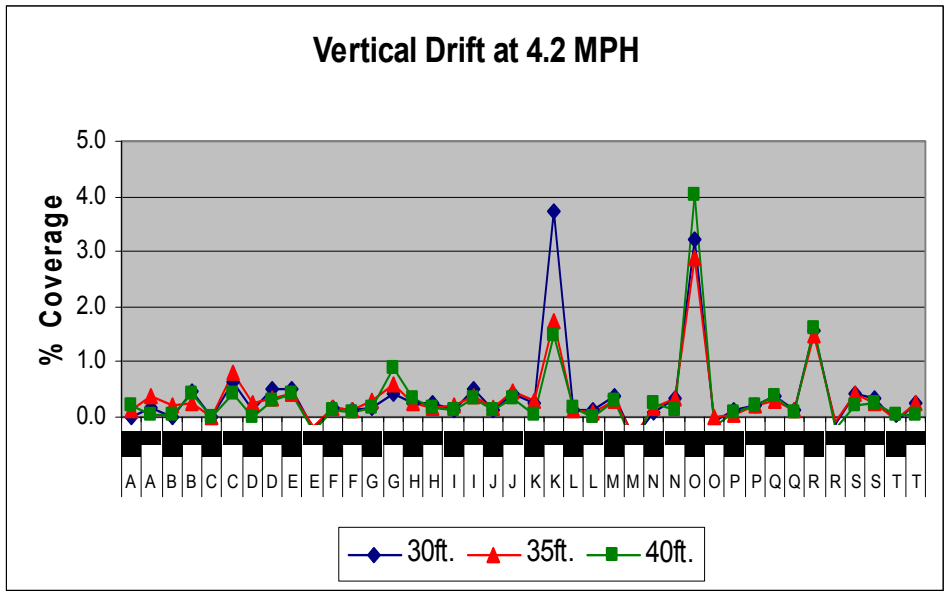


Figure 4 continued (10-15 Ft)

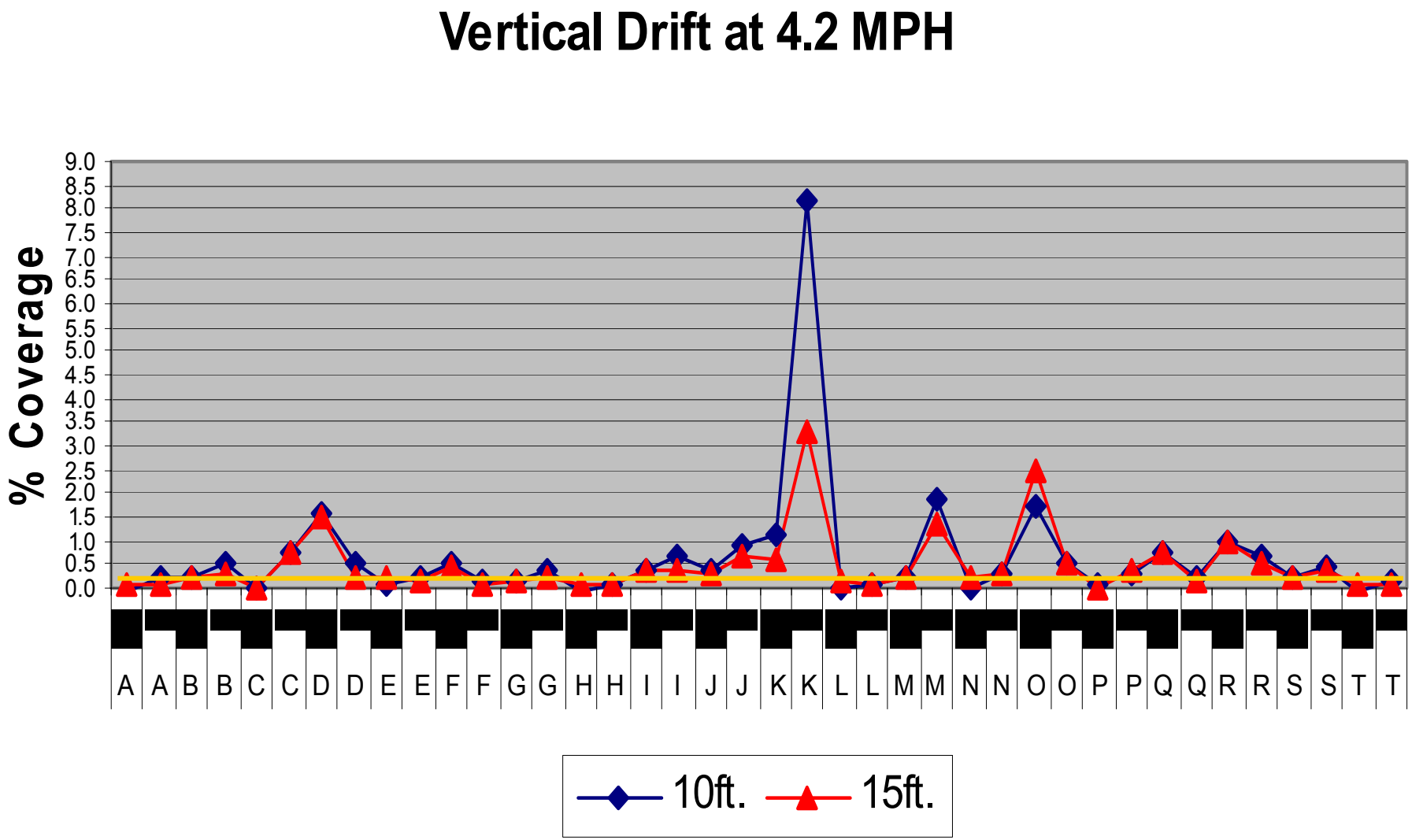
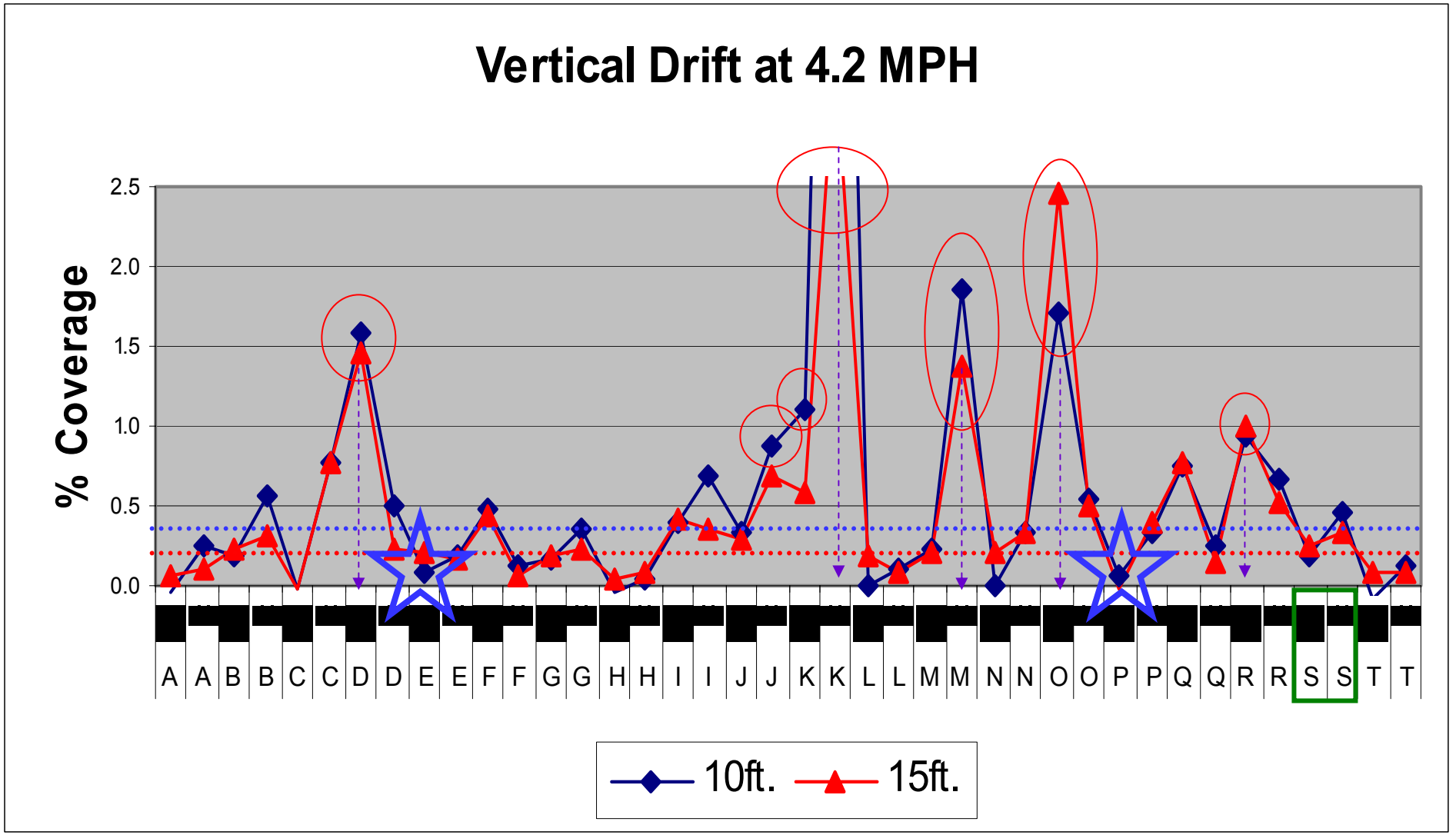


