Operation S.A.F.E. for Quality Performance/Web Based Decision making

Dennis R. Gardisser, PhD, P.E.
WRK of Arkansas LLC

153 92nd West

Dennis' hangar

Bev's house

30 Country Air Lane

Rwy 11 - 29

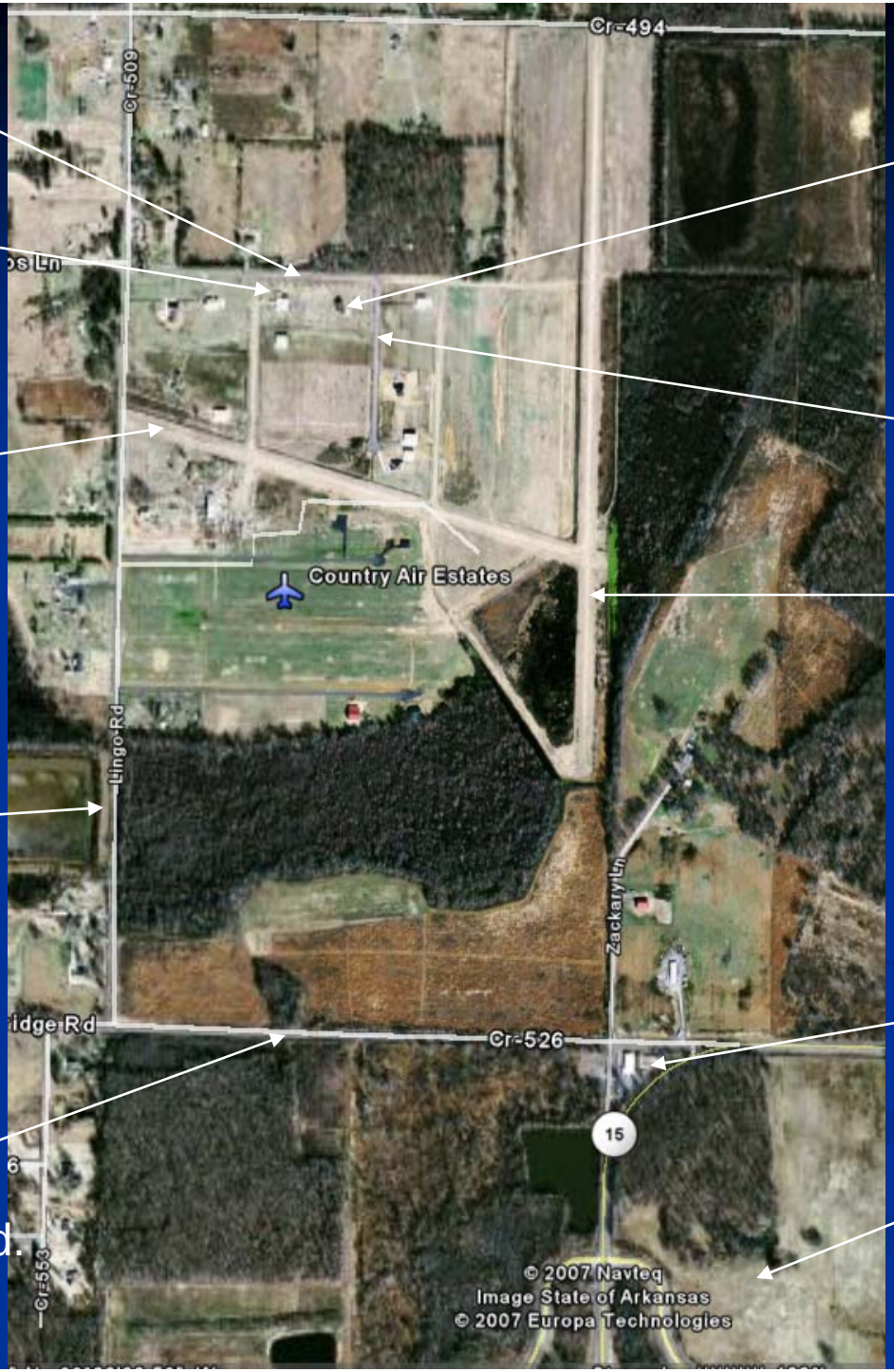
Rwy 18 - 36

Lingo Rd.

Church

Carson Bridge Rd.

Exit 169 – I40
Remington arms




WRK
153 92nd West
www.countryairestates.com
30 Country Air Lane

Montana 10/06

Montana 10/07

11/29/09

Arkansas
11/28/08

Aerial Application Compliance

Carol Ramsay

Washington State University

Pesticide Education Specialist

Certified Operation S.A.F.E. Analyst

Focus on aerial application

but TRUE for all application equipment

Today's Goal

- Job of the plane to deliver insecticides, herbicides and fungicides efficiently
- Assess spray pattern and droplet spectrum at fly-ins
- Why care?

SPRAY DRIFT PRECAUTIONS

BUFFER ZONES

Vegetative Buffer Strip

Construct and maintain a minimum 10-foot-wide vegetative
tion between the field edge and down gradient aquatic habit
rivers; permanent streams; marshes or natural ponds; estuarie

Only apply products containing Karate Insecticide onto fields
at least 10 feet exists between the field and down gradient a

Application Triangle

Adapted from Ken Giles, UC Davis

Efficacy and Drift Management

Rely on Calibration for:

1. Droplet spectrum
2. Spray pattern uniformity
3. Spray volume application

What influences the droplets and spray pattern created by airplanes?

Factors Affecting Pattern/Droplets

Spray Characteristics

- chemical
- formulation
- additives
- evaporation

Equipment & Application

- nozzle type - deflection
- nozzle size & pressure
- height of release
- aircraft speed
- airflow obstructions

Weather

- air movement (direction and velocity)
- temperature and humidity
- air stability/inversions
- topography

Agricultural Aircraft


Air Tractor - Olney, TX


Thrush, Albany, GA


Piper Brave

Cessna


Ag Cat


Air Tractor AT802

Engine Types, Propeller Rotation/Length

Radial

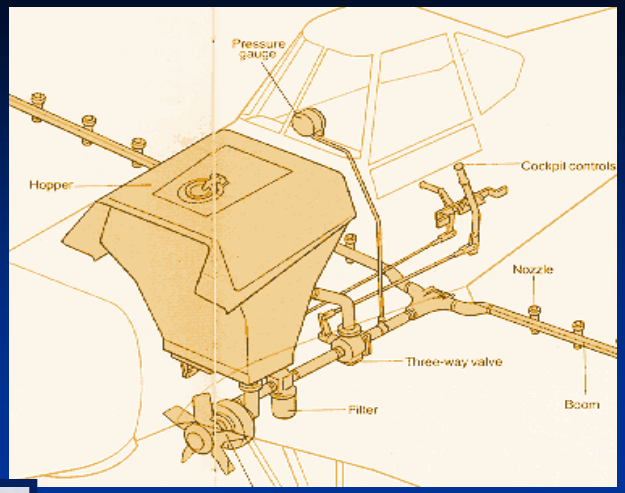
Piston
Orenda

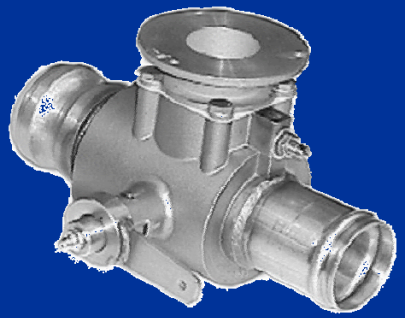
Turbine

System Components:

Equipment must be capable of lifting, transporting, and dispensing pesticides

- pump, tank, hose, boom, filters, regulators, controllers, and nozzles
- tank: emergency dump, site gauge, air vent, agitation system
- pump: centrifugal
  - propeller or hydraulic driven
- electronics

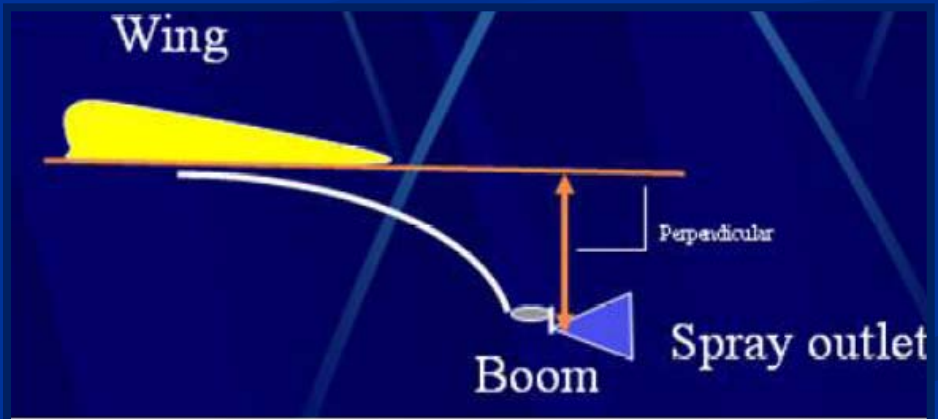




Boom length/location

Boom:

- 75% of wingspan or less and no longer than 80% rotor length
- Behind and below wing
- Unbalanced spacing across the boom
- Must have check valves on nozzles
- Boom and pressure control:
  - Positive and quick shut-off



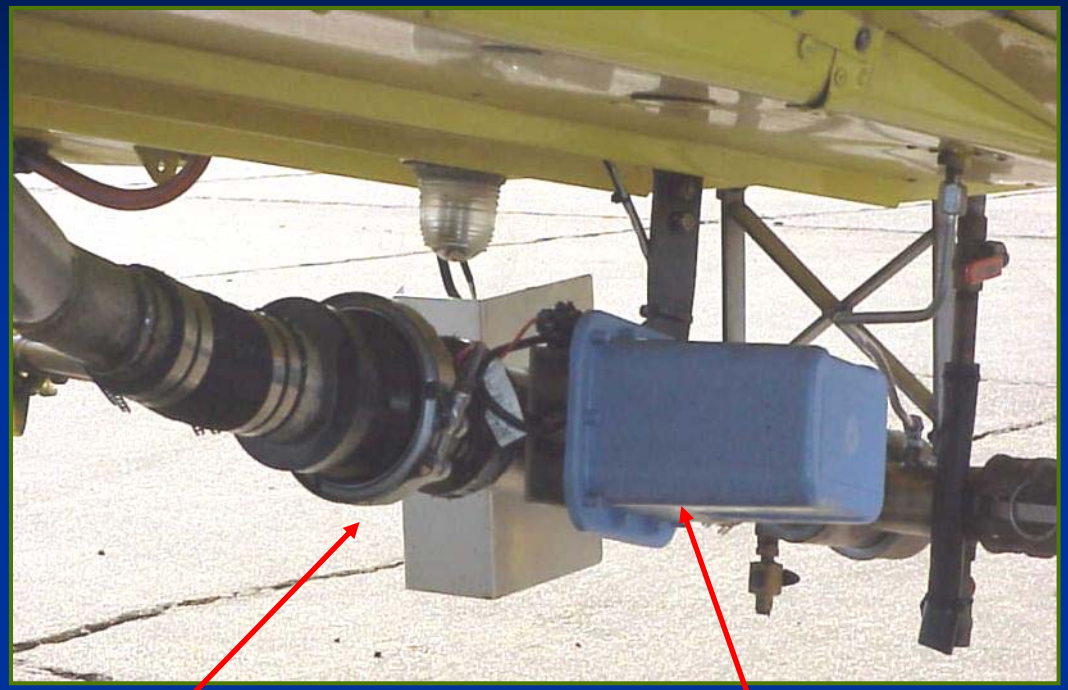
Nozzles should be a minimum of 10 inches below the trailing edge of the wing – 16-20 inches is even better.

Drop Boom:

Boom Hangers


N6175S

Pattern Obstructions:



Flow Sensor

Flow Controller

CP Swivel:

- Quick change angle device
- 15 degree increments
- Flexibility to increase the angle of attack
- Will this influence the droplet spectrum?

What about the nozzle?

Nozzles are important because:

- Control delivery rate – GPA
- Determine uniformity of application
- Affect coverage
- Influence drift potential

Fly-in Workshops:

Operation S.A.F.E.

- Self-Regulating Application and Flight Efficiency
  - Certified Analysts
  - Education program
  - Application analysis
  - Commitment to the principles outlined by the NAAA Board of Directors which includes:
    - Demonstrate responsibility to minimize the potential for adverse health and environmental effects from applying crop protection chemicals.

Operation S.A.F.E.

