

A yellow biplane is flying over a field, spraying a mist of pesticides. The plane is viewed from a low angle, and the mist is visible around the wings and fuselage. The field below is dark brown, and there are some green plants in the foreground. The sky is a pale blue.

Reducing Driftable Fines in Aerial Application of Pesticides – Using A Controlled Environment

By

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What Are Driftable Fines?

Droplets formed during atomization
less than 200 microns in size

Critical air velocity at which droplets break up (water)

Critical Velocity, (km/h / mph)	Drop Size (microns, μ)
80.5 / ~ 50 mph	1500
105 / ~ 65 mph	900
137 / ~ 85 mph	535
161 / ~ 100 mph	385
241 / ~ 210 mph	170

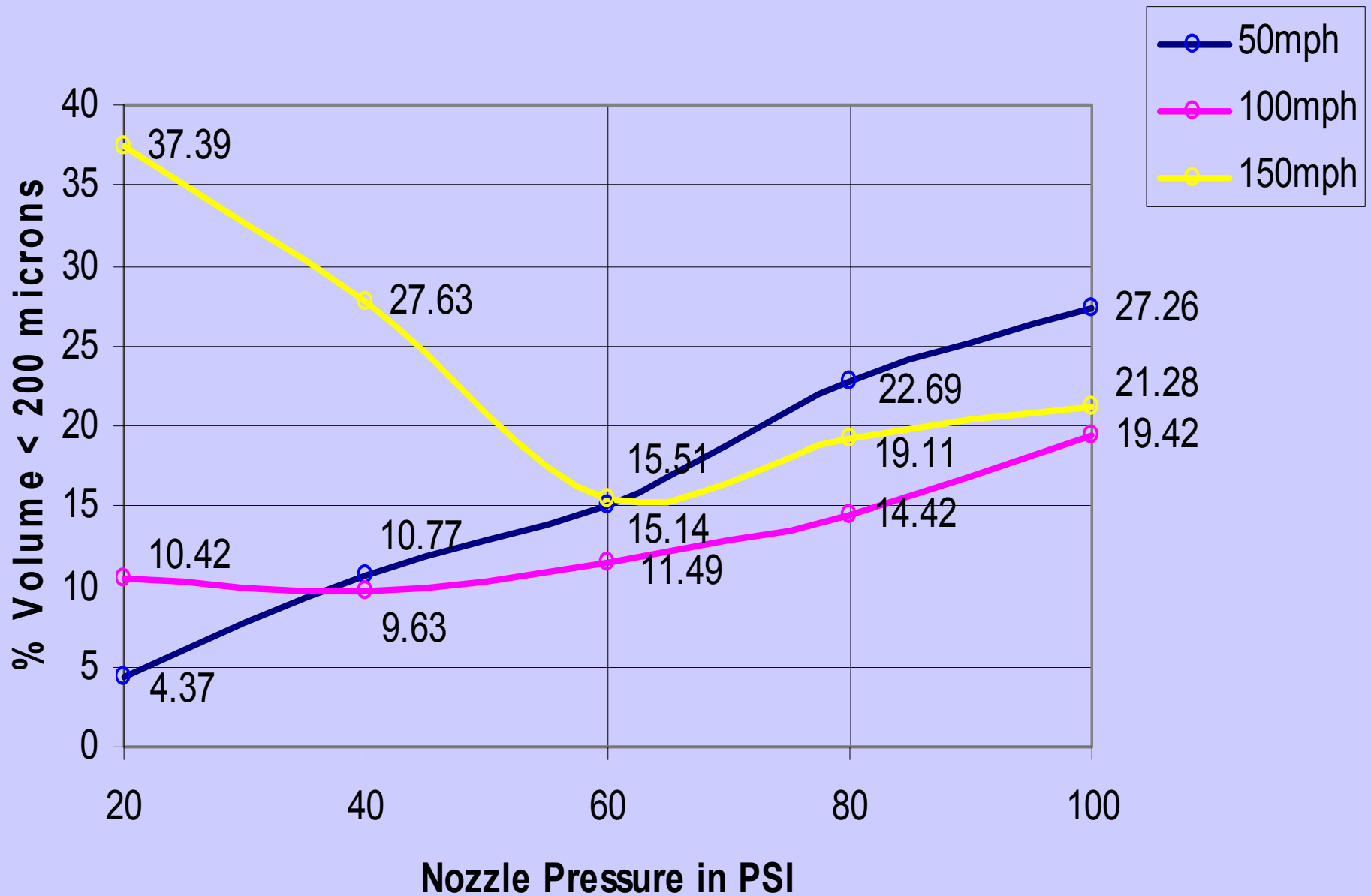
Spray Exit Velocity

Spray Pressure in psi

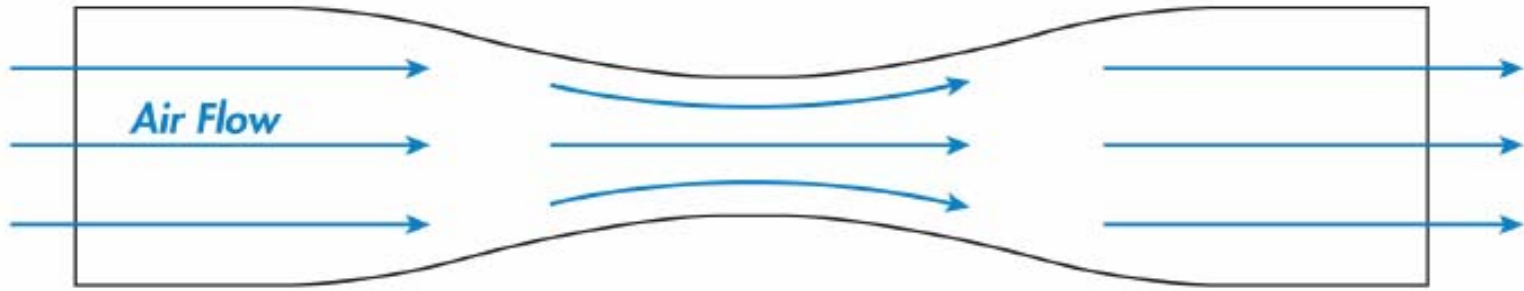
Exit Velocity in mph

20	37
40	53
60	64
207	120
325	150

Atomization Profile H1/8VV-2505



Venturi



Reverse Venturi

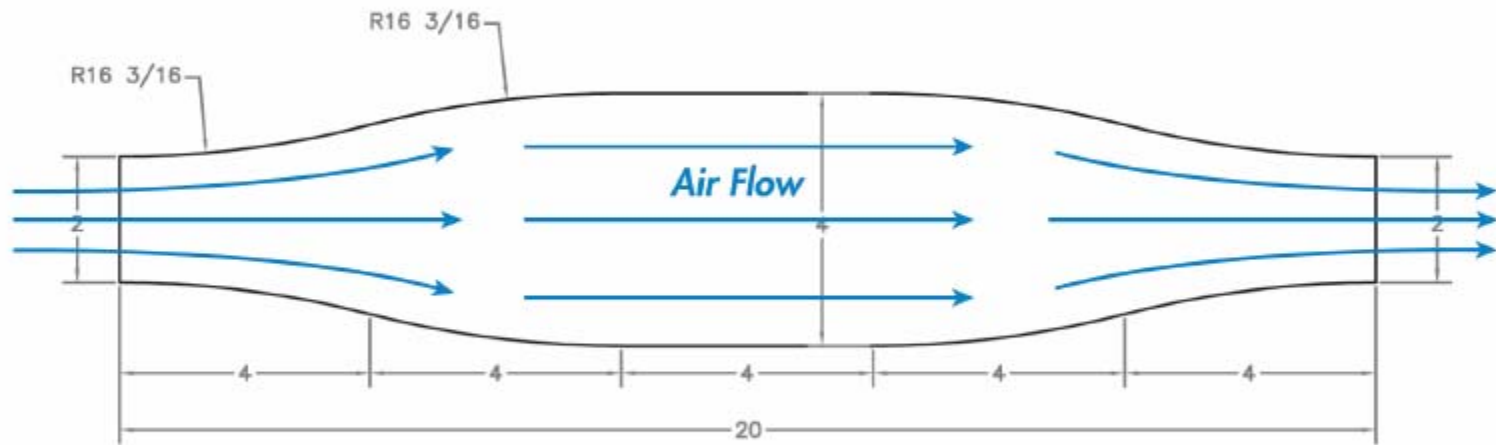
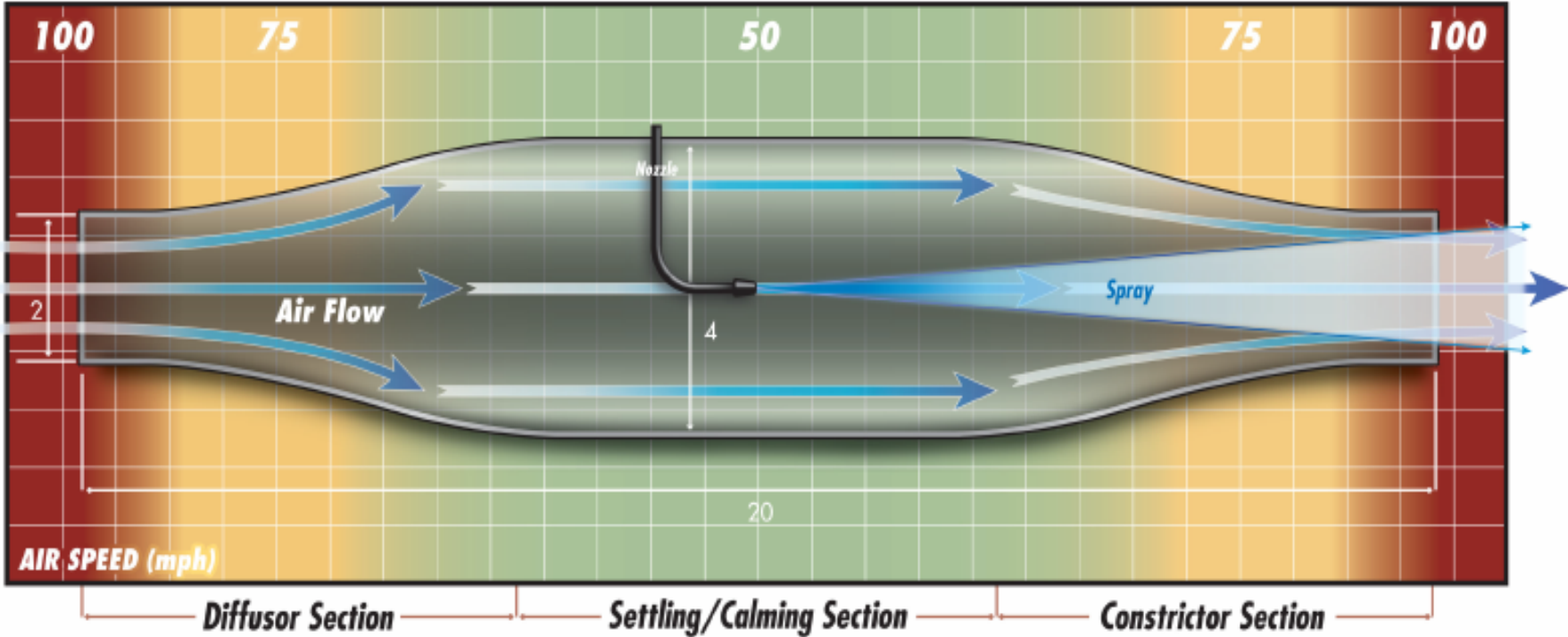
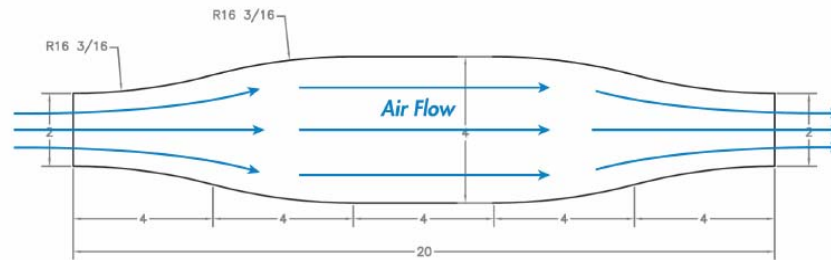
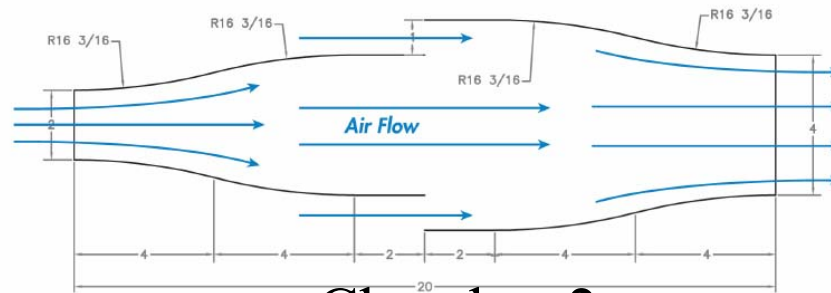