Figure 4 continued (10-15 Ft)



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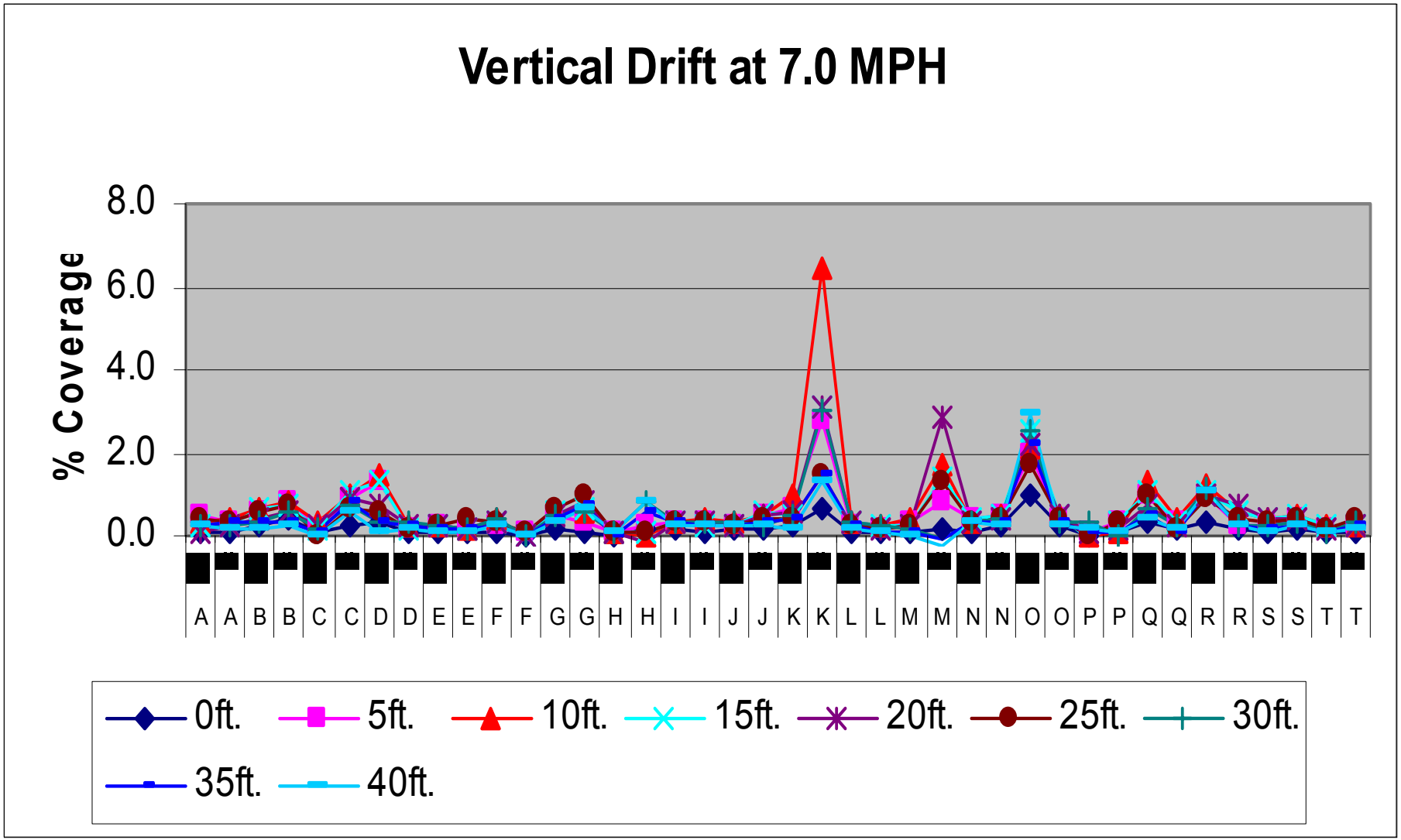
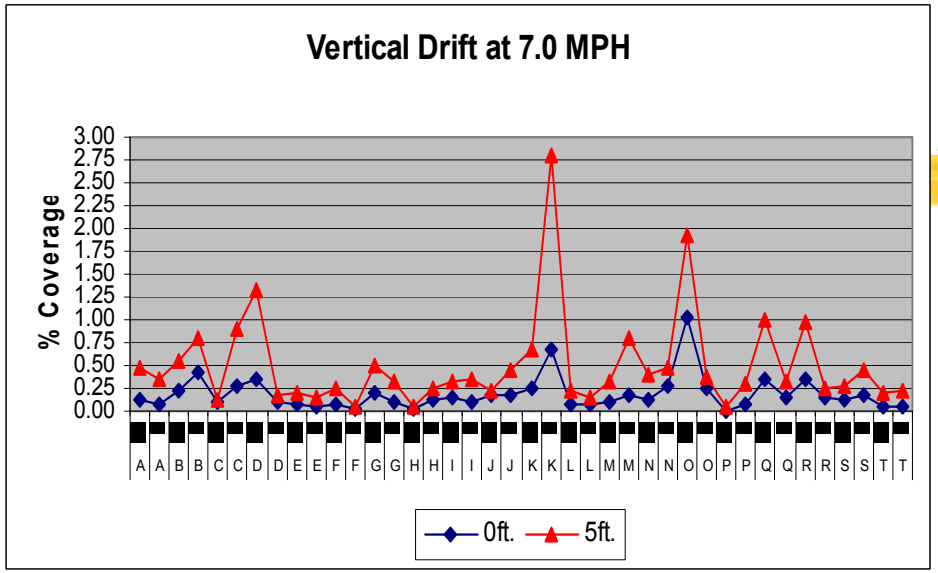
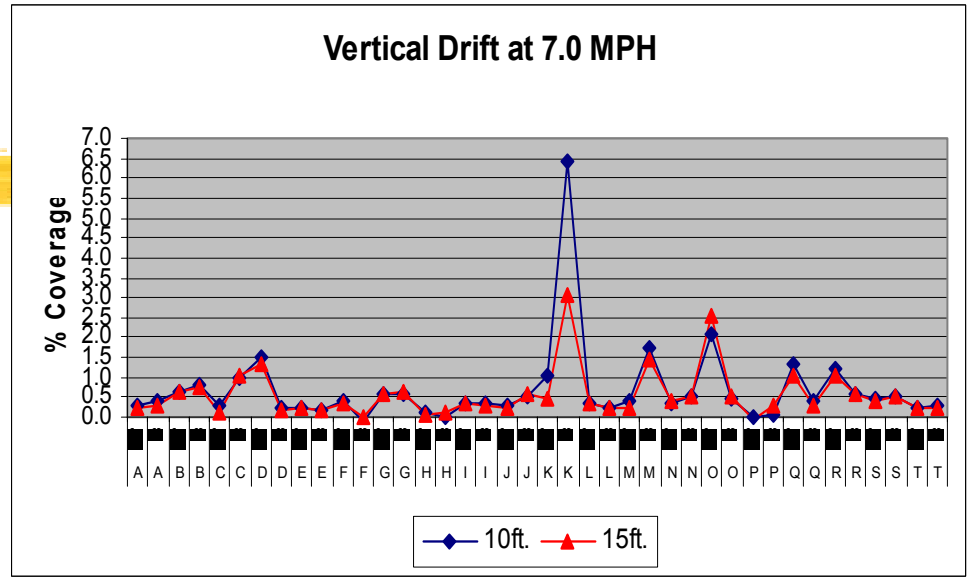
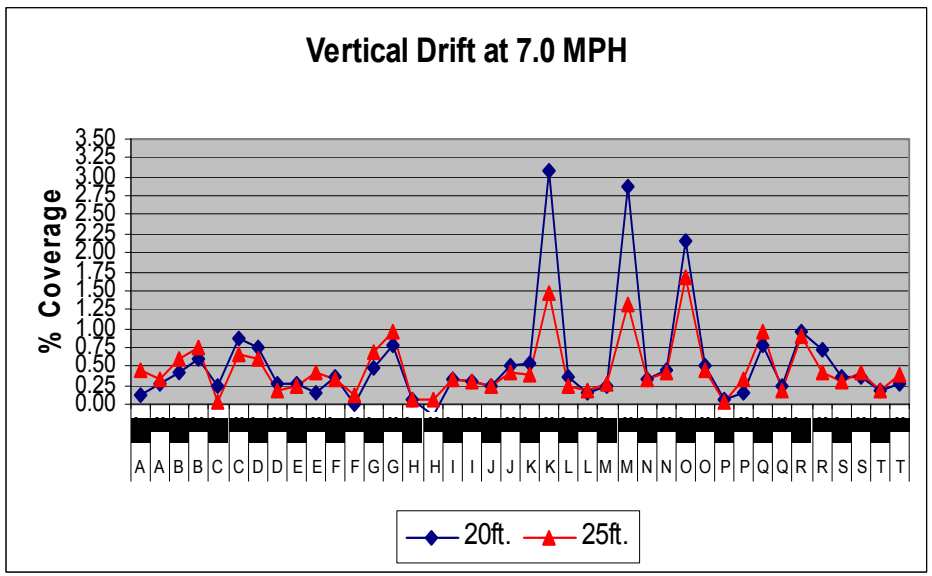