S.A.F.E. Fly-in Workshop

- Swath/Pattern and droplet analysis – open to all licensed operators or agricultural aviators
- Requested and managed by state's aerial applicator association
- Active & Certified S.A.F.E. Analysts
  - Carol Ramsay, WSU
  - Tom Karsky, Univ. of Idaho
  - Bob Wolf, Kansas State University
  - Dennis Gardisser, WRK of Arkansas
  - Scott Bretthauer, Univ. of Illinois

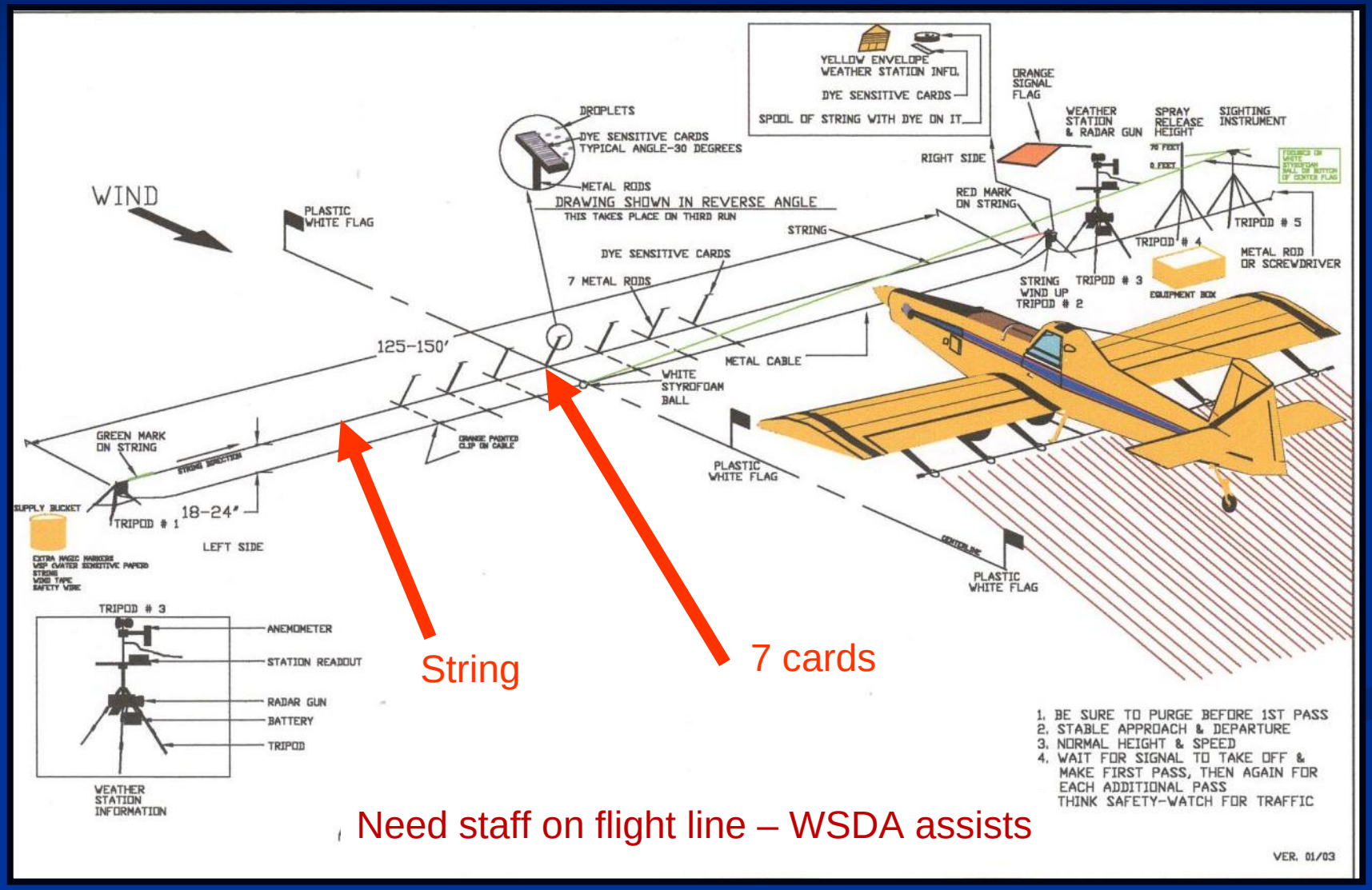
Analyses

- Spray Pattern Analysis
  - Fluorescent dye
  - 3 flight passes over string collector
  - Run string through fluorometer
  - Computer generates graphs and analysis of relative deposition on string
    - Individual passes and Average of passes
    - Variation between highs and lows

Analyses

- Droplet Spectrum Analysis
  - Single pass collection
    - 7 water sensitive cards
    - 3 inches x 1 inch
  - 42-foot swath sample
  - Flatbed scanner
  - Computer program
    - Measures drop sizes, number of droplets and relative volume
    - CV for best swath width

Operation S.A.F.E. Flight-line



Need staff on flight line – WSDA assists

Fly-in data sheet

- Nozzle type, size, number, deflection, airspeed, pressure, target rate & swath

Pilot Name _____

Aircraft #_____ Aircraft Make/Model_____

Test Run Series	1	2	3
Nozzle Manufacturer *e.g. CP, Flat Fan, Lund, Disc46 core, etc*			
Nozzle Orifice Size, *e.g. .062, .078, .125, .172, 4, 5, 6, 15, 20*			
# of Nozzles *if split, note: 26@ .125 and 25@ .078*			
Deflection (angle) *e.g. 0, 5, 10, 30, 60*			
Pressure Setting			
Target Rate (gpa)			
Target Swath Width (ft)			

Notes:

3 Passes, then Analyze

Fluorometer Assessment

Pattern Data

Aircraft Data

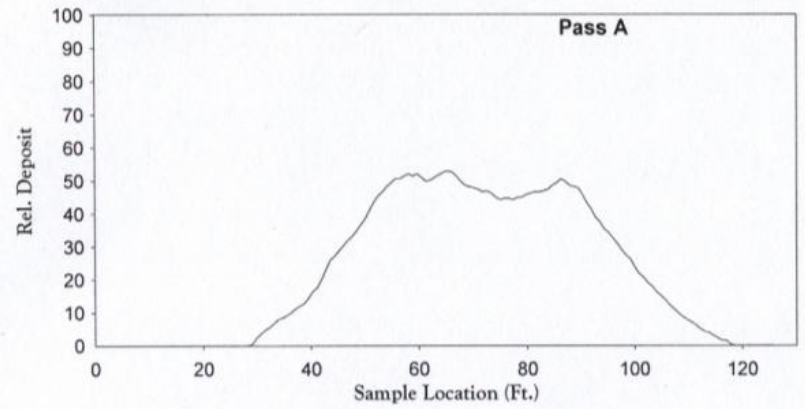
Reg. Nbr.:			
Nozzle I:	36\FF40LargeOrif\# 15 at 30°	Series:	2
Pressure:	40 PSI	Make/Model:	AT 402B
Target Swath:	67.0 Ft.	Active Nozzles:	36
		Target Rate:	3.0 GPA

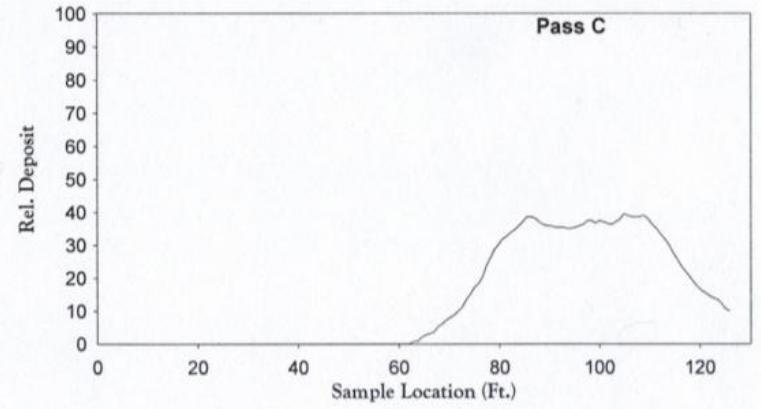
(Dr. I.W. Kirk spray-nozzle models, USDA/ARS,College Station, TX.) [= Data outside mode led range]*

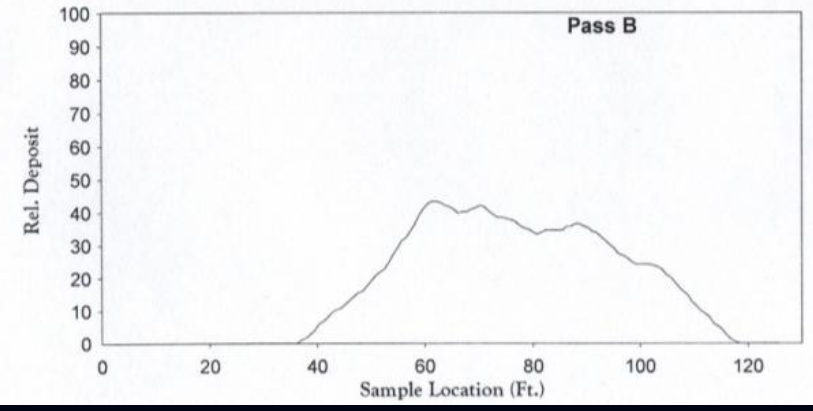
Composite spray data: VMD = 273 5.97 %<100µm 17.54 %<200µm

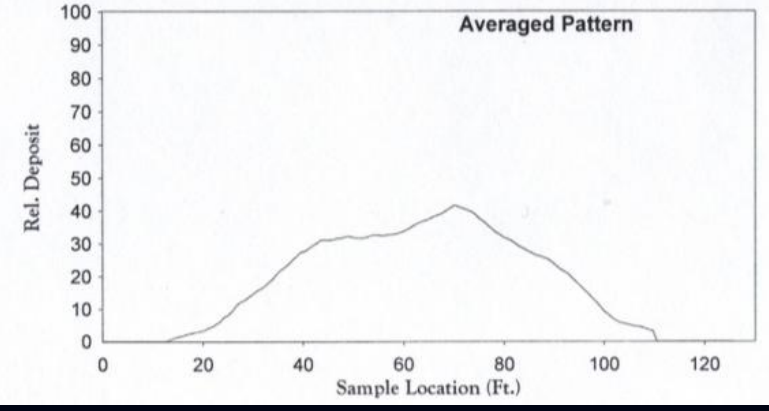
Flight-Line Data

	Pass-A	*Pass-B*	*Pass-C*	*Avg*
Aircraft Speed: (MPH)	150	150	141	147
Aircraft Height: (Ft.)	6.0	5.0	5.0	5.3
Wind Velocity: (MPH)	4.0	1.0	0.0	1.7
Cross-wind: (MPH)	-2.6	-0.5	0.0	-1.0
Ambient Temp: (F)	73	73	73	73
Relative Hum: (%)	1	1	1	01









Five Passes

KSU-KAAA SAFE Flyin Workshop
Barker Farm Services
304 Washington
Goodland, KS 67735

Aircraft Data

Reg. Nbr :	N5003C	Make/Mod:	AT 502B
Nozzle I:	40 FF40SmallOrif / # 8	Orif @	0 º
Nozzle II:			
Pressure:	38 PSI	Rate: 2.0 GPA	Swath: 66.0 Ft.

PDN5003C.5

Program Options

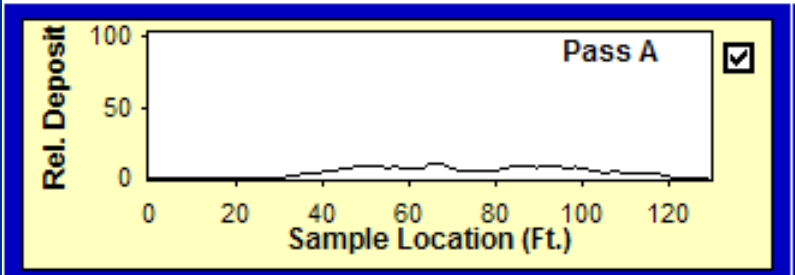
Print Passes | Print Average | Print Both

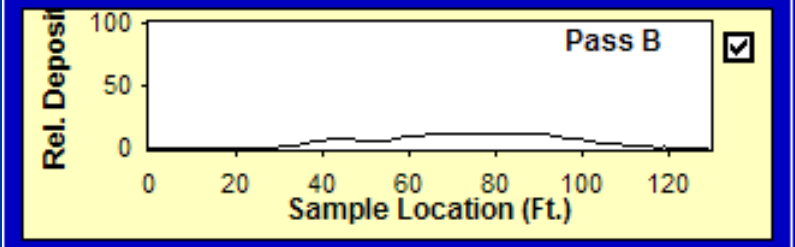
Flight-Line Data

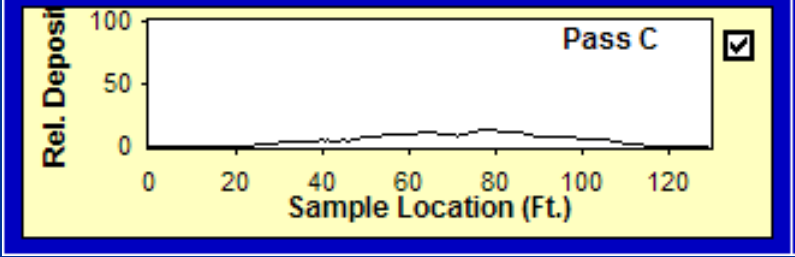
		A	B	C	D	E	Avg
Speed:	MPH	120	119	119	0	0	119
Height:	Ft.	11.0	10.0	12.0	0.0	0.0	11.0
Wind Vel :	MPH	9.0	8.0	9.0	0.0	0.0	8.7
X-wind:	MPH	1.9	1.0	0.6	0.0	0.0	1.2
Temp:	F	0	0	0	0	0	00
Humidity:	%	0	0	0	0	0	00

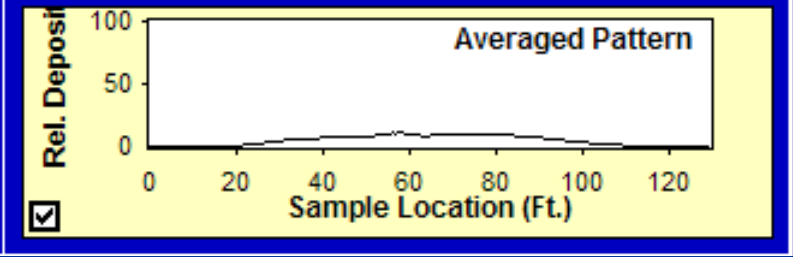
VMD = 348 | <100 µm = 3.69 % | < 200 µm = 10.86 %

From models by Dr. I.W. Kirk, USDA/ARS (* = Data outside modelled range)









Swath Analysis

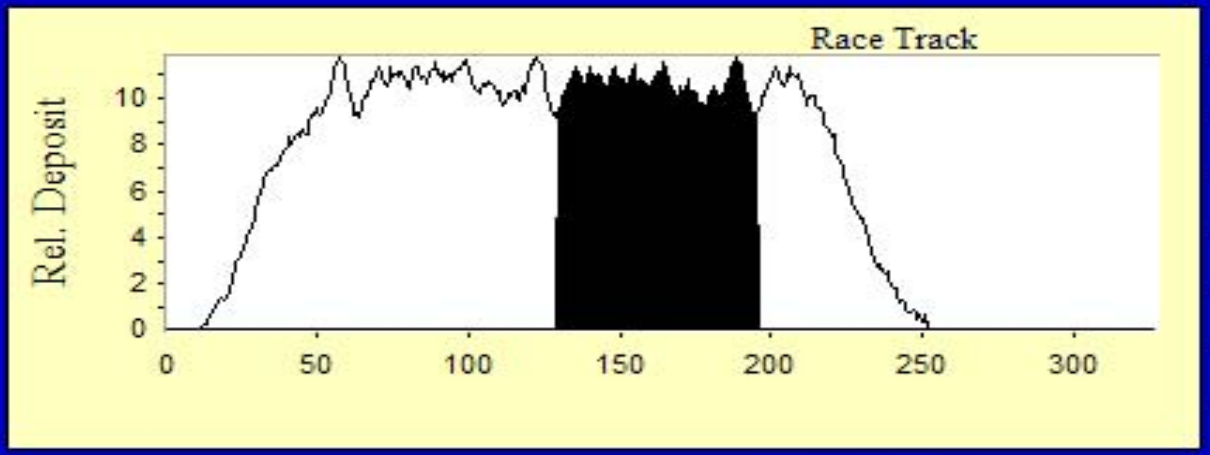
Slide to select a swath interval.