Illustration: Reverse Venturi Atomization Chamber with Spray Nozzle

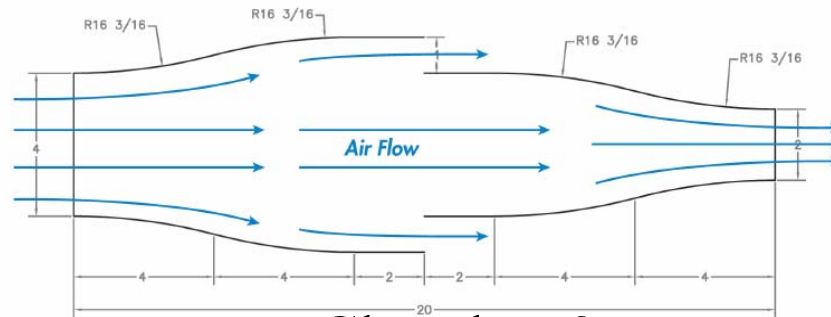




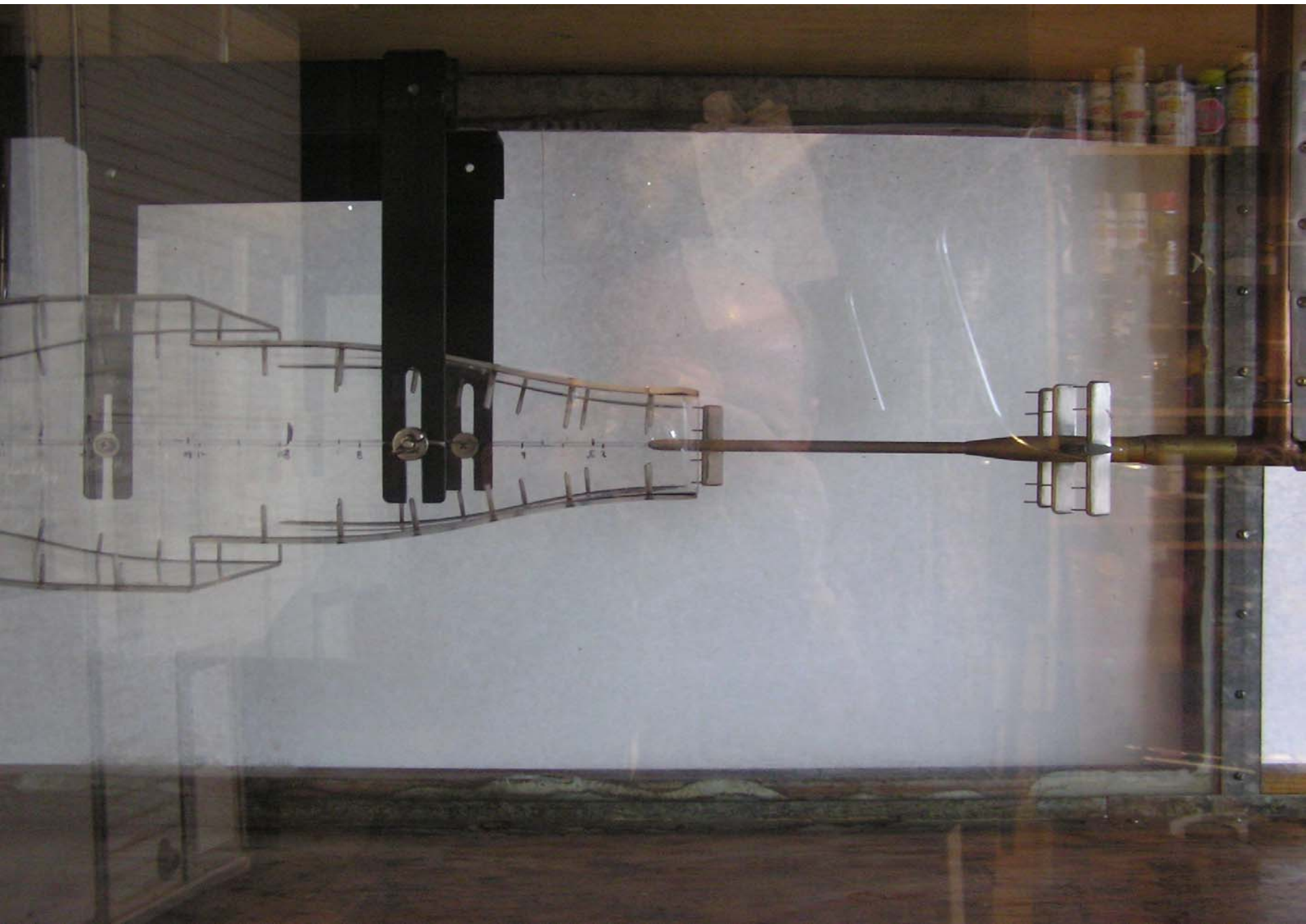
Chamber 1