Vertical Drift at 7.0 MPH
% Coverage
8.0
6.0
4.0
2.0
0.0
A A B B C C D D E E F F G G H H I I J J K K L L M M N N O O P P Q Q R R S S T T
0ft.
5ft.
10ft.
15ft.
20ft.
25ft.
30ft.
35ft.
40ft.

Figure 5 continued:







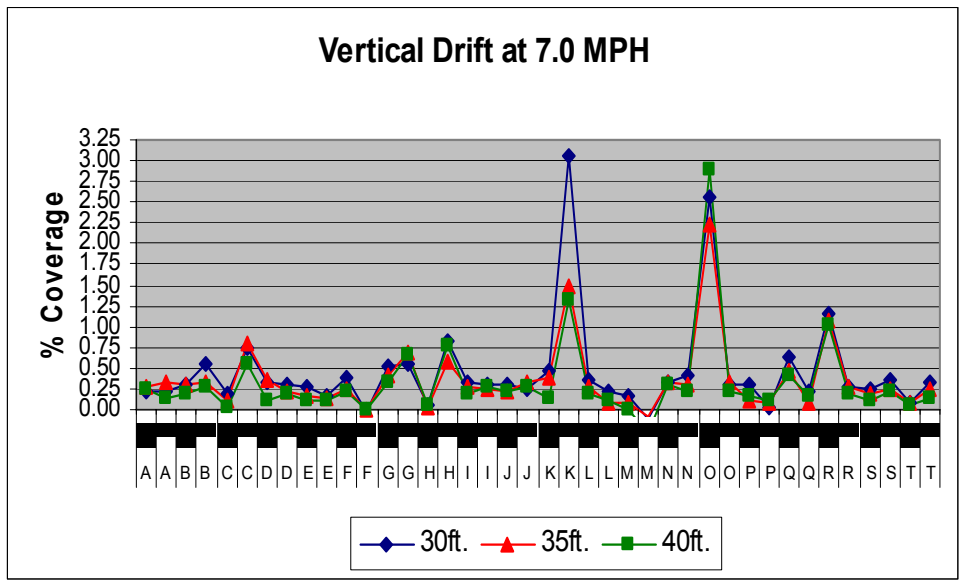


Figure 6:

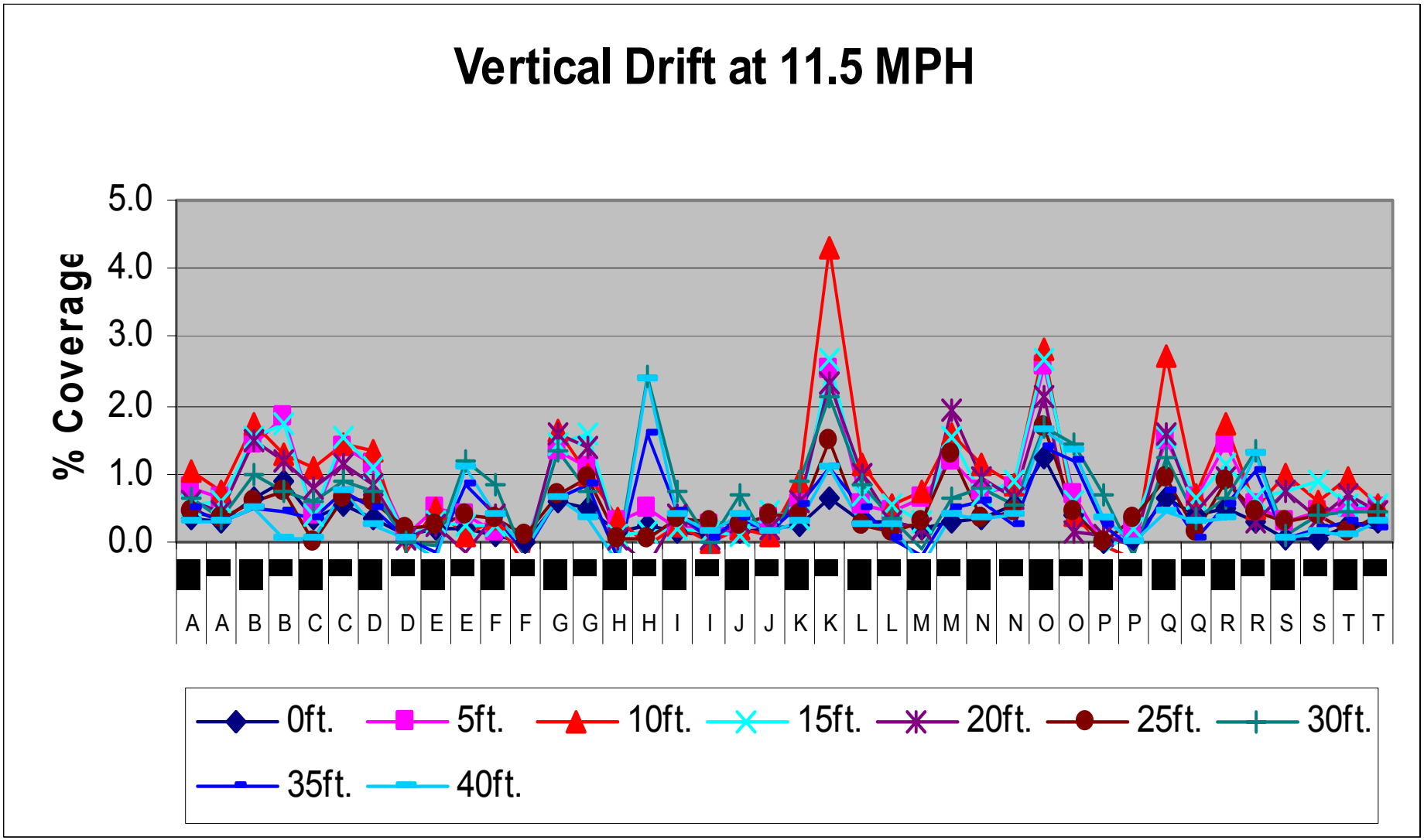
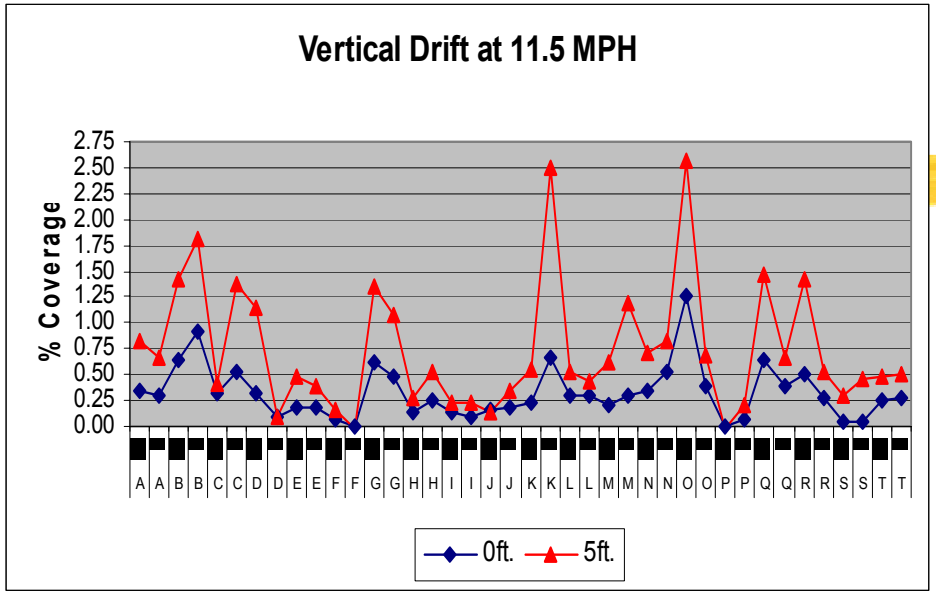
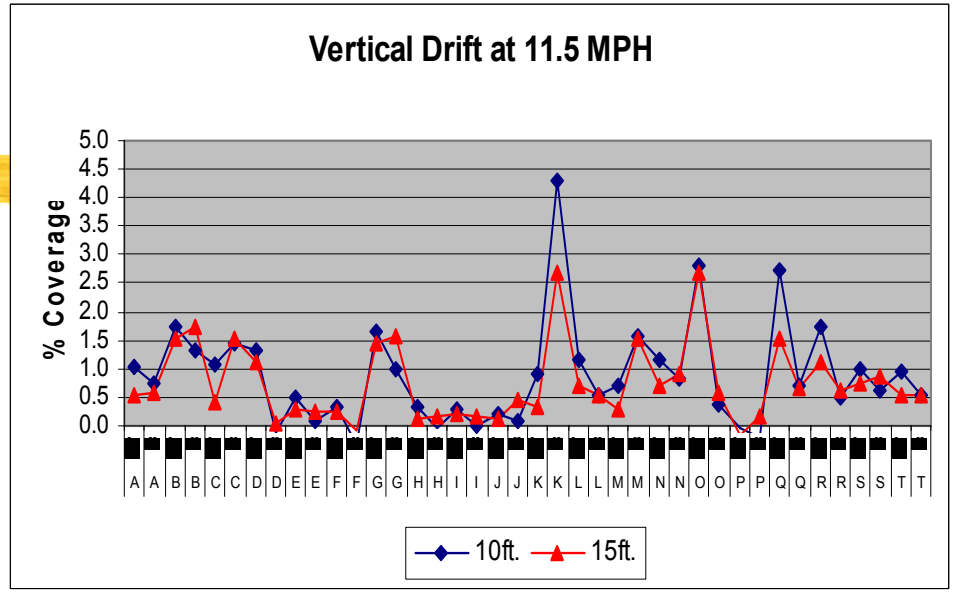