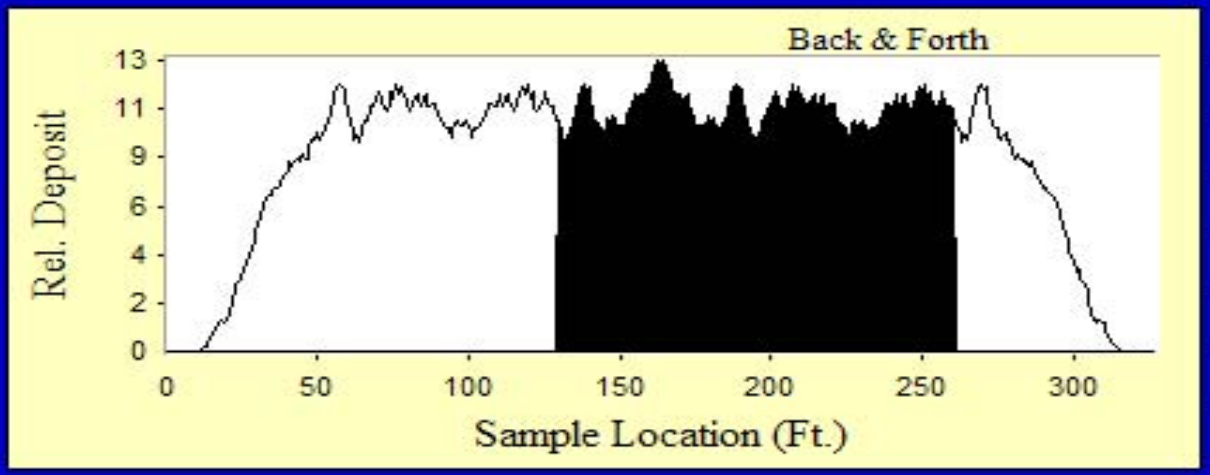
Selected
66 Ft.

Program Options
Print

PDN5003C.5

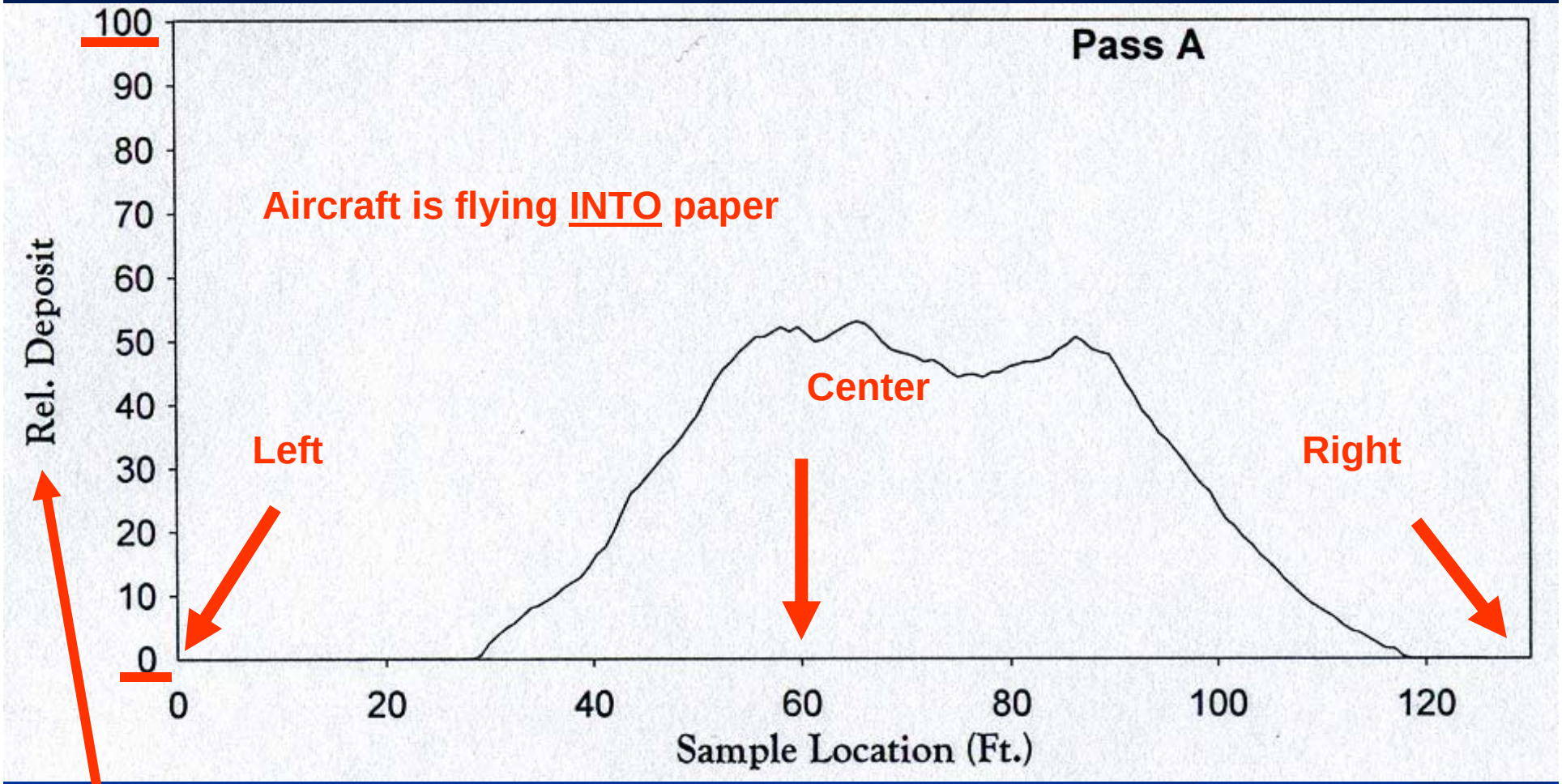
Est. Rate	R T CV	B & F CV
1.86 GPA	5 %	7 %





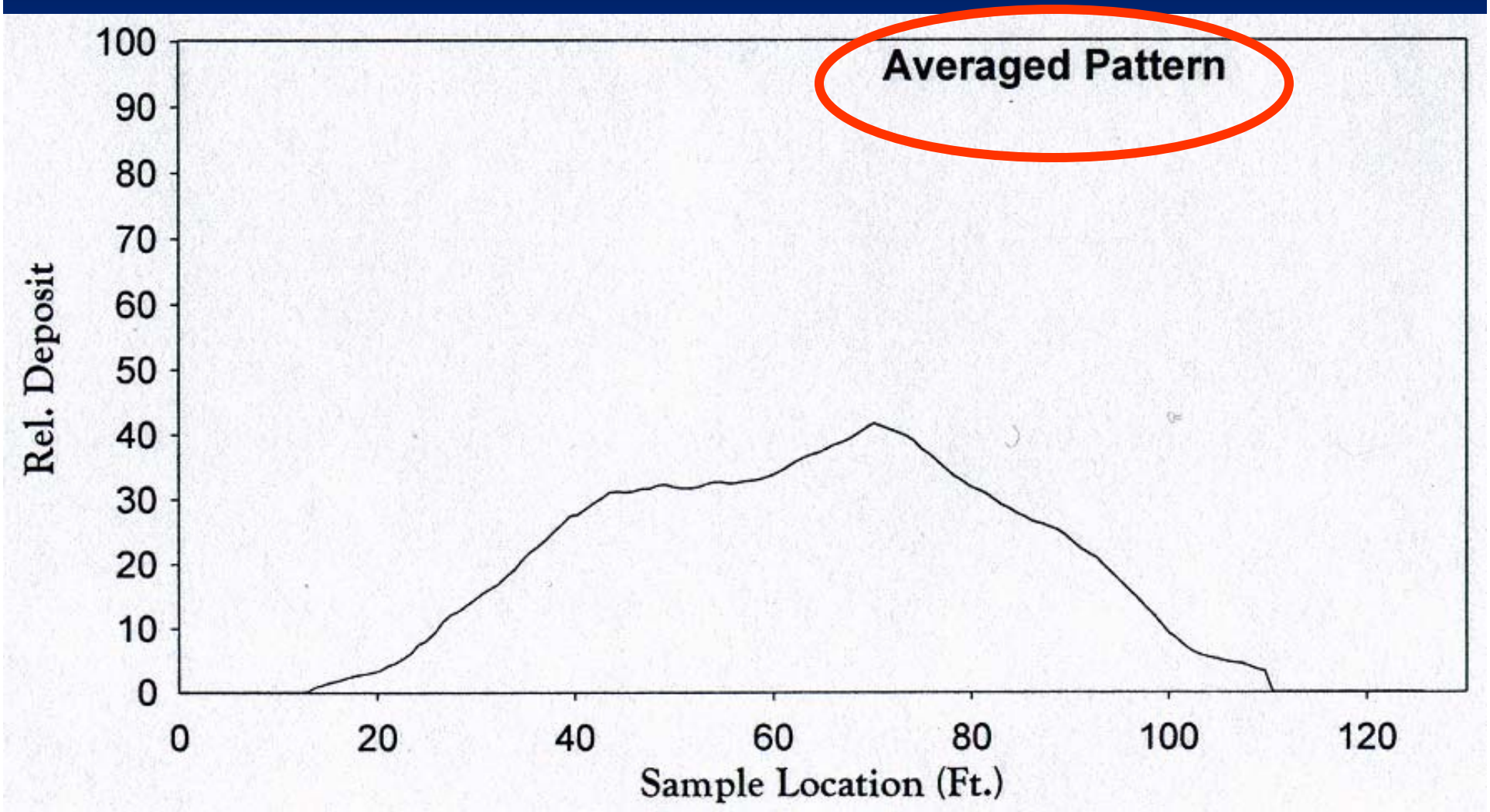
Swath Ft.	Est. Rate GPA	R T CV	B F CV
56	2.19	11 %	11 %
57	2.15	11 %	10 %
58	2.12	11 %	10 %
59	2.08	10 %	10 %
60	2.05	9 %	9 %
61	2.01	8 %	9 %
62	1.98	8 %	8 %
63	1.95	7 %	8 %
64	1.92	7 %	8 %
65	1.89	6 %	8 %
66	1.86	5 %	7 %
67	1.83	5 %	7 %
68	1.8	5 %	8 %
69	1.78	6 %	8 %
70	1.75	7 %	9 %
71	1.73	8 %	9 %
72	1.7	9 %	10 %
73	1.68	10 %	12 %
75	1.66	11 %	12 %
74	1.64	13 %	13 %
76	1.61	14 %	14 %
77	1.59	15 %	15 %

Individual passes



Relative deposition – not GPA deposition: 0 to 100%

Averaged pattern



Averaged pattern

WRK Version 3 Development
Software Division
Stillwater, OK
June 2003

Aircraft Data

Reg. Nbr.:
Nozzle I: 36\FF40LargeOrif\# 15 at 30°
Pressure: 40 PSI
Target Swath: 67.0 Ft.
Series: 2
Make/Model: AT 402B
Active Nozzles: 36
Target Rate: 3.0 GPA

(Dr. I.W. Kirk spray-nozzle models, USDA/ARS,College Station, TX.) [= Data outside mode led range]*

Composite spray data: VMD = 273 5.97 %<100µm 17.54 %<200µm

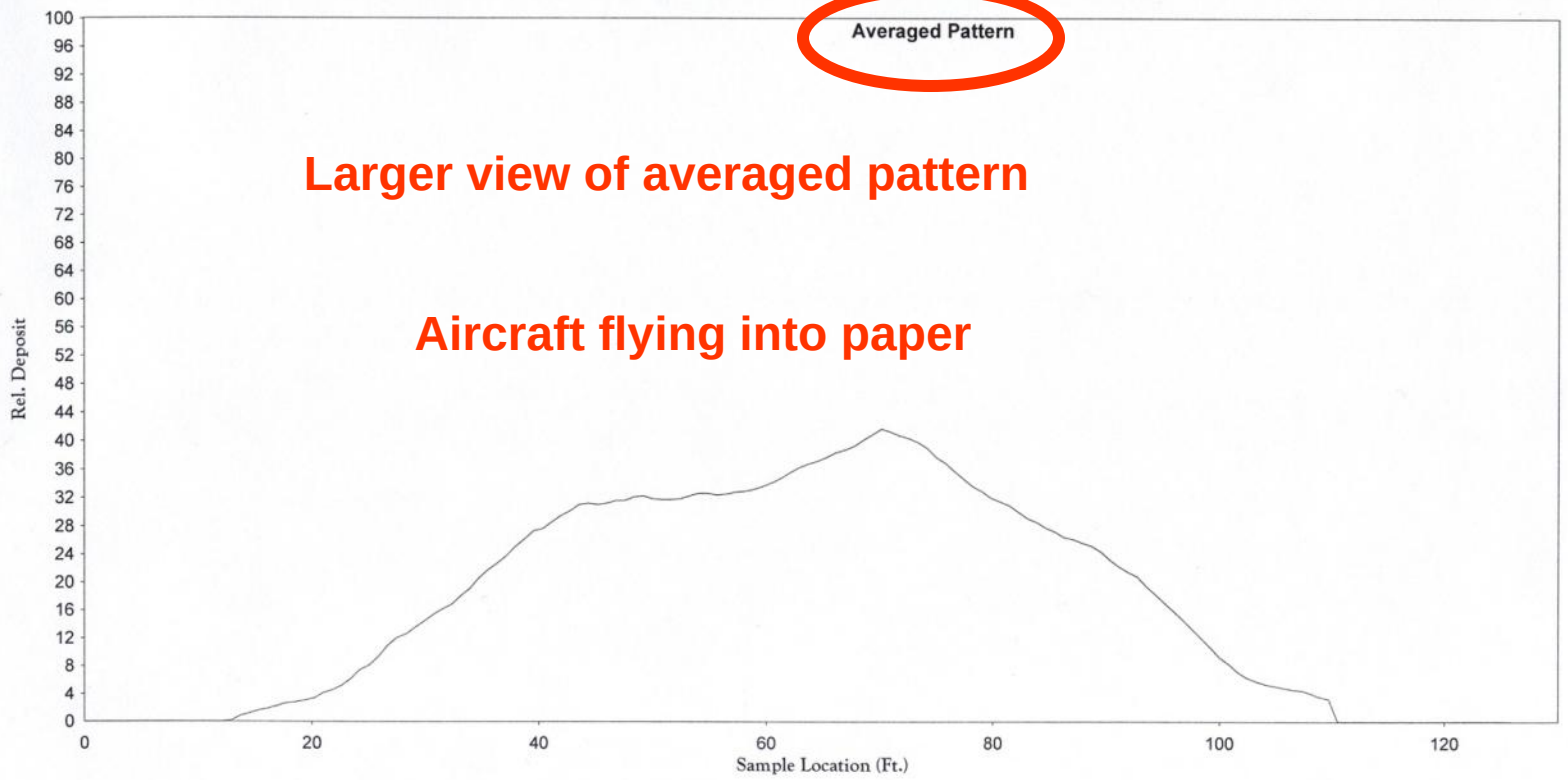
Flight-Line Data

	Pass-A	*Pass-B*	*Pass-C*	*Avg*
Aircraft Speed: (MPH)	150	150	141	147
Aircraft Height: (Ft.)	6.0	5.0	5.0	5.3
Wind Velocity: (MPH)	4.0	1.0	0.0	1.7
Cross-wind: (MPH)	-2.6	-0.5	0.0	-1.0
Ambient Temp: (F)	73	73	73	73
Relative Hum: (%)	1	1	1	01