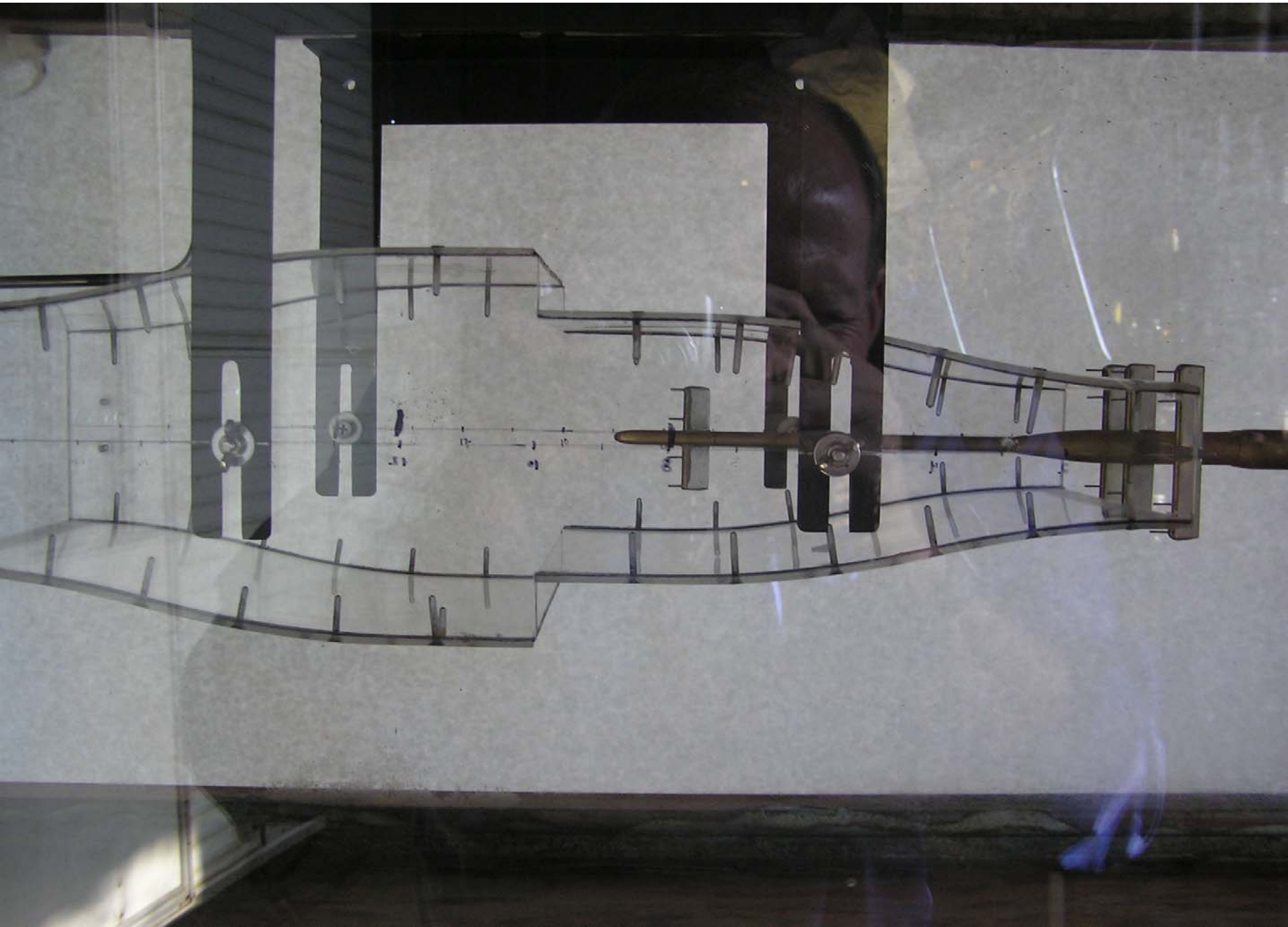


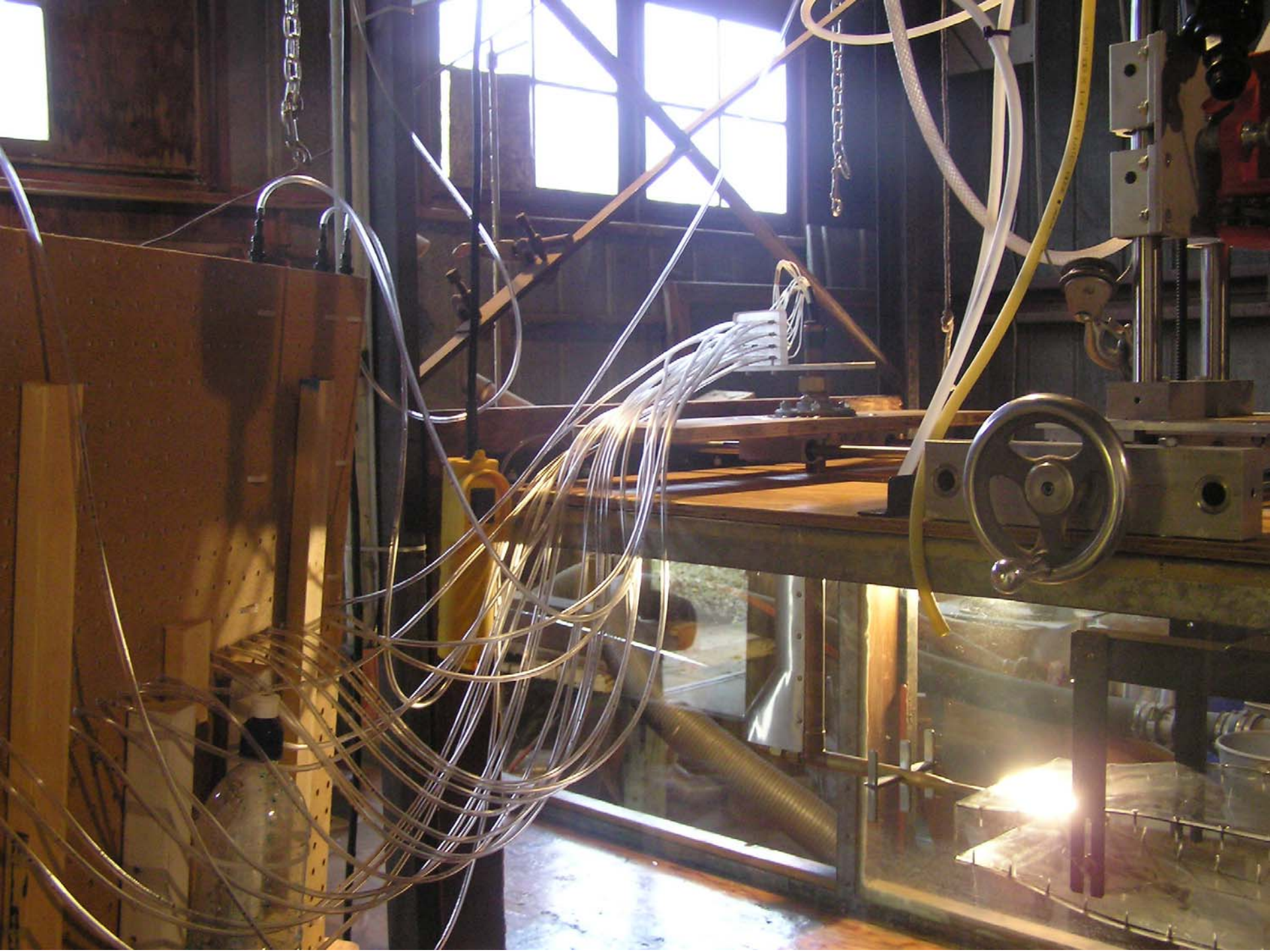
Chamber 2



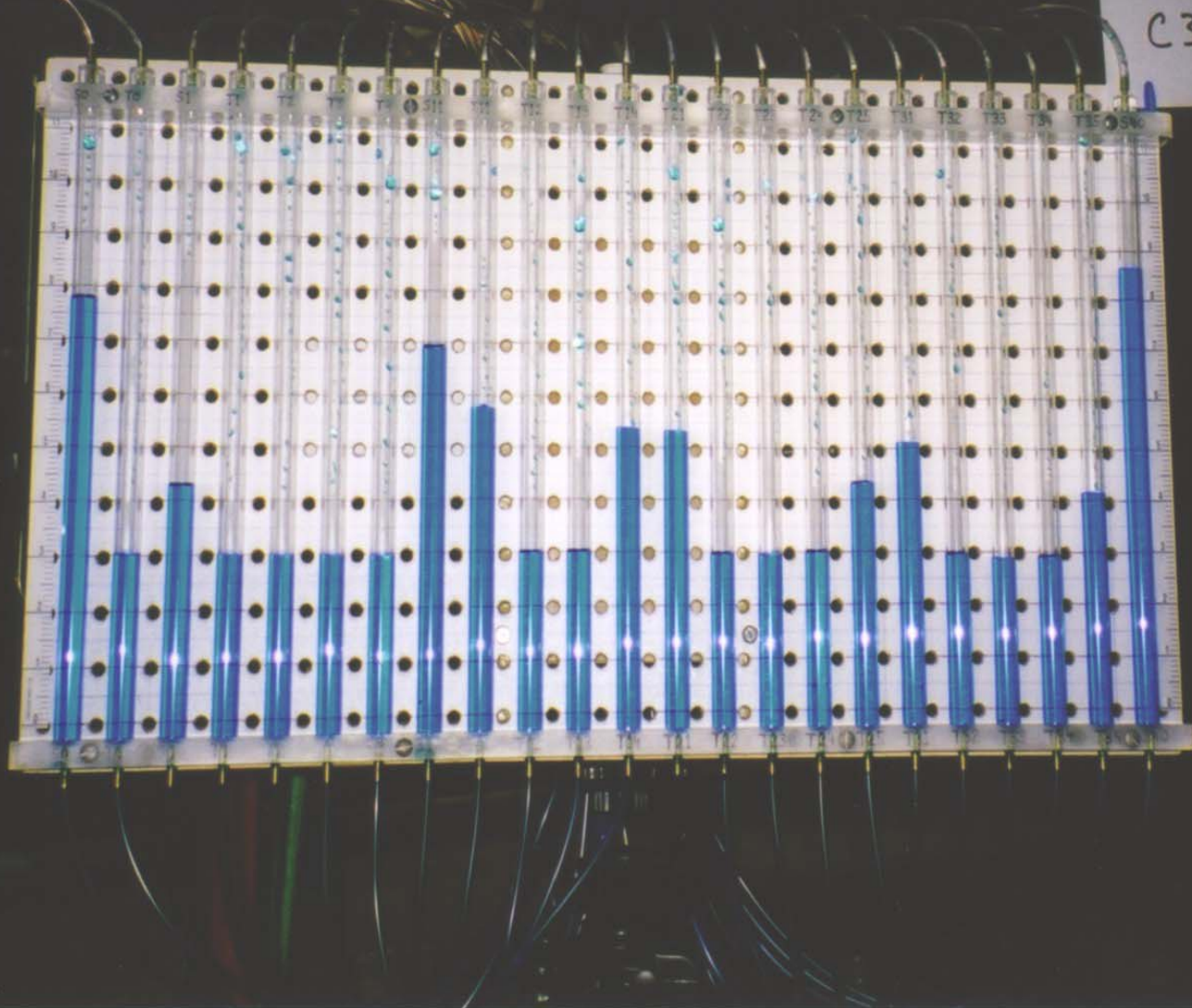
Chamber 3