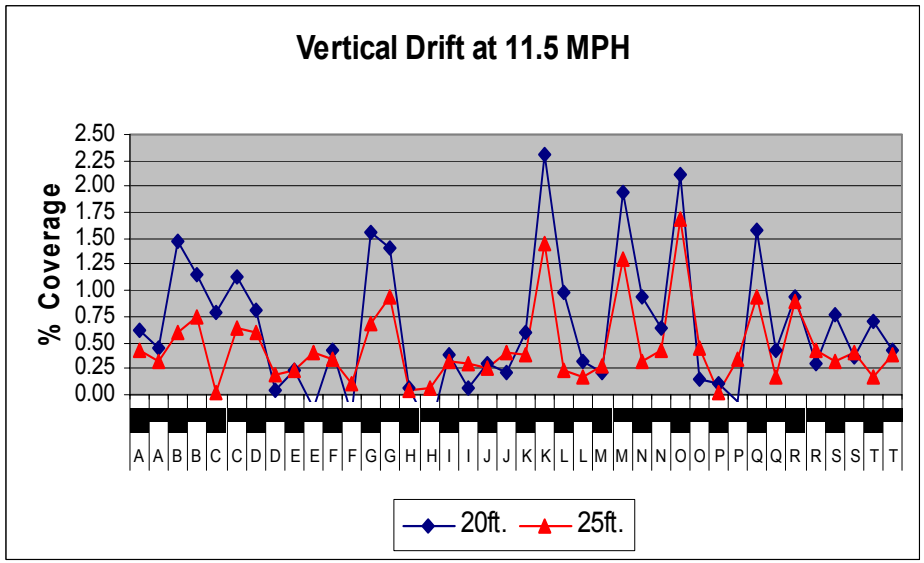
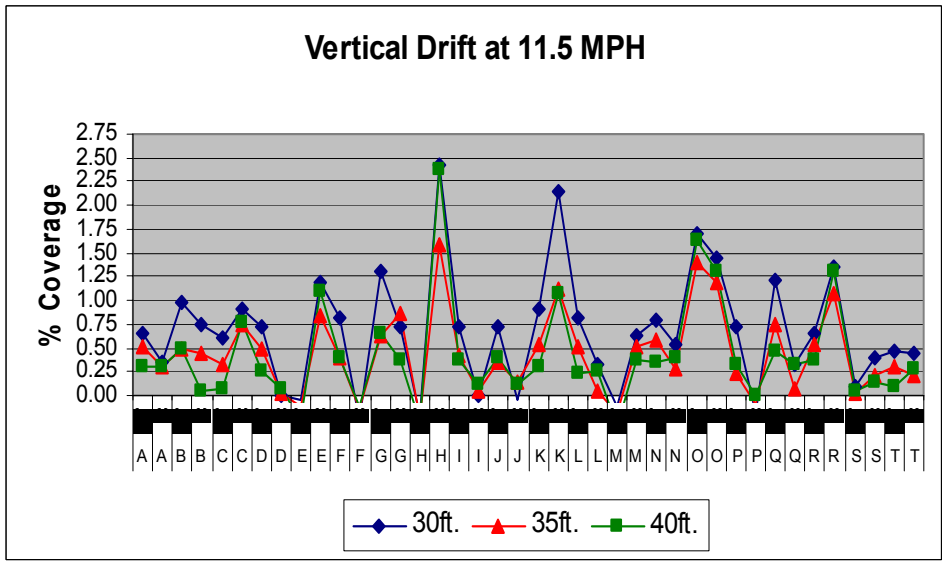