Averaged Pattern

Larger view of averaged pattern

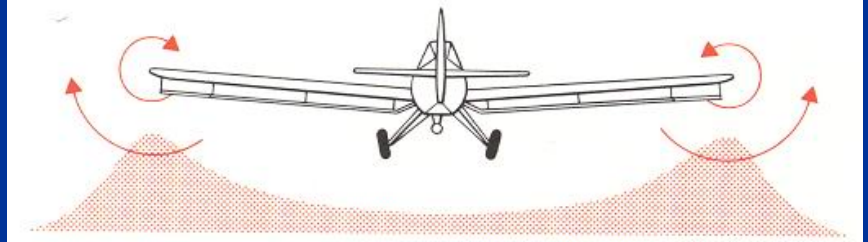
Aircraft flying into paper



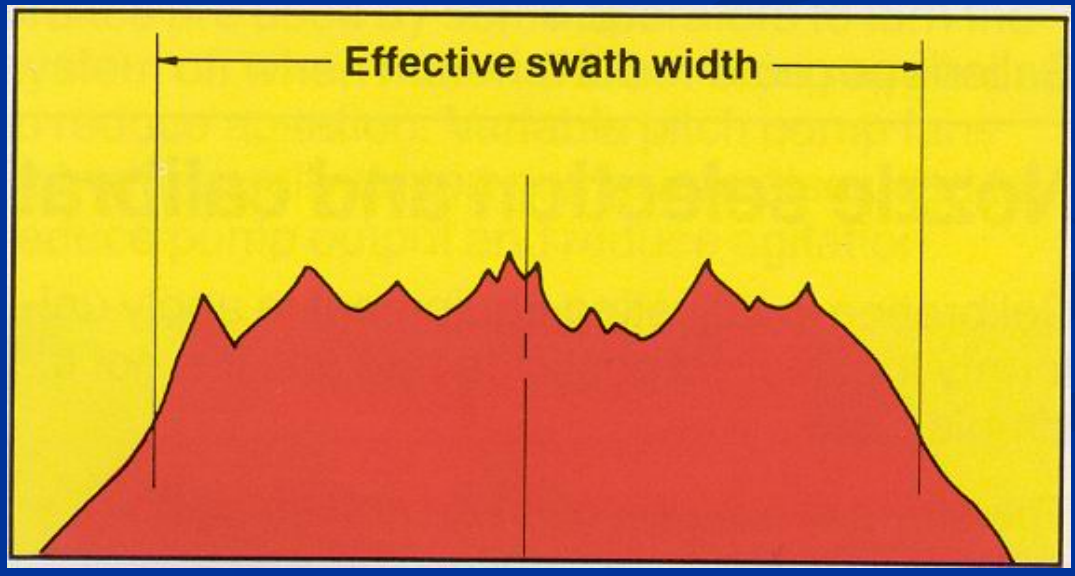
WRK_String Analysis\Graphics\Version 3

Spray pattern analysis

The effect of propwash on spray recovery.



Wing tip vortices affecting spray pattern.



Spray pattern analysis

Aircraft Data

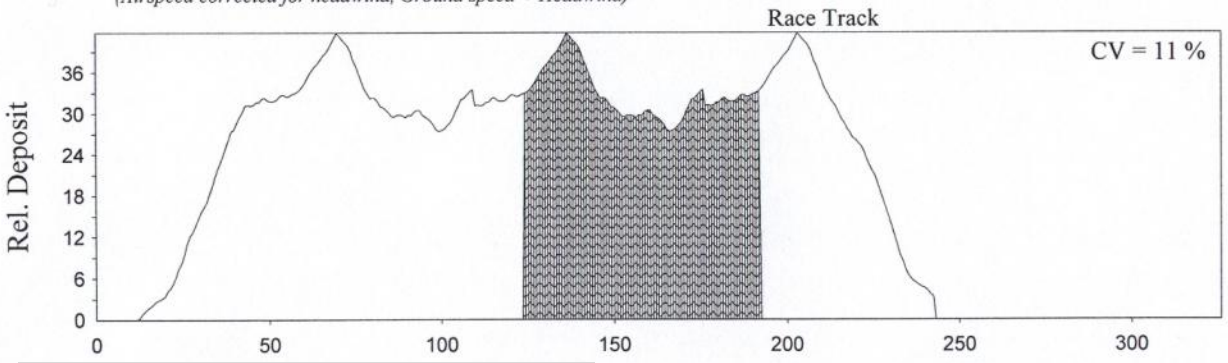
Reg. Nbr.:		Series:	2
Nozzle I:	36\FF40LargeOrif\# 15 at 30°	Nbr. Noz.:	36
Pressure:	40 PSI	Trg. Rate:	3.0 GPA
Trg. Swath:	67.0 Ft.	Est. Rate:	2.57 GPA
		Swath:	67 Ft.

Flight-Line Data

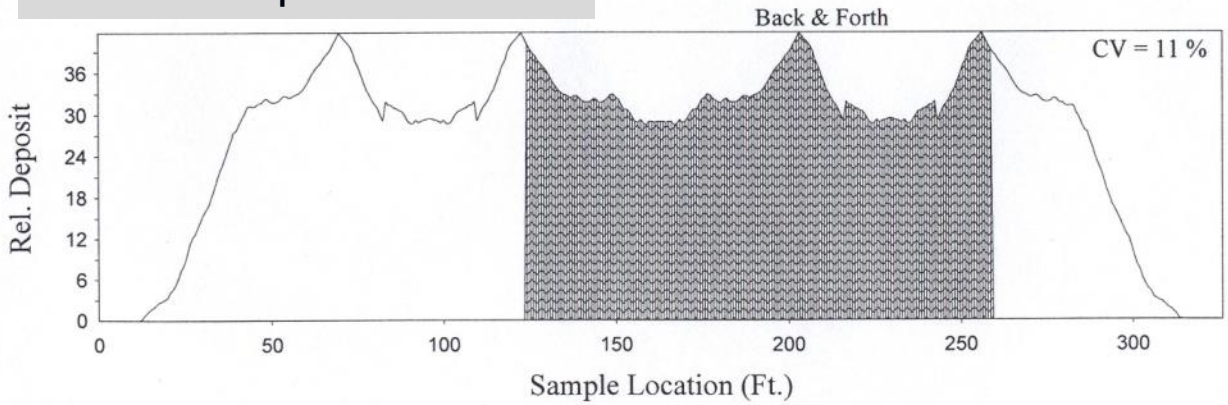
	Pass-A	Pass-B	Pass-C	Avg
Aircraft Speed: (MPH)	150	150	141	147
Aircraft Height: (Ft.)	6.0	5.0	5.0	5.3
Wind Velocity: (MPH)	4.0	1.0	0.0	1.7
Cross-wind: (MPH)	-2.6	-0.5	0.0	-1.0
Ambient Temp: (F)	73	73	73	73
Humidity: (%)	1	1	1	01

Note 1: "Estimated Rate" is a computed value based on 36 active nozzles (FF40LargeOrif) operating at 40 PSI on a swath interval of 67 Ft. and aircraft ground-speed of 147 MPH.
Allowance has been made for an assumed 10% reduction in boom pressure due to fitting and pipe friction losses.
Note 2: "CV" estimates the degree of uniformity of deposition across the field (0 = best, 100 = worst, <25 = normally acceptable).
Note 3: Shaded areas represent the repeating portion of the overlapped swath deposition across the field. CV is computed from this overlapped section.
Note 4: Spray data based on Dr. I.W. Kirk spray-nozzle models, USDA/ARS,College Station, TX. *[* = Data outside modeled range]*
(Airspeed corrected for headwind, Ground speed + Headwind)

Composite data: VMD = 273
5.97 %<100µm 17.54 %<200µm



Relative deposit not GPA



Swath (Ft)	Rate (GPA)	RT CV	B&F CV
57	3.03	8 %	8 %
58	2.97	7 %	7 %
59	2.92	7 %	7 %
60	2.88	7 %	7 %
61	2.83	7 %	6 %
62	2.78	7 %	7 %
63	2.74	7 %	7 %
64	2.70	9 %	8 %
65	2.65	8 %	9 %
66	2.61	10 %	10 %
67	2.57	11 %	11 %
68	2.54	13 %	13 %
69	2.50	13 %	14 %
70	2.46	16 %	15 %
71	2.43	17 %	17 %
72	2.40	19 %	19 %
73	2.36	19 %	20 %
74	2.33	22 %	21 %
75	2.30	23 %	23 %
76	2.27	24 %	25 %
77	2.24	27 %	27 %
78	2.21	27 %	28 %

WRK_String Analysis\Graphics/Version 3

Spray pattern analysis

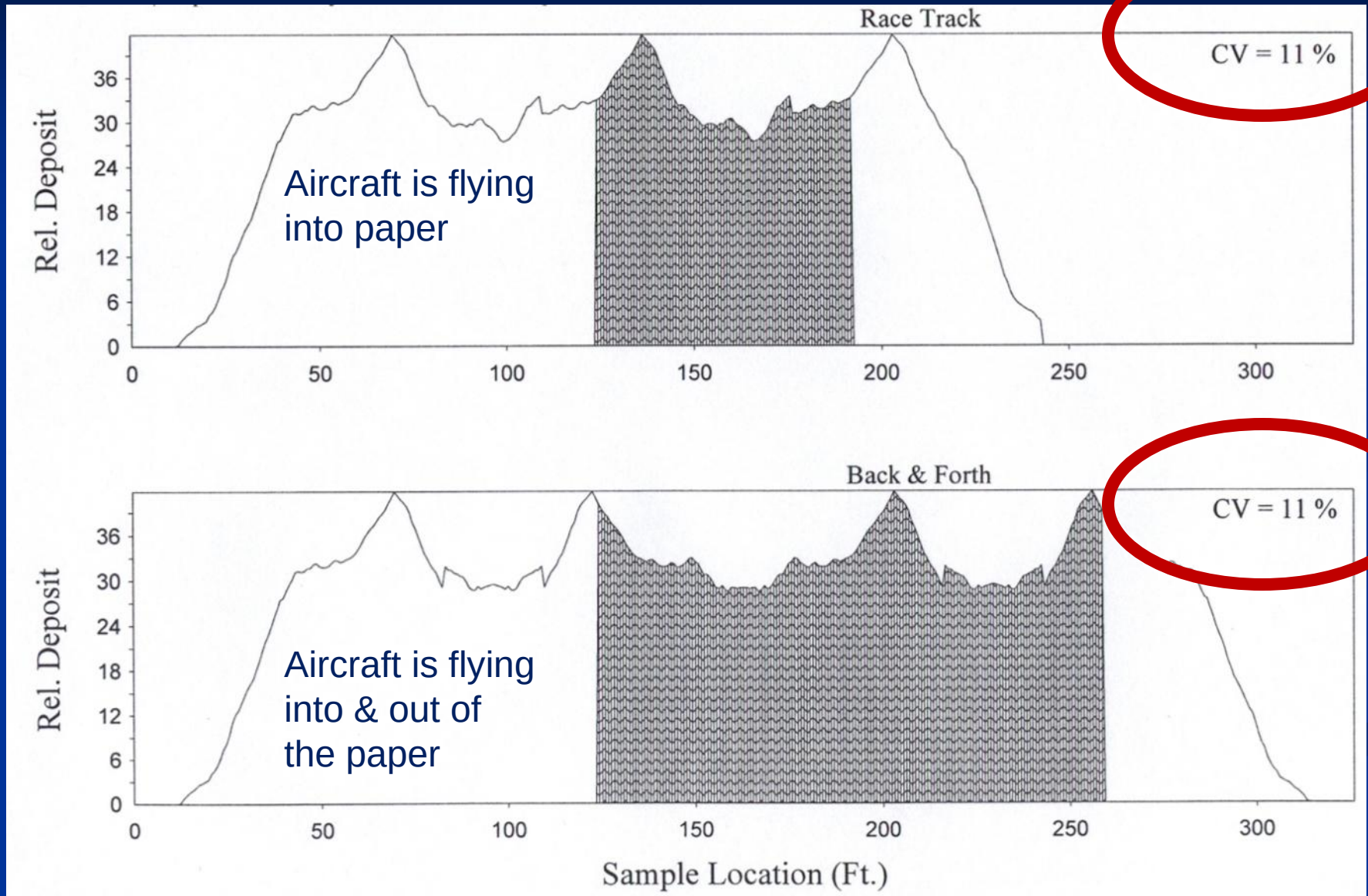
Aircraft Data

Reg. Nbr.:		Series:	2
Nozzle I:	36\FF40LargeOrif\# 15 at 30°	Nbr. Noz.:	36
Pressure:	40 PSI	Trg. Rate:	3.0 GPA
Trg. Swath:	67.0 Ft.	Est. Rate:	2.57 GPA
		Swath:	67 Ft.