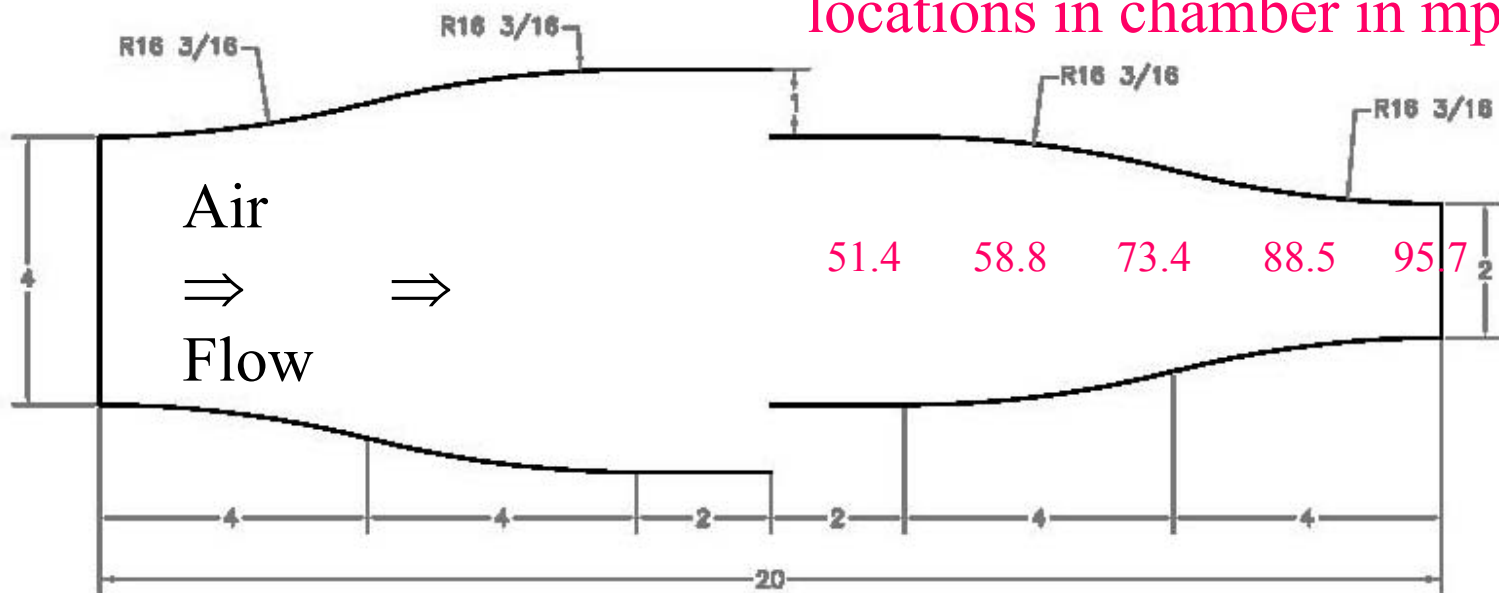


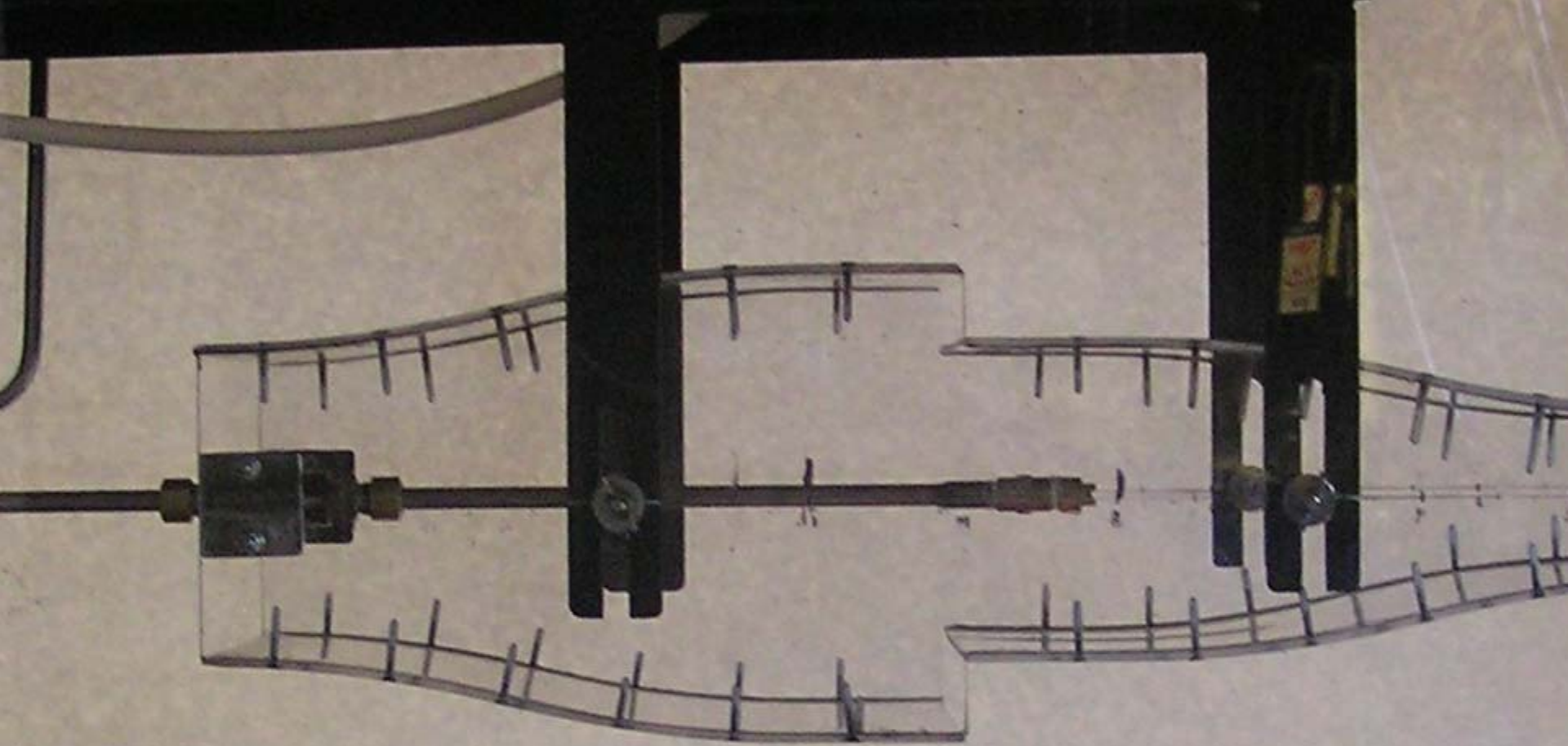
C3C8



Reverse Venturi Atomization Chamber In Wind Tunnel at 100 mph

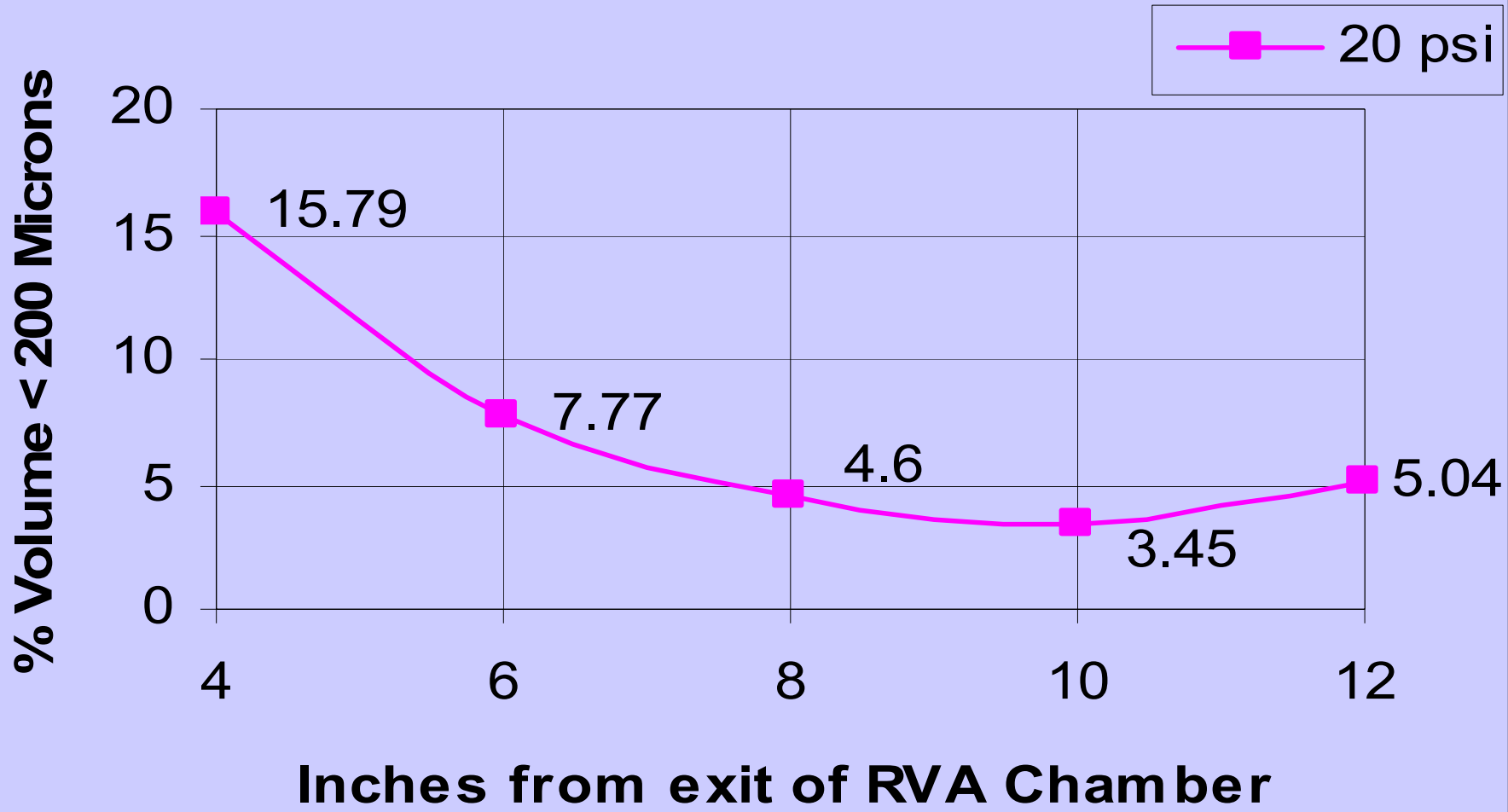