Vertical Drift at 11.5 MPH
% Coverage
5.0
4.0
3.0
2.0
1.0
0.0
A A B B C C D D E E F F G G H H I I J J K K L L M M N N O O P P Q Q R R S S T T
0ft.
5ft.
10ft.
15ft.
20ft.
25ft.
30ft.
35ft.
40ft.

Figure 6 continued:









Derived from Table 7 - p. 17

Figure 7a: Air Tractor Canopy Droplet Spectra with water trend lines

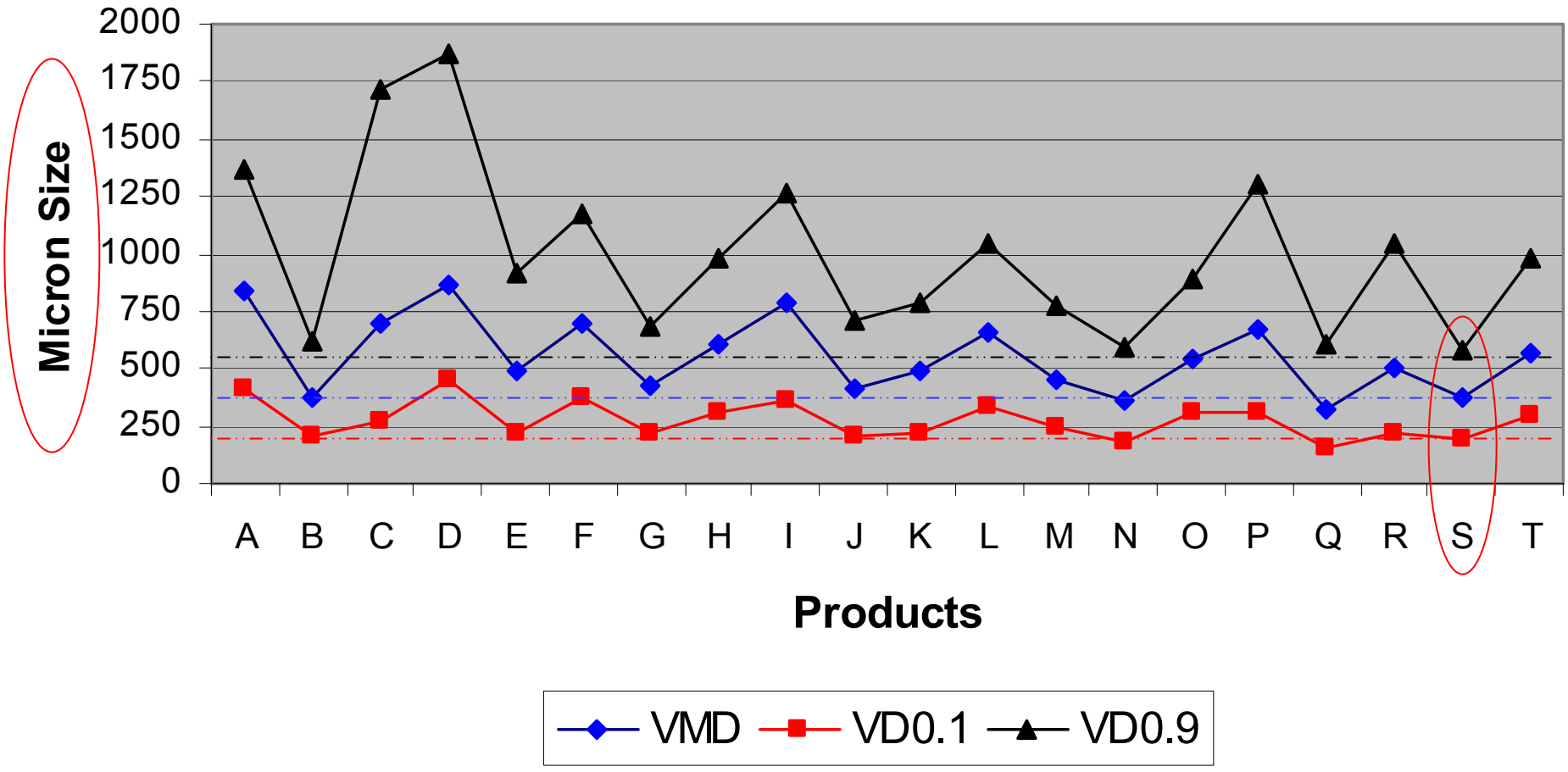
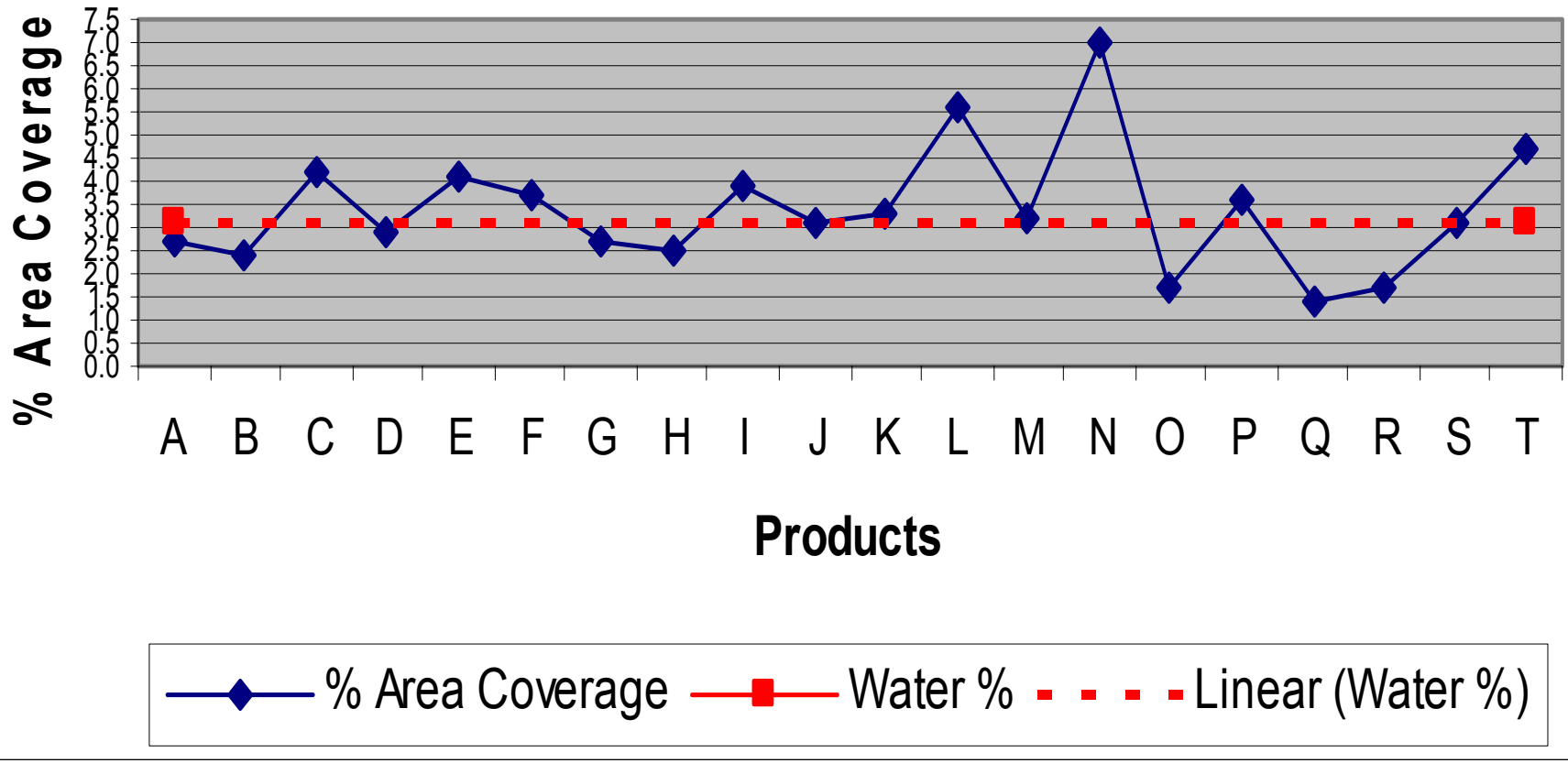