Flight-Line Data

	Pass-A	*Pass-B*	*Pass-C*	*Avg*
Aircraft Speed: (MPH)	150	150	141	147
Aircraft Height: (Ft.)	6.0	5.0	5.0	5.3
Wind Velocity: (MPH)	4.0	1.0	0.0	1.7
Cross-wind: (MPH)	-2.6	-0.5	0.0	-1.0
Ambient Temp: (F)	73	73	73	73
Humidity: (%)	1	1	1	01

Spray pattern analysis



Use B&F pattern if testing under strong crosswind conditions

Spray pattern analysis

Composite data: VMD = 273
5.97 %<100µm 17.54 %<200µm

Swath (Ft)	Rate (GPA)	RT CV	B&F CV
57	3.03	8 %	8 %
58	2.97	7 %	7 %
59	2.92	7 %	7 %
60	2.88	7 %	7 %
61	2.83	7 %	6 %
62	2.78	7 %	7 %
63	2.74	7 %	7 %
64	2.70	9 %	8 %
65	2.65	8 %	9 %
66	2.61	10 %	10 %
67	2.57	11 %	11 %
68	2.54	13 %	13 %
69	2.50	13 %	14 %
70	2.46	16 %	15 %
71	2.43	17 %	17 %
72	2.40	19 %	19 %
73	2.36	19 %	20 %
74	2.33	22 %	21 %
75	2.30	23 %	23 %
76	2.27	24 %	25 %
77	2.24	27 %	27 %
78	2.21	27 %	28 %

Computer model for volume median diameter (VMD) and % small, driftable droplets.

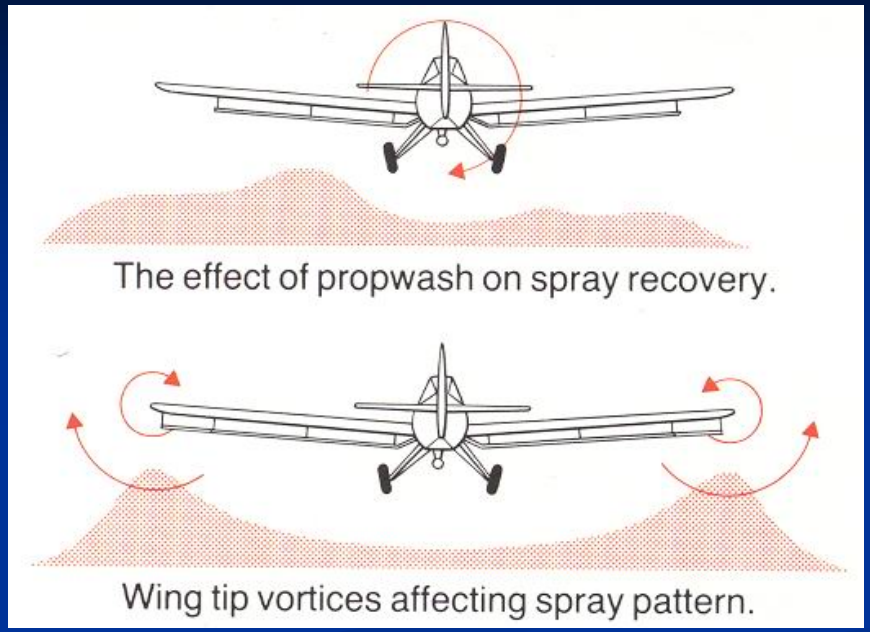
Max. acceptable CV is 25%; under 15% is very good

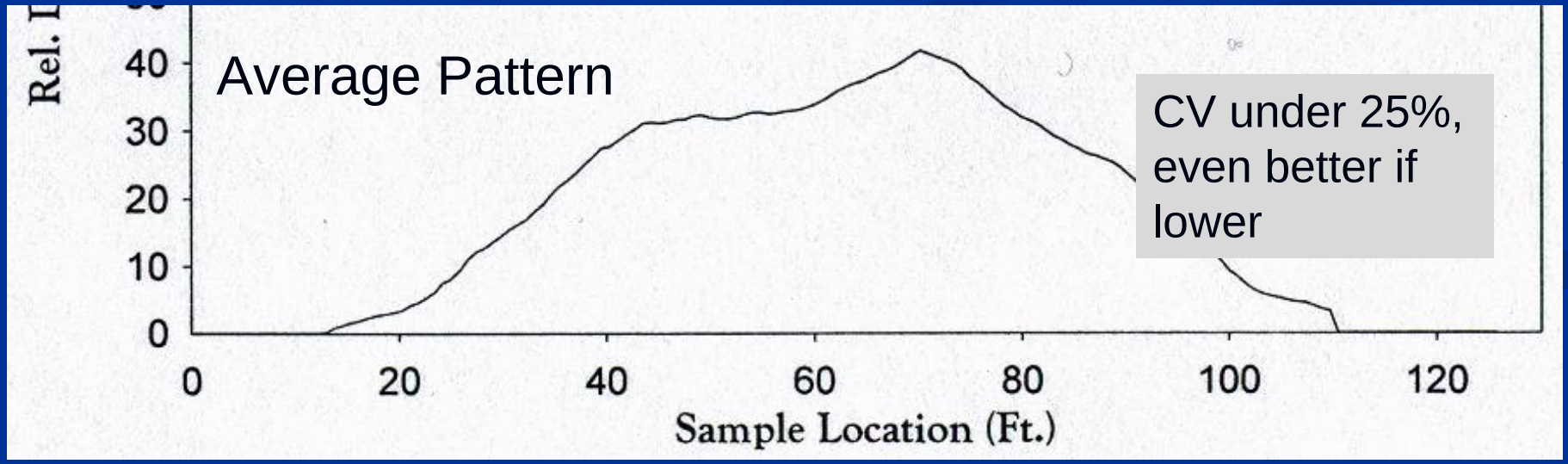
Indicates acceptable swath width

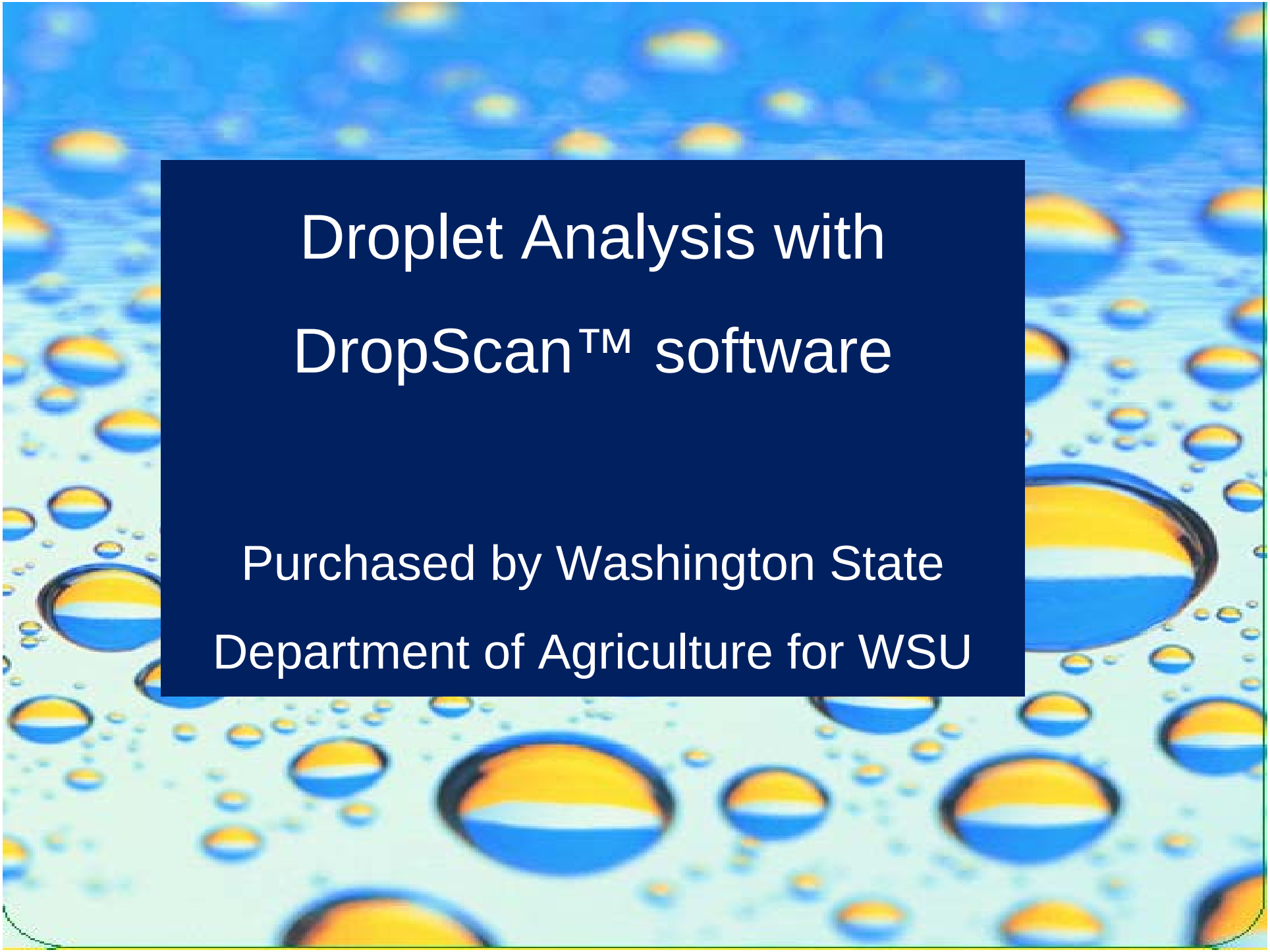
CV = Coefficient of Variation

You should expect a GOOD pattern

with minimal deposition variation (highs & lows)

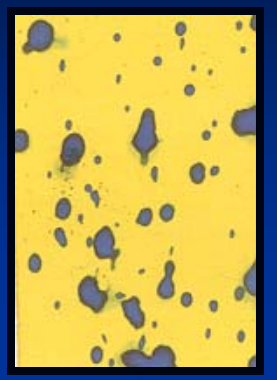





Droplet Analysis with
DropScan™ software
Purchased by Washington State
Department of Agriculture for WSU

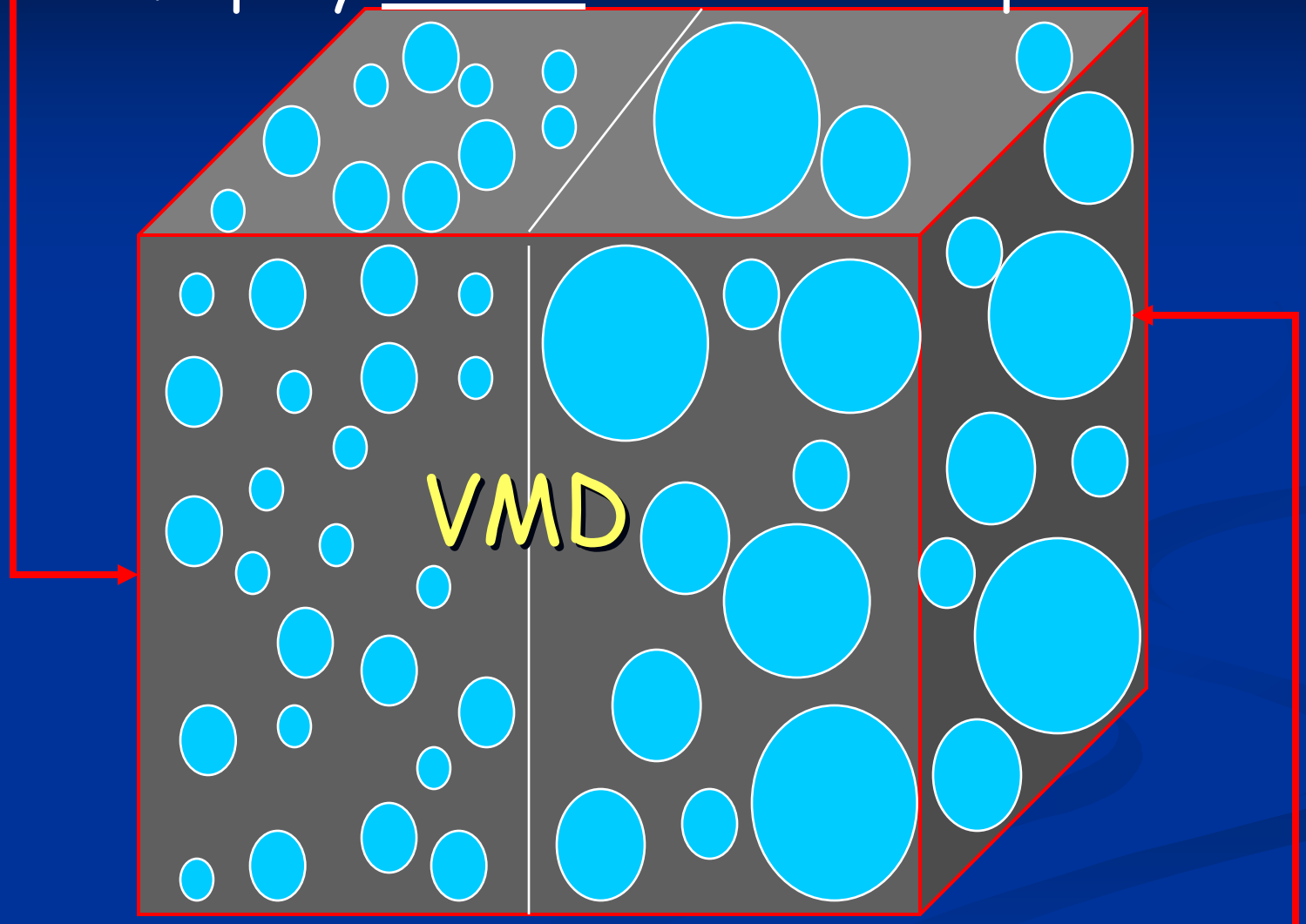
Spray Droplet Determines Efficacy

- Need knowledge of the product being used.
- Herbicide, Fungicide, Insecticide
  - Systemic or Contact
- What is the target?
  - Soil, Grass, Broadleaf
  - Leaves smooth, hairy, waxy
  - Leaf orientation – time of day
  - Penetration into canopy