Air velocities at different
locations in chamber in mph







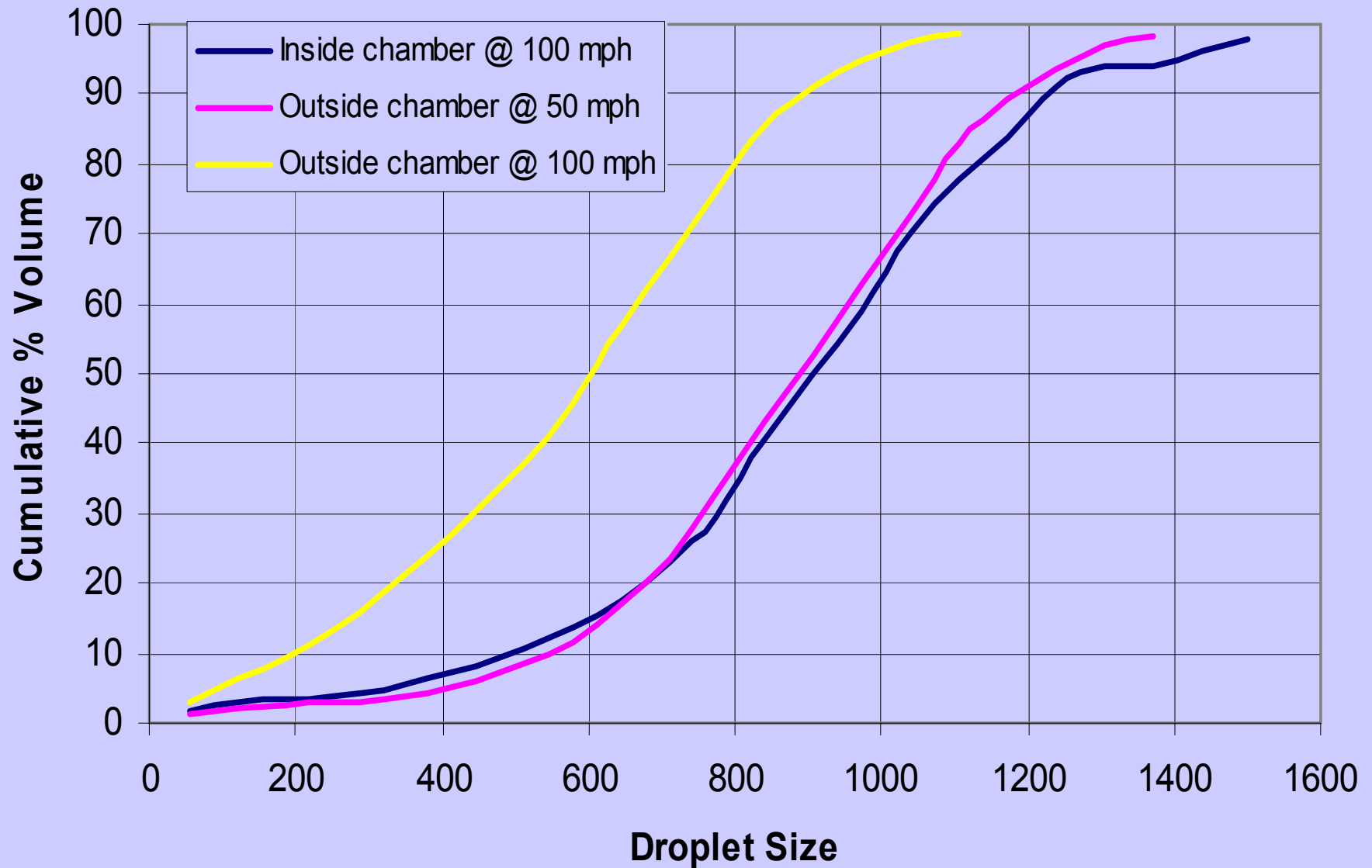
Spraying Systems Co. H1/8VV- 2505 Nozzle @ 100 mph