Figure 7b: Air Tractor Canopy % Area Coverage with water trend line



Derived from Table 7 – p. 17

Figure 7c: Cessna Canopy Droplet Spectra with water trend lines

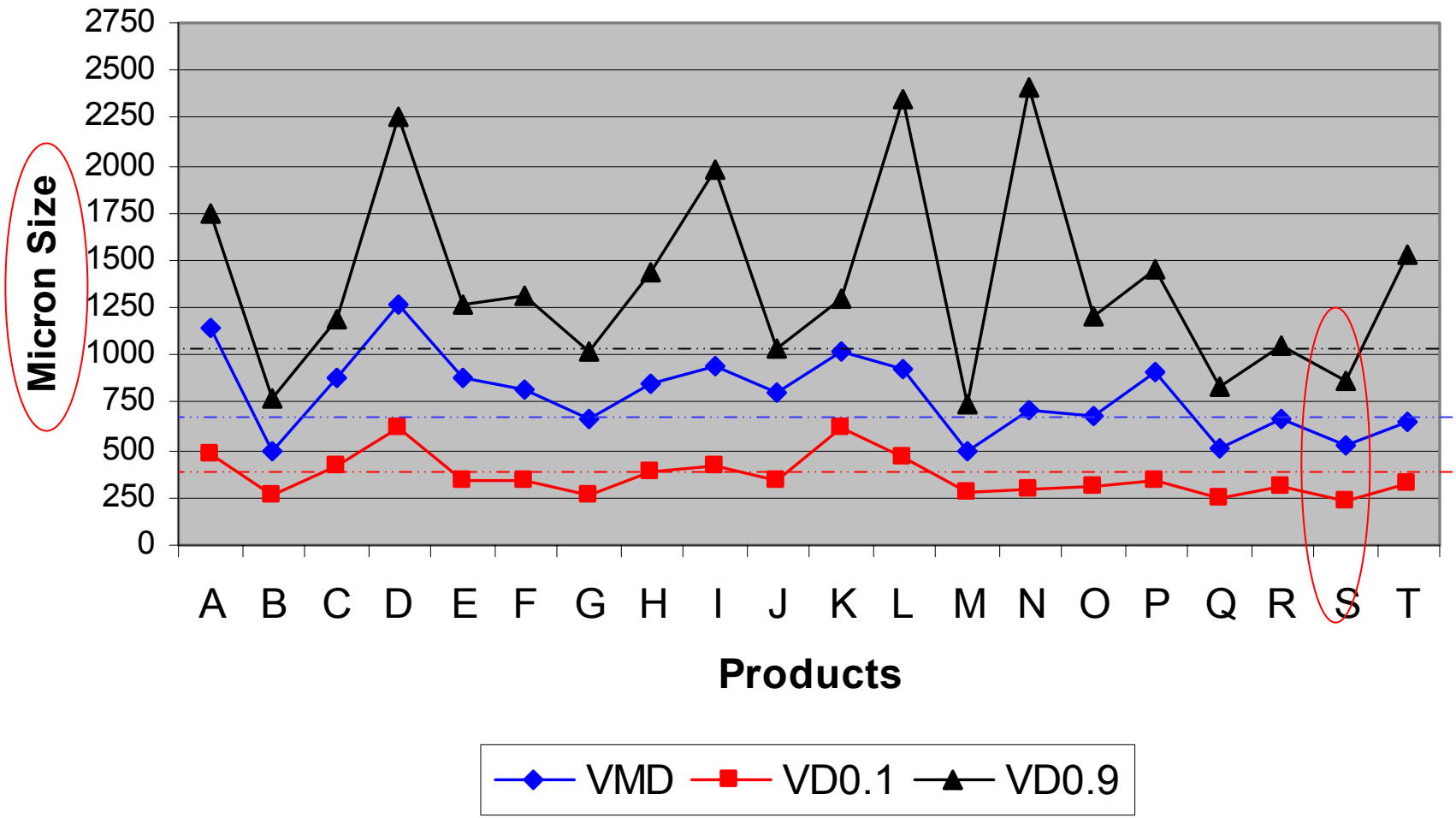


Figure 7d: Cessna Canopy % Area Coverage with water trend line

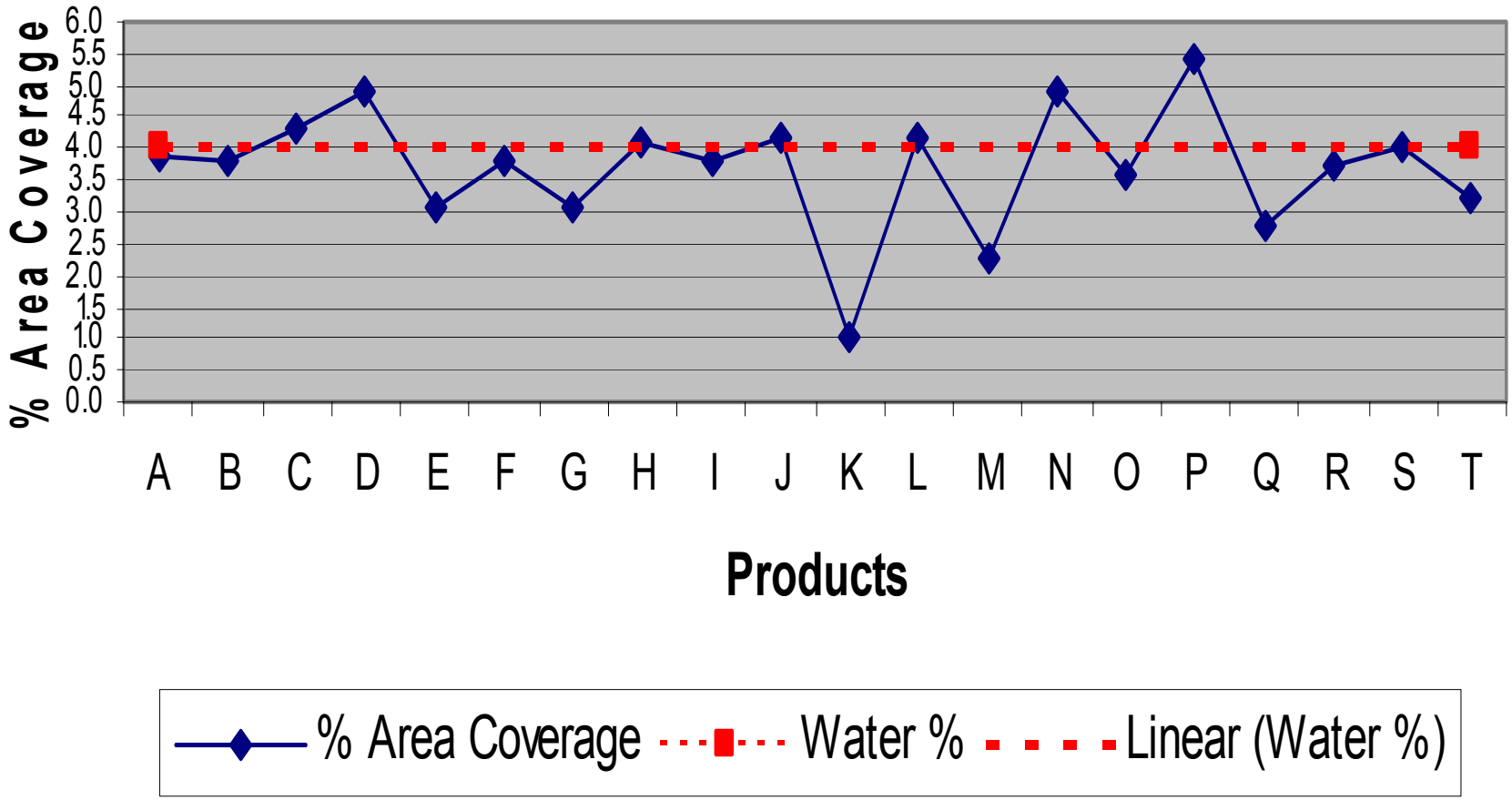


Figure 7a: Air Tractor Canopy Droplet Spectra with water trend lines

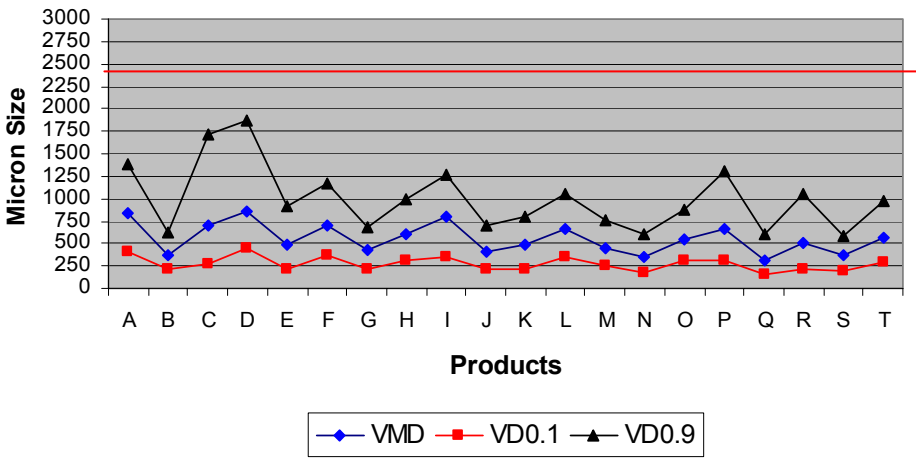


Figure 7c: Cessna Canopy Droplet Spectra with water trend lines

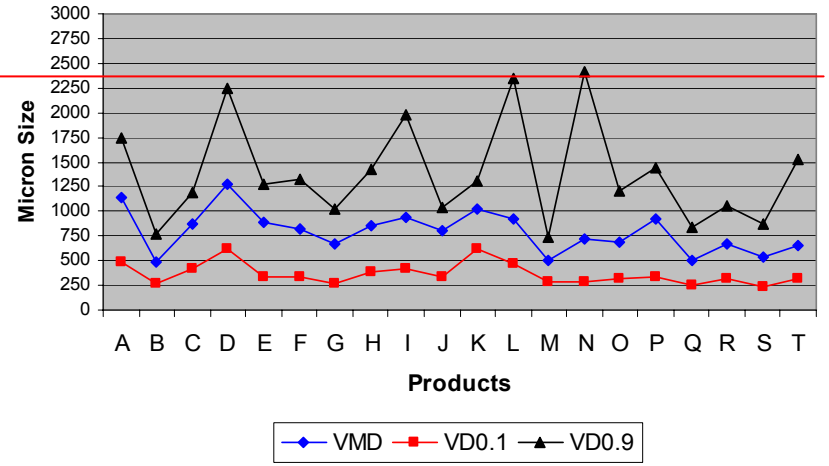


Figure 7b: Air Tractor Canopy % Area Coverage with water trend line

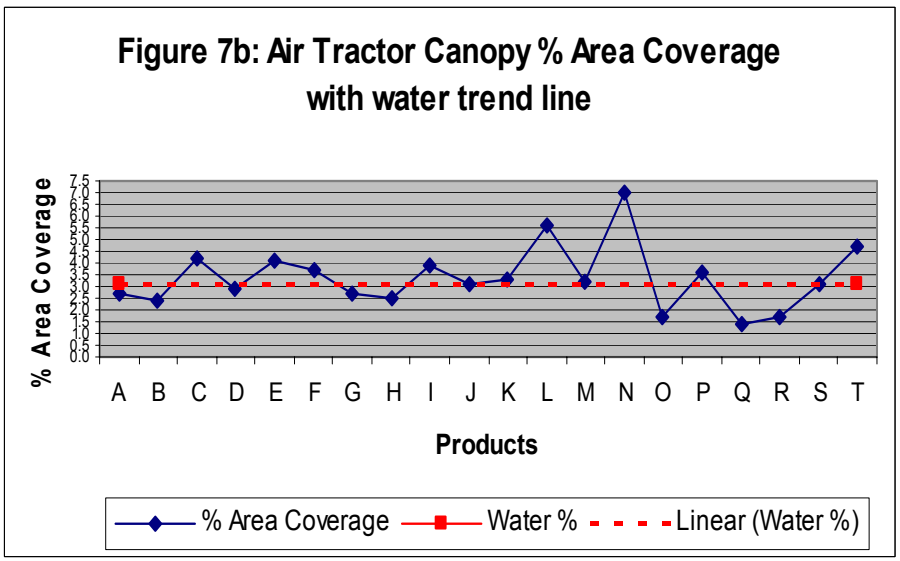
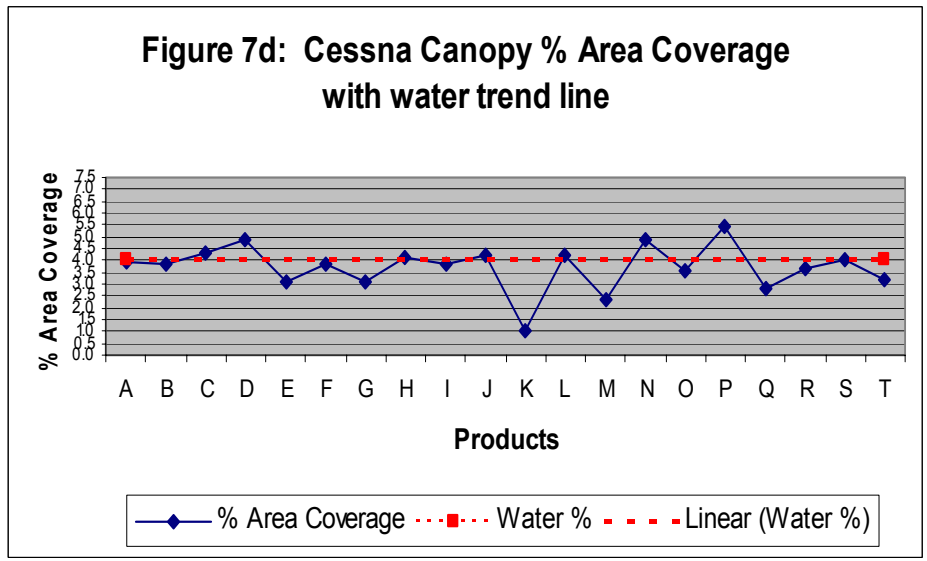


Figure 7d: Cessna Canopy % Area Coverage with water trend line



Summary of findings:

- ✓ Product differences at all horizontal and vertical positions.
- ✓ Differences in the airplanes.
- ✓ Differences in the wind profiles.
- ✓ Some products did better than water alone.
- ✓ Others were the same or worse.
- ✓ Droplet Spectra was influenced – larger (VMD, VD0.1, VD0.9).
- ✓ DS different between airplanes

Summary continued:

- ✓ This is a single study, do not base your decisions solely on the information provided.
- ✓ Complexities of interpreting the results require an extensive review of all the data – treatment by treatment to water, other treatments, and each aircraft.
- ✓ Tank mix compatibility critical – self test!
- ✓ Consider all the BMP's available for your applications!!!
- ✓ Reduce drift while improving coverage.
- ✓ Better than water!!!!


Acknowledgements:
University of Arkansas CES
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Spraying Systems Company
Barker Farm Services, Inc.
Kansas Department of Ag
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Chemical Companies
LPCAT
Thank you!