Volume Median Diameter

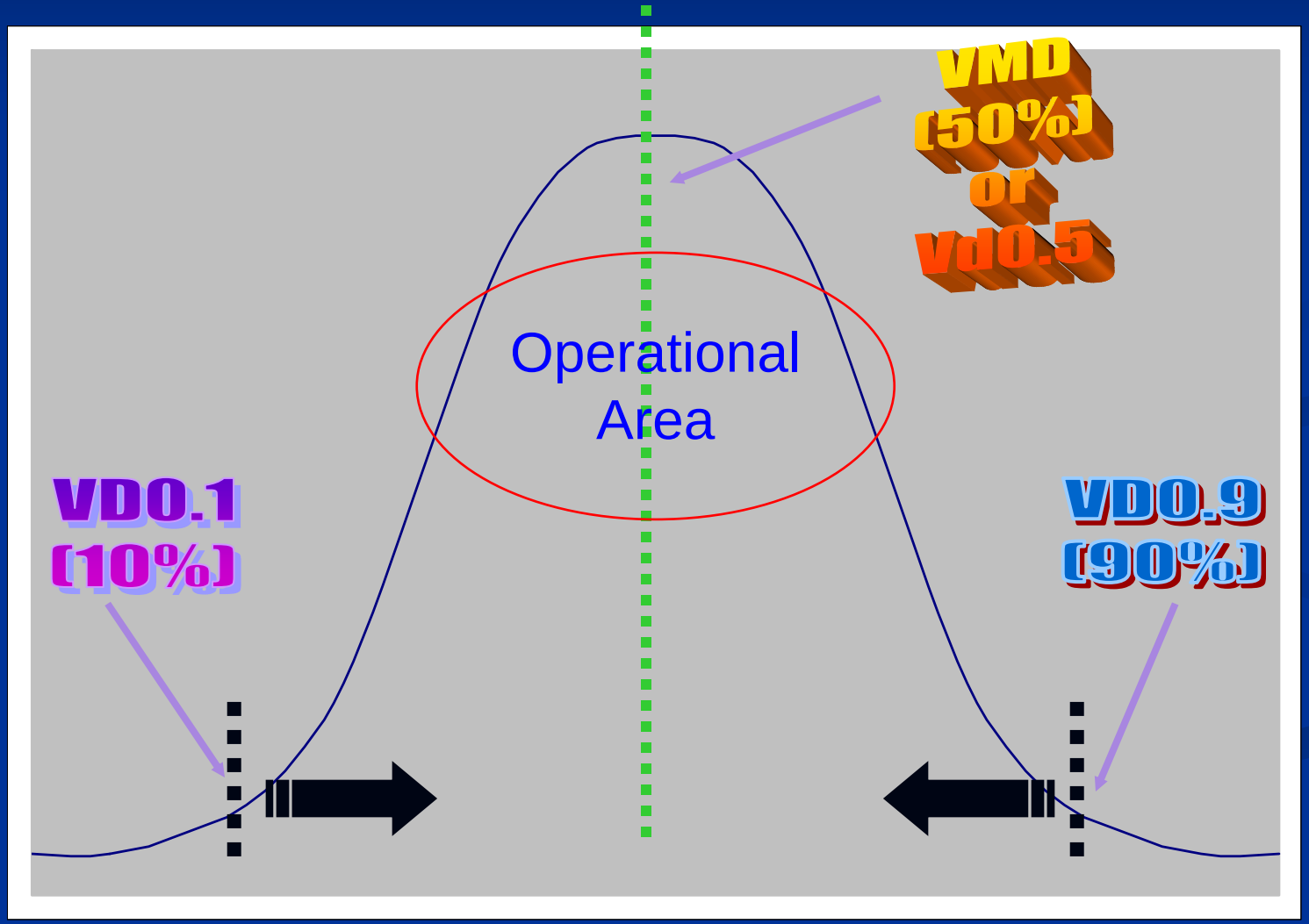
1/2 of spray volume = smaller droplets



1/2 of spray volume = larger droplets

Volume Diameters - size at

VD 0.1 – 10%, VMD – 50%, VD 0.9 -90%



Relative Span

$$RS = (Vd.9 - Vd.1)/VMD$$

Vd.9 = 400, VMD = 300, Vd.1 = 100

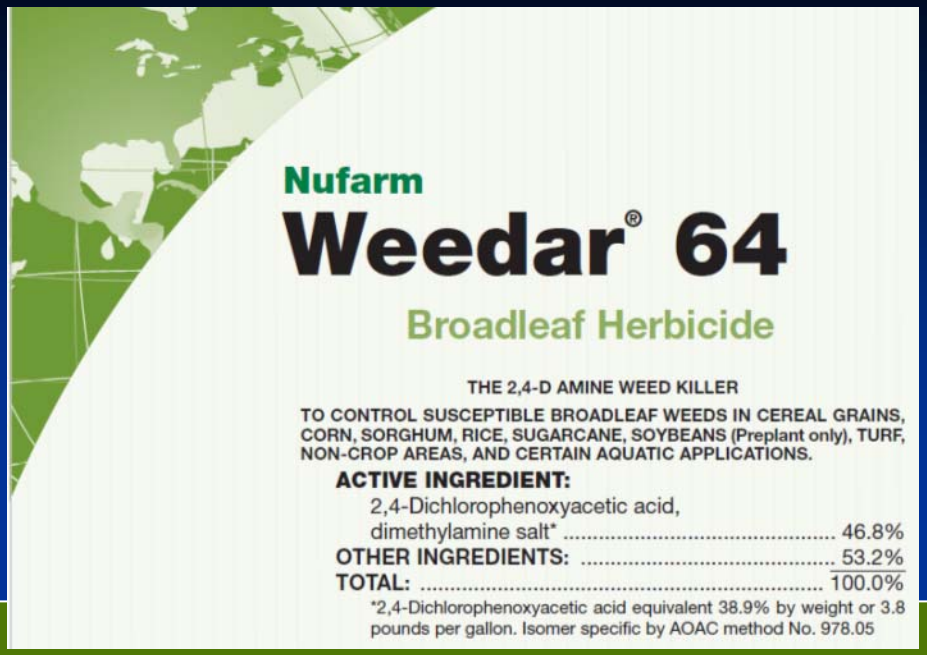
Vd.9 = 625, VMD = 300, Vd.1 = 25

ASAE Standard				Comparative Size		
Symbol	Category	Code	Apx. VMD	Relative Size	Comparative Size	Atomization
VF	Very Fine	Red	>150		Point of Need	
F	Fine	Orange	151-250		(100 Microns)	Fine Mist
M	Medium	Yellow	251-350		Sewing Thread (150 Microns)	Fine Drizzle
C	Coarse	Blue	351-450			
VC	Very Coarse	Green	451-550		Staple (420 Microns)	Light Rain
EC	Extremely Coarse	White	>551		#2 Pencil Lead (2000 Microns)	Thunderstorm

Insecticides, Fungicides

Herbicides

Source: Crop Life – July 2002



Droplet Size

When applying sprays that contain 2,4-D as the sole active ingredient, or when applying sprays that contain 2,4-D mixed with active ingredients that require a Coarse or coarser spray, apply only as a Coarse or coarser spray (ASAE standard 572) or a volume mean diameter or 385 microns or greater for spinning atomizer nozzles.

When applying sprays that contain 2,4-D mixed with other active ingredients that require a Medium or more fine spray, apply only as a Medium or coarser spray (ASAE standard 572) or a volume mean diameter of 300 microns or greater for spinning atomizer nozzles.

Select Droplet Size for Task

Efficacy of a particular plant protection product is dependent on coverage

Table 1. Droplet spectra category and recommendation for various pesticide types or uses. An X represents a recommendation.

ASABE Standard S-572 Droplet spectrum Categories1	Contact insecticide and fungicide	Systemic insecticide and fungicide	Contact foliar herbicide	Systemic foliar herbicide	Soil-applied herbicide	Incorporated soil-applied herbicide
Very Fine (VF)						
Fine (F)	X					
Medium (M)	X	X	X	X		
Coarse (C)		X		X	X	X
Very Coarse (VC)				X	X	X
Extremely Coarse (XC)						X

[1]Based on $V_{D0.5}$ (Volume Median Diameter – VMD) designation.

Kansas State University Agricultural Experiment Station and Cooperative Extension Service

Nozzle Manufacturers' Websites

Spraying Systems - TeeJet	*http://www.teejet.com/*
Greenleaf Technologies	*http://www.turbodrop.com/*
Hypro Pumps	*http://www.hypropumps.com/*
Wilger	*http://www.wilger.net/*
Hardi – North America	*http://www.hardi-us.com/*
Delavan Ag Spray	*http://www.delavanagspray.com/*
Lechler	*http://www.lechlerusa.com/*
Albuz	*http://www.albuz.saint-gobain.com/index.htm*
CP Products	*http://www.cpproductsinc.com/*
ABJ Agri Products	*http://www.abjagri.com/*

Droplet Data from CP Products Web Site

DV0.1 =	228	µm
DV0.5 =	330	µm
DV0.9 =	622	µm
RS =	1.20	-
%V<100µm =	0.24	%
%V<200µm =	5.16	%

DSCV0.1 =	COARSE	-
DSCV0.5 =	MEDIUM	-
DSCV0.9 =	MEDIUM	-
DSC =	MEDIUM	-

THE CP® PRODUCTS COMPANY, INC.

APPLICATION PARAMETERS FOR 40-DEGREE FLAT FAN NOZZLE (SMALL ORIFICE)

USDA ARS AH-726
I. W. Kirk, ARS, USDA, College Station, Texas

ASAE, 2950 Niles Rd., St. Joseph, MI 49085-9659 USA
Voice: 616.429.0300 FAX: 616.429.3852

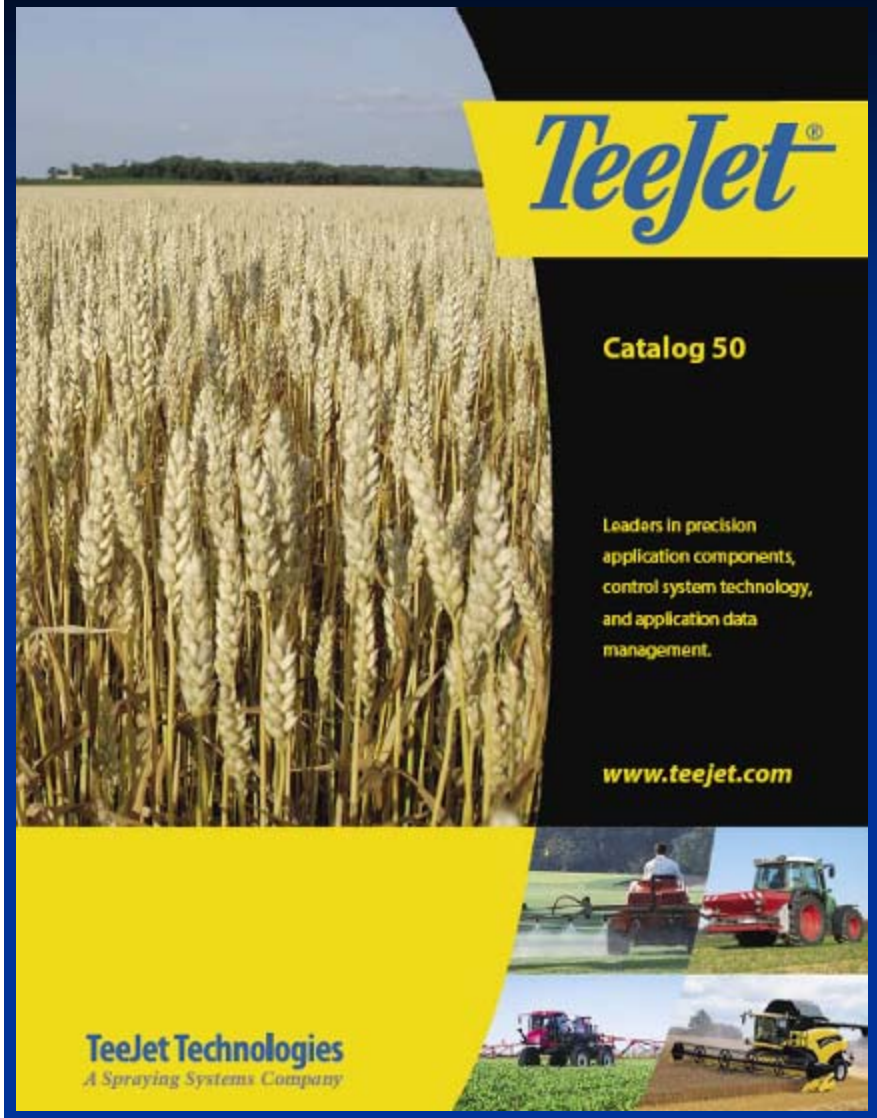
Directions: Enter CP nozzle parameters, pressure, and airspeed in the fields below.

	Nozzle Tip Size	Nozzle Angle, Degrees	Pressure, PSI	Airspeed, MPH
Acceptable Range:	2 to 10	0 to 90	20 to 60	100 to 160
	10	8	40	130

Results will appear in a new window.

Calculate! Clear Fields

THE CP® PRODUCTS COMPANY, INC.



Drop Size Classification

Nozzle selection is often based upon droplet size. The droplet size from a nozzle becomes very important when the efficacy of a particular plant protection chemical is dependent on coverage, or the prevention of spray leaving the target area is a priority.

The majority of the nozzles used in agriculture can be classified as producing either fine, medium, coarse, or very coarse droplets. Nozzles that produce fine droplets are usually recommended for post-emergence applications, which require excellent coverage on the intended target area. The most common nozzles used in agriculture are those that produce medium-sized droplets. Nozzles producing medium- and coarse-sized droplets can be used for contact and systemic herbicides, pre-emergence surface-applied herbicides, insecticides and fungicides.

An important point to remember when choosing a spray nozzle that produces a droplet size in one of the six categories is that one nozzle can produce different droplet size classifications at different pressures. A nozzle might produce medium droplets at low pressures, while producing fine droplets as pressure is increased.

Droplet size classes are shown in the following tables to assist in choosing an appropriate spray tip.

VF	F
Very Fine	Fine
M	C
Medium	Coarse
VC	XC
Very Coarse	Extremely Coarse

Droplet size classifications are based on BCPC specifications and in accordance with ASAE Standard S-572 at the date of printing. Classifications are subject to change.