Spray droplet comparisons.

Nozzle	Air Velocity (mph)	Liquid pressure (psi)	Droplet Size Indicators			% of volume <200 μ	R.S.	% ↓ in fines
			Dv 0.1	Dv 0.5	Dv 0.9			
H1/8VV-2505	50	20	554	963	1419	2.32	0.89	
H1/8VV-2505	100	20	172	577	908	13.16	1.30	73.8%
H1/8VV-2505+RVA	100	20	508	924	1311	3.45	0.87	

Droplet Comparison inside and outside chamber



Current Objectives

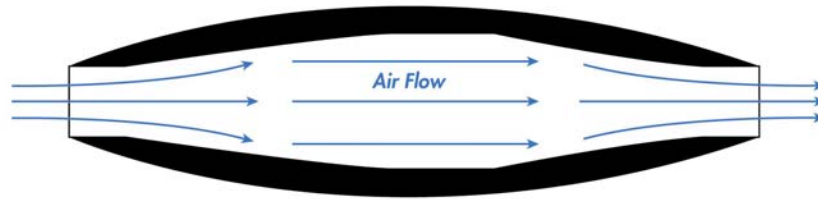
1. Evaluate Nozzles
2. Refine Chamber
3. Test Nozzle Chamber Combination
4. Evaluate Mounting Effects on Aircraft

Standard Nozzles with water in free airstream

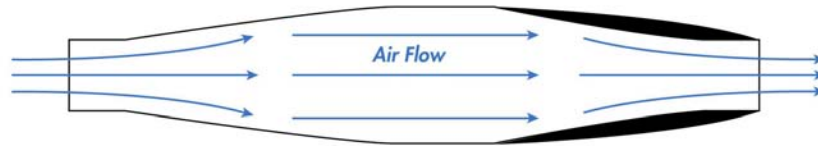
Nozzle model	Air Velocity (mph)	Liquid pressure (psi)	Dv 0.1	Dv 0.5	Dv 0.9	R.S.	% of volume <200 μ
H1/8VV-1505	50	20	790	1210	1506	0.59	2.16
	50	50	453	897	1414	1.07	4.46
	100	20	118	664	1059	1.42	12.91
	100	50	310	698	1008	1	6.4
	150	20	52	286	540	1.71	34.07
	150	50	81	423	634	1.31	17.33
H1/8VV-2505	50	20	552	940	1391	0.89	2.48
	50	50	261	638	986	1.14	7.61
	100	20	169	616	901	1.19	11.34
	100	50	128	482	809	1.42	14.04
	150	20	55	283	501	1.58	33.29
	150	50	57	349	603	1.57	29.14
H1/8VV-4003	50	20	341	628	948	0.96	4.65
	50	50	97	398	611	1.26	18.4
	100	20	112	385	652	1.41	17.67
	100	50	201	514	755	1.08	9.78
	150	20	71	269	459	1.44	29.31
	150	50	119	314	500	1.22	18.42
H1/8VV-0003	50	20	1656	1847	2023	0.2	0.23
	50	50	1630	1853	2009	0.2	0.07
	100	20	329	1047	1418	1.04	6.62
	100	50	432	1365	1742	0.97	7.05
	150	20	71	486	790	1.48	19.2
	150	50	61	349	605	1.56	26.32

Optimal Nozzles

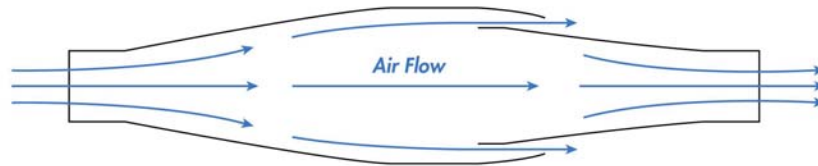
Nozzle model	Air Velocity (mph)	Liquid pressure	Dv 0.1	Dv 0.5	Dv 0.9	R.S.	% of volume <200 μ
H1/8VV-4010	50	20	324	680	1112	1.16	5.64
Spaying System Co.	50	50	128	523	873	1.42	13.82
	100	20	184	553	880	1.27	11.04
	100	50	56	375	784	1.96	28.82
	150	20	52	267	539	1.82	36.39
	150	50	59	362	646	1.62	27.63
H1/8VV-4003	50	20	341	628	948	0.96	4.65
Spaying System Co.	50	50	97	398	611	1.26	18.4
	100	20	112	385	652	1.41	17.67
	100	50	201	514	755	1.08	9.78
	150	20	71	269	459	1.44	29.31
	150	50	119	314	500	1.22	18.42
H1/8VV-2505	50	20	552	940	1391	0.89	2.48
Spaying System Co.	50	50	261	638	986	1.14	7.61
	100	20	169	616	901	1.19	11.34
	100	50	128	482	809	1.42	14.04
	150	20	55	283	501	1.58	33.29
	150	50	57	249	603	1.57	29.14
AVI 25.05	50	20	725	1368	1826	0.81	2.36
ALBUZ	50	50	413	1045	1633	1.17	4.85
	100	20	112	550	905	1.45	14.78
	100	50	251	706	1014	1.08	7.88
	150	20	51	253	558	2.01	39.16
	150	50	52	297	585	1.8	32.92