Turbo TeeJet® (TT) and Turbo TeeJet® Duo (QJ90-2XTT)

	PSI										
	15	20	25	30	35	40	50	60	70	80	90
TTI 1001 QJ90-2XTTI1001	C	M	M	M	M	M	F	F	F	F	F
TTI 10015 QJ90-2XTTI10015	C	C	M	M	M	M	M	M	F	F	F
TTI 1002 QJ90-2XTTI1002	C	C	C	M	M	M	M	M	M	M	F
TTI 10025 QJ90-2XTTI10025	VC	C	C	C	M	M	M	M	M	M	F
TTI 1003 QJ90-2XTTI1003	VC	VC	C	C	C	C	M	M	M	M	M
TTI 1004 QJ90-2XTTI1004	XC	VC	VC	C	C	C	C	C	M	M	M
TTI 1005 QJ90-2XTTI1005	XC	VC	VC	VC	VC	C	C	C	C	M	M
TTI 1006 QJ90-2XTTI1006	XC	XC	VC	VC	VC	C	C	C	C	C	M
TTI 1008 QJ90-2XTTI1008	XC	XC	VC	VC	VC	VC	C	C	C	C	M

AI TeeJet® (AI) and AIC TeeJet® (AIC)

	PSI											
	30	35	40	45	50	55	60	70	80	90	100	115
AI 10015	VC	VC	VC	VC	VC	C	C	C	C	C	C	C
AI 1002	VC	VC	VC	VC	VC	VC	VC	C	C	C	C	C
AI 10025	VC	VC	VC	VC	VC	VC	VC	VC	C	C	C	C
AI 1003	XC	XC	VC	VC	VC	VC	VC	VC	VC	C	C	C
AI 1004	XC	XC	XC	VC	VC	VC	VC	VC	VC	C	C	C
AI 1005	XC	XC	XC	VC	VC	VC	VC	VC	VC	VC	C	C
AI 1006	XC	XC	XC	XC	VC	VC	VC	VC	VC	VC	C	C
AI 1008	XC	XC	XC	XC	XC	VC	VC	VC	VC	VC	VC	C
AI 1010	XC	XC	XC	XC	XC	VC	VC	VC	VC	VC	VC	C

Turbo TwinJet® (TTJ60)

	PSI										
	15	20	25	30	35	40	50	60	70	80	90
TTJ60-11002	VC	C	C	C	C	C	M	M	M	M	M
TTJ60-110025	XC	VC	C	C	C	C	C	C	M	M	M
TTJ60-11003	XC	VC	C	C	C	C	C	C	C	M	M
TTJ60-11004	XC	VC	C	C	C	C	C	C	C	C	M
TTJ60-11005	XC	VC	C	C	C	C	C	C	C	C	C
TTJ60-11006	XC	XC	VC	VC	C	C	C	C	C	C	C

Turbo TeeJet® Induction (TTI)

	PSI											
	15	20	25	30	35	40	50	60	70	80	90	100
TTI 10015	XC	XC	XC	XC	XC	XC	XC	XC	XC	XC	XC	XC
TTI 1002	XC	XC	XC	XC	XC	XC	XC	XC	XC	XC	XC	XC
TTI 10025	XC	XC	XC	XC	XC	XC	XC	XC	XC	XC	XC	XC
TTI 1003	XC	XC	XC	XC	XC	XC	XC	XC	XC	XC	XC	XC
TTI 1004	XC	XC	XC	XC	XC	XC	XC	XC	XC	XC	XC	XC
TTI 1005	XC	XC	XC	XC	XC	XC	XC	XC	XC	XC	XC	XC
TTI 1006	XC	XC	XC	XC	XC	XC	XC	XC	XC	XC	XC	XC

TeeJet® There's No Better Way to Spray

Turbo TeeJet® (TT)

	PSI										
	15	20	25	30	35	40	50	60	70	80	90
TT11001	C	M	M	M	M	M	F	F	F	F	F
TT110015	C	C	M	M	M	M	M	M	F	F	F
TT11002	C	C	C	M	M	M	M	M	M	M	F
TT11003	VC	VC	C	C	C	C	M	M	M	M	M
TT11004	XC	VC	VC	C	C	C	C	C	M	M	M
TT11005	XC	VC	VC	VC	VC	C	C	C	C	M	M
TT11006	XC	XC	VC	VC	VC	C	C	C	C	C	M
TT11008	XC	XC	VC	VC	VC	VC	C	C	C	C	M

XR TeeJet® (XR) and XRC TeeJet® (XRC)

	PSI						
	15	20	25	30	40	50	60
XR8001	M	F	F	F	F	F	F
XR80015	M	M	M	F	F	F	F
XR8002	M	M	M	M	F	F	F
XR8003	M	M	M	M	M	M	F
XR8004	C	C	M	M	M	M	M
XR8005	C	C	C	C	M	M	M
XR8006	C	C	C	C	C	C	C
XR8008	VC	VC	VC	C	C	C	C
XR11001	F	F	F	F	F	VF	VF
XR110015	F	F	F	F	F	F	F
XR11002	M	F	F	F	F	F	F
XR11003	M	M	M	F	F	F	F
XR11004	M	M	M	M	M	F	F
XR11005	M	M	M	M	M	M	F
XR11006	C	C	M	M	M	M	M
XR11008	C	C	C	C	C	M	M

TwinJet®

	PSI				
	30	35	40	50	60
TJ60-11002	F	F	F	F	F
TJ60-11003	F	F	F	F	F
TJ60-11004	M	F	F	F	F
TJ60-11006	M	M	M	M	M
TJ60-11008	C	M	M	M	M
TJ60-11010	C	C	C	M	M

DG TwinJet®

	PSI				
	30	35	40	50	60
DGTJ60-110015	F	F	F	F	F
DGTJ60-11002	M	M	M	F	F
DGTJ60-11003	C	M	M	M	M
DGTJ60-11004	C	C	C	C	M
DGTJ60-11006	C	C	C	C	C
DGTJ60-11008	C	C	C	C	C

Droplet size classifications are based on BCPC specifications and in accordance with ASAE Standard S-572 at the date of printing. Classifications are subject to change.

VF	F	M	C	VC	XC
Very Fine	Fine	Medium	Coarse	Very Coarse	Extremely Coarse

Note: Very Fine, Fine, Medium, and Coarse droplets are best suited for applying fungicides to control soybean rust. Make sure the capacity and pressures used fall within the correct droplet size category.

TeeJet® Spray Products

USDA Aerial Nozzle Atomization Models

The models are implemented in Microsoft® Excel® computer spreadsheets and are available for download at:
http://apmru.usda.gov/downloads/downloads.htm

USDA Aerial Nozzle Atomization Models

F I X E D - W I N G

CP-03 NOZZLE

FOR USE ON FIXED-WING AIRCRAFT

AERIAL APPLICATORS SPRAY NOZZLE HANDBOOK
USDA ARS AGRICULTURAL HANDBOOK NO. XXX

I. W. Kirk, Agricultural Engineer, Areawide Pest Management Research Unit,
Southern Plains Agricultural Research Center, Agricultural Research Service, U. S. Department of Agriculture, 2771F&B Road, College Station, TX 77845-4966, USA.

Directions: Enter CP-03 nozzle settings, pressure, and airspeed in the cells highlighted below.
(Atomization parameters are valid only with nozzle and operational settings specified in the Acceptable Range.)

	Orifice Size, inches	Deflector Angle, degrees	Pressure, psi	Airspeed, mph
Acceptable Range:	.061 to .171	30 to 90	20 to 60	100 to 160
	0.125	**30**	**60**	**130**

Atomization parameters are displayed in the box below.

CAUTION: Do not enter or clear data in the cells in this box!

$D_{V0.5}$ =	301 µm	= Volume median diameter
RS =	1.01	= Relative Span
%V<100µm =	6.62 %	= Percentage of spray volume in droplets smaller than 100 µm diameter.
%V<200µm =	17.51 %	= Percentage of spray volume in droplets smaller than 200 µm diameter.
DSC =	MEDIUM	= ASAE S572 AUG99 Droplet Spectra Classification

Values and classifications reported here are least-squares best-estimate predictions from experimental data collected in a wind tunnel.
Values reported from other laboratories may not yield the exact same values, but similar trends would be expected.
The ASAE droplet spectra classification category is based on droplet sizes in the mid-80% of the spectrum and not a single data point.

Operation S.A.F.E.

DropletScan

Preview Window

Zoom In | Zoom Out | Previous Page | Next Page | Go To Page | 1/6

Report generated by DropletScan, a product of WRK and DSI
File: C:\aerial\Kansas Flyins\Goodland-2003\Droplets\N61758-1.dif 5:58:52 PM

KSU-KAAA Fly-in S.A.F.E. Workshop
Goodland, KS
Sept. 2003

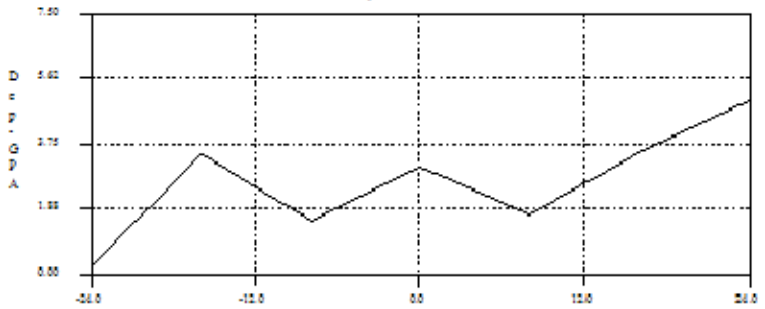
Material:	water-dye		
Number of Nozzles:	39		
Nozzle Pres. (PSI):	31		
Flow Rate at 40 PSI (GPM):		0	
Nozzle Type:		CP Flat Fan 10 SB	

Spread Factors Equation
SF = 1.6555 + 0.0009*D + 0.0000*D*D

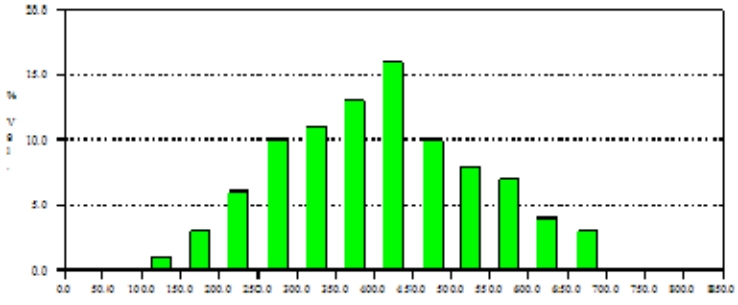
Composite results
VMD = 404
VD(0.1) = 237
VD(0.9) = 592
GPA = 2.650

% Area Coverage =	6.4
Run ID:	1
Time:	4:45
Target Rate (GPA):	2
Target Swath (Ft):	66
Application Height (Ft):	12
Number of Passes:	1
Ground Speed (MPH):	128
Wind Velocity (MPH):	16
Wind Direction (deg.):	180
Cross Wind (MPH):	0
Temperature (F):	83
Humidity (%):	18

Deposition vs Distance

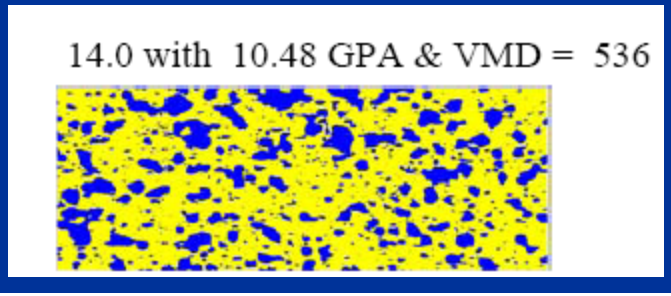


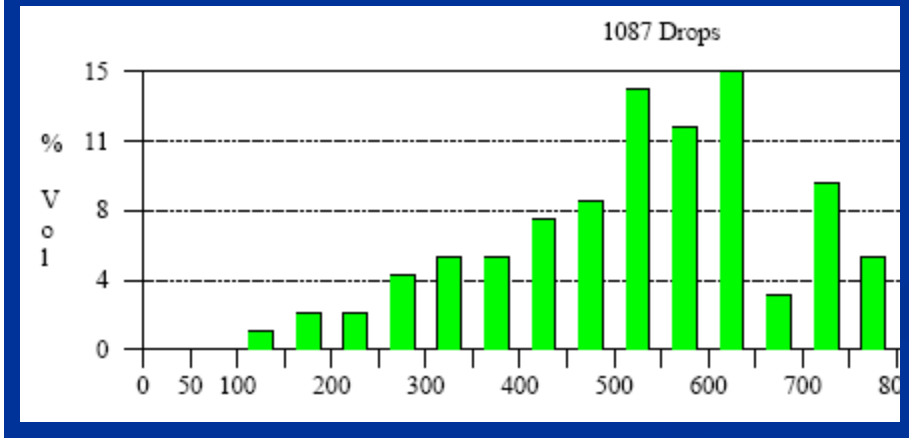
Histogram of Drop Diameters



Droplet Spectra from Aircraft

- Composite results
- VMD = 510
- VD(0.1) = 252
- VD(0.9) = 727
- GPA = 9.30



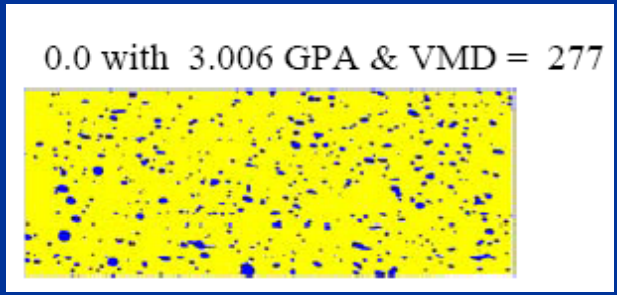


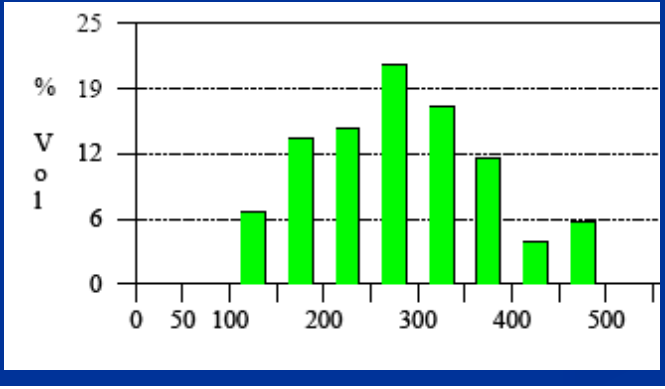
- Target Rate (GPA): 5
- Target Swath (Ft): 85
- Application Height (Ft): 13
- Ground Speed (MPH): 106

- Wind Velocity (MPH): 17
- Wind Direction(deg.): 160
- Temperature (F): 69.1
- Humidity (%): 29

Droplet Spectra from Aircraft

- Composite results
- VMD = 329
- VD(0.1) = 196
- VD(0.9) = 467
- GPA = 2.042





- Target Rate (GPA): 5
- Target Swath (Ft): 80
- Application Height (Ft): 15
- Ground Speed (MPH): 140

- Wind Velocity (MPH): 10
- Wind Direction(deg.): 220
- Temperature (F): 85.2
- Humidity (%): 15

Droplet size recommendations

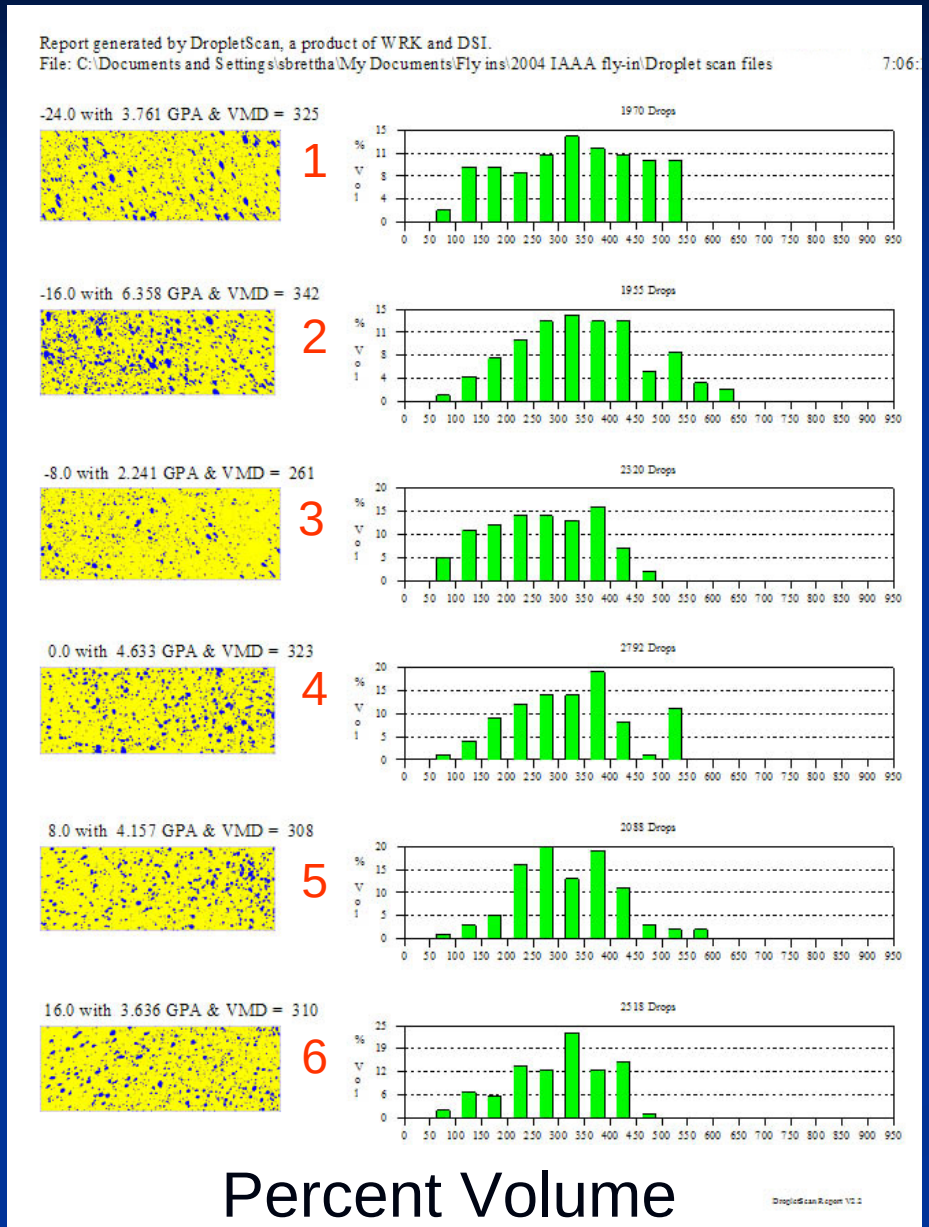
- VMD usually should be in 300-350 micron range
- A smaller VMD required for lower GPA rates
- VD(0.1) > 200 microns – reduce the risk of drift
- VD(0.9) < 600 microns – prevent large droplets that can reduce coverage by consuming large portions of the total volume
- RS – relative span - should be around 1 - provides suitable variation for differences in target structure (span between LARGE and SMALL droplets

Droplet size recommendations

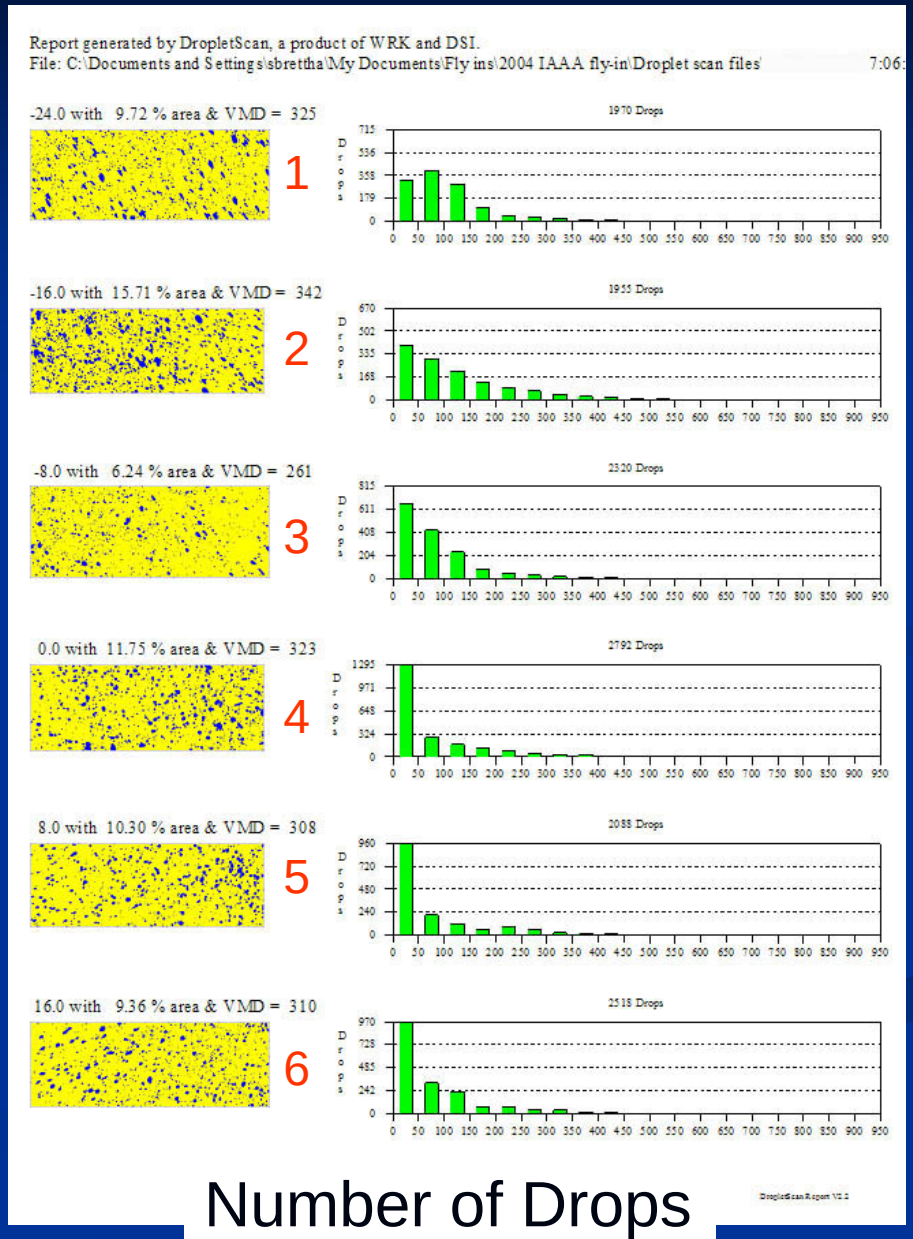
- VD 0.1 – lower 10% of volume droplet limit
  - 200 microns or greater for herbicides
  - 285-300 microns - insecticides/fungicides
  - 300-325 microns - contact fungicides

Composite results
VMD = 318
VD(0.1) = 163
VD(0.9) = 475
GPA = 3.800

Individual card analysis



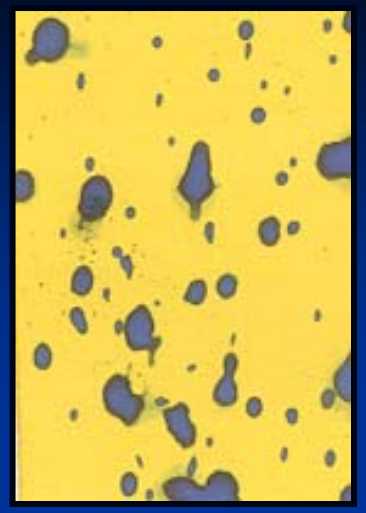
Percent Volume



Number of Drops

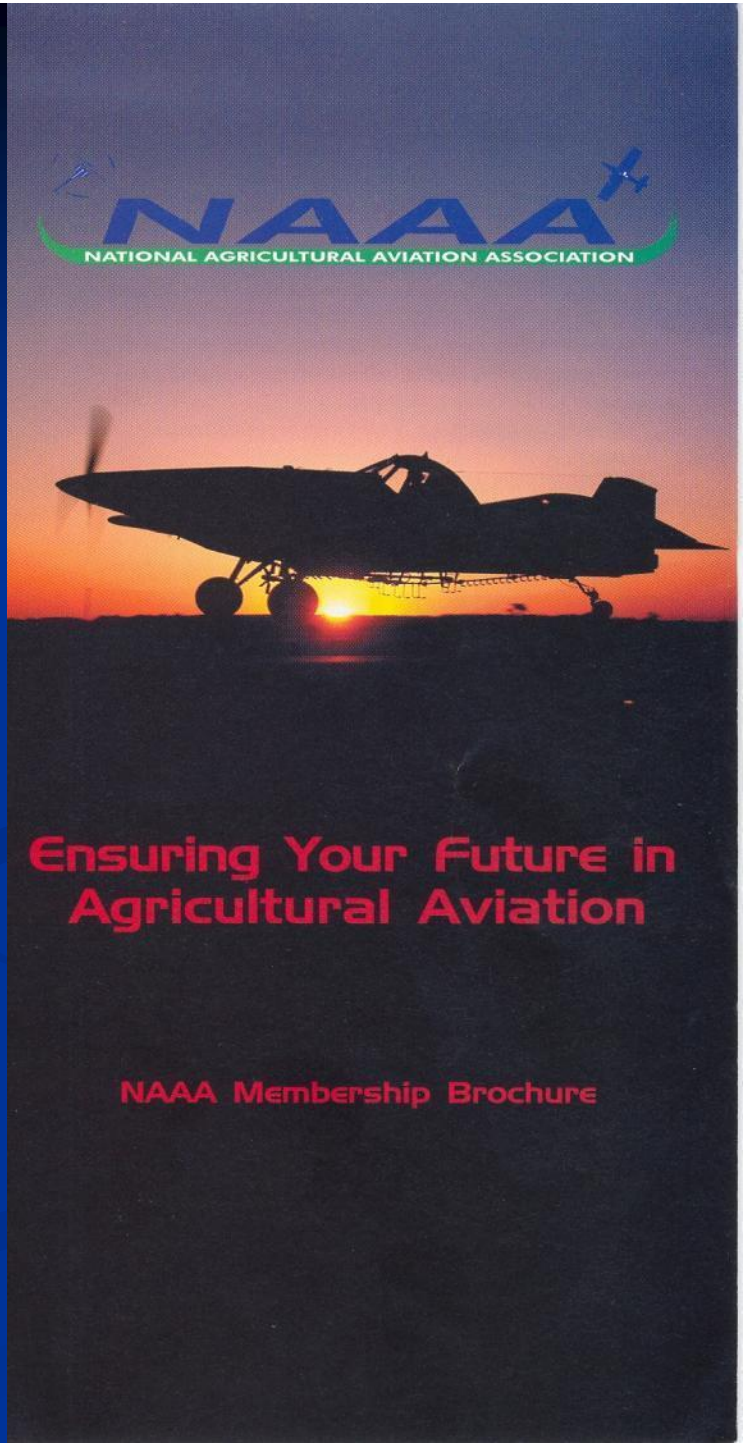
You should expect a EFFICACIOUS droplet spectrum

efficient coverage, drift minimization



NAAA Membership

- Program's designed to help your application business
- Strong presence in WDC
- Education and Safety Training
  - PAASS
  - S.A.F.E.
  - Leadership Training
  - Pilot Mentoring
- Support Aerial Research
- Magazine
- Meeting and Trade Show



Disclaimer:

- Brand names appearing in this presentation are for identification and illustration purposes only.
- No endorsement is intended, nor is criticism implied of similar products not mentioned.

Why Care?

- Efficiency with quality spray
- Label language
  - Buffer variances
  - Droplet size for efficacy and drift minimization
- Litigation
- Competition
- Professional Ethics

Fly-in Certified Analysts

Used presentation materials from Bob & Scott

Carol Ramsay, WSU

Scott Bretthauer
Univ. of Illinois

Dennis Gardisser
WRK of Arkansas

Tom Karsky,
Univ. of Idaho

Carolyn Baecker
CP Products, Inc.

Bob Wolf, KSU

Any Questions? More details at:
www.agaviation.org & www.wrkofar.com