Chamber 4



Chamber 5



Chamber 6

Comparison of chamber performance to free air stream velocity

	Area Ratio	Ejectors	Wind tunnel air speed mph (T)	Settling section air speed mph (U)	Ratio to tunnel air speed (U/T)	Velocity at exit (E) air speed mph	Ratio to tunnel air speed (E/T)	Air speed ratio (U/E)
Chamber 1	2	No	101.28	52.5	0.518	89.09	0.88	0.589
Chamber 2	2	No	101.58	70.75	0.696	92.11	0.907	0.768
Chamber 3	2	Yes	99.75	45.6	0.466	91.34	0.934	0.499
Chamber 4 w/o side fences	2	No	100.72 150.02	48.34 74.43	0.480 0.496	91.81 139.47	0.912 0.930	0.527 0.534
Chamber 4 with side fences	2	No	100.82 149.71	47.29 76.12	0.469 0.508	90.7 141.28	0.900 0.944	0.521 0.539
Chamber 5	2.1	No	114.15	58.5	0.512	103.6	0.905	0.565
Chamber 6 w/o vanes	3	Yes	151.58	66.8	0.441	141.3	0.932	0.473
Chamber 6 with vanes	3	Yes	150.96	64	0.424	132.28	0.876	0.484
Chamber 6 w/o vanes with ejector extensions	3	Yes	148.28	62.63	0.422	141.4	0.954	0.471

Comparison of Chambers 3, 4, 5 and 6 with H1/8V-2502 Nozzle

	Chamber 3	Chamber 4	Chamber 5	Chamber 6
Air Velocity	100	100	100	100
Liquid Pressure	20	20	20	20
Dv 0.1	508	436	447	417
Dv 0.5	924	844	892	801
Dv 0.9	1311	1229	1236	1169
R.S.	0.87	0.94	0.89	0.94
% < 200 μ	3.45	4.75	4.47	4.1

Chamber 6

Nozzle model	Air Velocity (mph)	Liquid pressure (psi)	Dv 0.1	Dv 0.5	Dv 0.9	R.S.	% of volume <200m
H1/8 VV-1505	100	20	401	986	1644	1.26	5.95
	100	50	381	825	1585	1.44	5.17
	150	20	57	442	738	1.54	26.09
	150	50	66	520	784	1.38	20.59
H1/8VV-2505	100	20	386	777	1111	0.94	4.75
	100	50	243	580	870	1.08	7.95
	150	20	65	452	672	1.34	23.49
	150	50	102	513	714	1.19	14.84
H1/8VV-4003	100	20	282	597	885	1.01	6.4
	100	50	82	364	618	1.47	20.69
	150	20	114	444	628	1.16	14.94
	150	50	81	410	633	1.35	20.73
H1/8VV-0003	100	20	479	1097	1717	1.13	4.24
	100	50	635	1630	1920	0.79	5.71
	150	20	53	382	654	1.57	29.01
	150	50	57	548	879	1.5	22.02

Chamber 6 Atomization Compared to Free Stream Air (FAS) Atomization (water)

Nozzle model	Air Velocity (mph)	Liquid pressure (psi)	% of volume <200m in chamber	% of volume < 200 μ in FAS	% change in droplets < 200 μ
H1/8 VV-1505	100	20	5.95	12.91	117
	100	50	5.17	6.4	23.8
	150	20	26.09	34.07	30.6
	150	50	20.59	17.33	-15.8
H1/8VV-2505	100	20	4.75	11.34	138.7
	100	50	7.95	14.04	76.6
	150	20	23.49	33.29	41.7
	150	50	14.84	29.14	97.5
H1/8VV-4003	100	20	6.4	17.67	176.1
	100	50	20.69	9.78	-52.7
	150	20	14.94	29.31	96.2
	150	50	20.73	18.42	-11.4
H1/8VV-0003	100	20	4.24	6.62	56.1
	100	50	5.71	7.05	23.5
	150	20	29.01	19.2	-33.8
	150	50	22.02	26.32	19.5

TritonX 100-in water @ 0.25% vol/vol in free air stream

Nozzle model	Air Velocity (mph)	Liquid pressure (psi)	Dv 0.1	Dv 0.5	Dv 0.9	R.S.	% of volume <200m
H1/8VV-1505	50	20	556	1227	1699	0.95	4.52
	50	50	96	643	1022	1.44	13.42
	100	20	119	462	645	1.14	14.45
	100	50	131	490	739	1.24	12.84
	150	20	45	205	375	1.61	48.83
	150	50	55	299	484	1.44	30.48
H1/8VV-2505	50	20	418	837	1232	1.00	4.30
	50	50	95	473	799	1.49	14.25
	100	20	58	403	599	1.34	23.15
	100	50	44	245	557	2.10	43.02
	150	20	42	185	370	1.77	53.40
	150	50	48	264	445	1.50	36.76
H1/8VV-4003	50	20	285	452	646	0.79	5.19
	50	50	61	290	519	1.58	30.07
	100	20	49	249	474	1.76	41.11
	100	50	45	200	473	2.27	49.24
	150	20	44	181	339	1.65	54.63
	150	50	42	178	390	2.01	54.00
H1/8VV-V0003	50	20	1577	1829	1973	0.22	0.57
	50	50	1612	1854	1994	0.21	0.07
	100	20	110	556	793	1.23	13.57
	100	50	71	674	1126	1.56	16.73
	150	20	49	244	435	1.58	40.51
	150	50	62	340	522	1.36	26.00

Water vs Triton X 100 in water @ 0.25% vol/vol in free air stream

Nozzle model	Air Velocity (mph)	Liquid Pressure (psi)	Water % <200 m	Triton X 100 % <200 m	% Change in Droplets < 200 μ
H1/8VV-1505	50	20	2.16	4.52	109.3
	50	50	4.46	13.42	200.9
	100	20	12.91	14.45	11.9
	100	50	6.40	12.84	100.6
	150	20	34.07	48.83	43.3
	150	50	17.33	30.48	75.9
H1/8VV-2505	50	20	2.48	4.30	73.4
	50	50	7.61	14.25	87.3
	100	20	11.34	23.15	104.1
	100	50	14.04	43.02	206.4
	150	20	33.29	53.40	60.4
	150	50	29.14	36.76	26.1
H1/8VV-4003	50	20	4.65	5.19	11.6
	50	50	18.40	30.07	63.4
	100	20	17.67	41.11	132.7
	100	50	9.78	49.24	403.5
	150	20	29.31	54.00	84.2
	150	50	18.42	54.63	196.6
H1/8VV-0003	50	20	0.23	0.57	147.8
	50	50	0.07	0.07	100.0
	100	20	6.62	13.57	105.0
	100	50	7.05	16.73	137.3
	150	20	19.20	40.51	111.0
	150	50	26.32	26.00	-1.2

Triton X 100 in water @ 0.25% vol/vol in free air stream vs Chamber 3

Nozzle model	Air Velocity (mph)	Liquid Pressure (psi)	Triton FAS % < 200 m	Triton in C-3 % < 200 m	% Change in Droplets < 200 m
H1/8VV-1505	100	20	14.45	23.83	64.90
	100	50	12.84	18.87	47.00
	150	20	48.83	51.22	4.90
	150	50	30.48	49.98	64.00
H1/8VV-2505	100	20	23.15	16.23	-30.00
	100	50	43.02	22.41	-47.90
	150	20	53.40	50.58	-5.30
	150	50	36.76	53.40	-45.30
H1/8VV-4003	100	20	41.11	20.87	-20.24
	100	50	49.24	37.73	-11.51
	150	20	54.00	40.40	-13.60
	150	50	54.63	36.77	-17.86
H1/8VV-0003	100	20	13.57	25.41	87.30
	100	50	16.73	15.21	9.10
	150	20	40.51	54.78	35.20
	150	50	26.00	49.88	91.80

**Funded by USDA SBIR
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