STONEAGE
TRAINING
For Industrial Cleaning Professionals

HIGH PRESSURE FIELD ENGINEERING HANDBOOK

Version 2.0

StoneAge®
ENGINEERING THE POWER OF WATER

CONTENTS

StoneAge®
ENGINEERING THE POWER OF WATER

WATERJET CUT PREVENTION CHECKLIST

- ☑ All operators are wearing proper Personal Protective Equipment (PPE)
- ☑ Person doing the work understands the procedure and is physically capable of performing the work
- ☑ All systems include a dump valve/relief system controlled by operator closest to nozzle and are guarded against accidental activation
- ☑ All shotguns have minimum 66 in./168 cm overall length, with a 6 ft./1.8 m safety shroud
- ☑ All line mole and flex lance jobs require backout preventer and (if conditions exist) a stinger to guard against reversal
- ☑ All safety devices have been tested before energizing the system

BACK THRUST

The following chart presents estimations of back thrust force during high pressure hydrobrasting.

BACK THRUST (LB & N)

Flow		GPM	LPM														
Pressure		5	9	10	38	15	57	20	76	25	95	30	114	35	132	40	151
1000	70	8	36	16	71	25	111	33	147	41	182	49	218	58	258	66	294
2000	140	12	53	23	102	35	156	47	209	58	258	70	311	81	360	93	414
3000	210	14	62	29	129	43	191	57	254	71	316	85	378	100	445	114	507
4000	275	16	71	33	147	49	218	66	294	82	365	99	440	115	512	132	587
5000	340	18	80	37	165	55	245	74	329	92	409	110	489	129	574	147	654
6000	410	20	89	40	178	60	267	81	360	101	449	121	538	141	627	161	716
7000	480	22	98	44	196	65	289	87	387	109	485	131	583	152	676	174	774
8000	550	23	102	47	209	70	311	93	414	116	516	140	623	162	721	186	827
9000	620	25	111	49	218	74	329	99	440	123	547	148	658	172	765	197	876
10000	690	26	116	52	231	78	347	104	463	130	578	156	694	182	810	208	925
11000	760	27	120	55	245	82	365	110	489	136	605	164	730	191	850	218	970
12000	830	29	129	57	254	85	378	114	507	142	632	171	761	199	885	228	1014
13000	900	30	133	59	262	89	396	119	529	148	658	178	792	207	921	237	1054
14000	970	31	138	62	276	92	409	123	547	154	685	185	823	215	956	246	1094
15000	1030	32	142	64	285	96	427	127	565	159	707	191	850	223	992	255	1134
16000	1100	33	147	66	294	99	440	132	587	164	730	197	876	230	1023	263	1170
17000	1170	34	151	68	302	102	454	136	605	170	756	203	903	237	1054	271	1205
18000	1240	35	156	70	311	104	463	140	623	174	774	209	930	244	1085	279	1241
19000	1300	36	160	72	320	108	480	143	636	179	796	215	956	251	1117	287	1277
20000	1380	37	165	74	329	110	489	147	654	184	818	221	983	257	1143	294	1307
psi	bar																

HYDRAULIC HORSEPOWER REQUIRED FOR JETTING

Flow		10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180
		38	76	114	151	189	227	265	303	341	379	416	454	492	530	568	606	644	681
Pressure																			
1000	70	6	12	17	23	29	35	41	47	52	58	64	70	76	82	87	93	99	105
2000	140	12	23	35	47	58	70	82	93	105	117	128	140	152	163	175	187	198	210
3000	210	17	35	52	70	87	105	122	140	157	175	192	210	227	245	262	280	297	315
4000	275	23	47	70	93	117	140	163	187	210	233	257	280	303	327	350	373	397	420
5000	340	29	58	87	117	146	175	204	233	262	292	321	350	379	408	437	466	496	525
6000	410	35	70	105	140	175	210	245	280	315	350	385	420	455	490	525	560	595	630
7000	480	41	82	122	163	204	245	286	327	367	408	449	490	531	571	612	653	694	735
8000	550	47	93	140	187	233	280	327	373	420	466	513	560	606	653	700	746	793	840
9000	620	52	105	157	210	262	315	367	420	472	525	577	630	682	735	787	840	892	945
10000	690	58	117	175	233	292	350	408	466	525	583	641	700	758	816	875	933	991	1050
11000	760	64	128	192	257	321	385	449	513	577	641	706	770	834	898	962	1026	1090	1155
12000	830	70	140	210	280	350	420	490	560	630	700	770	840	910	980	1050	1120	1190	1259
13000	900	76	152	227	303	379	455	531	606	682	758	834	910	985	1061	1137	1213	1289	1364
14000	970	82	163	245	327	408	490	571	653	735	816	898	980	1061	1143	1224	1306	1388	1469
15000	1030	87	175	262	350	437	525	612	700	787	875	962	1050	1137	1224	1312	1399	1487	1574
16000	1100	93	187	280	373	466	560	653	746	840	933	1026	1120	1213	1306	1399	1493	1586	1679
17000	1170	99	198	297	397	496	595	694	793	892	991	1090	1190	1289	1388	1487	1586	1685	1784
18000	1240	105	210	315	420	525	630	735	840	945	1050	1155	1259	1364	1469	1574	1679	1784	1889
19000	1300	111	222	332	443	554	665	776	886	997	1108	1219	1329	1440	1551	1662	1773	1883	1994
20000	1380	117	233	350	466	583	700	816	933	1050	1166	1283	1399	1516	1633	1749	1866	1983	2099
psi	bar																		

HHP = pressure (psi) * volume (gpm) / 1714
HHP = pressure (bar) * volume (lpm) / 447

BRAKE HORSEPOWER APPLIED	HYDRAYLIC HORSEPOWER REALIZED
100	85
150	127.5
200	170
250	212.5
300	255
350	297.5
400	340
450	382.5
500	425
600	510

Due to mechanical loss, the actual hydraulic horsepower realized is slightly less than brake horsepower generated:

BHP = HHP / 0.85
HHP = BHP x 0.85

MAXIMUM EFFICIENT FLOW

The following chart presents specifications for thermoplastic hose, highlighting maximum efficient flow.

HOSE ID		CRIMP OD		BN/BT FITTING	MAXIMUM EFFICIENT FLOW		HOSE WEIGHT PER FOOT	
in.	mm	in.	mm		GPM	LPM	lb	kg
0.12	**3**							
	3/2	0.35	9	P1	**4-5**	**15-19**	0.048	0.021
	3/4	0.48	12	MP4 L/R			0.091	0.041
	3/6	0.60	15	H4L or H6L				
0.16	**4**							
	4/2	0.40	10	P1	**6-7**	**23-26**	0.075	0.034
	4/4	0.58	16	MP4 L/R			0.157	0.071
	4/6	0.67	17	H4 or H6				
0.20	**5**							
	5/2	0.51	13	P2	**11**	**42**	0.084	0.038
	5/4	0.59	15	MP6 L/R			0.175	0.079
	5 UHP	0.81	21	H6L				
0.25	**6**							
133	6/2	0.55	14	P4	**14**	**53**	0.118	0.054
138	6/4	0.65	17	MP 6 L/R			0.198	0.090
0.375	**8**							
147	8/2	0.69	19	P6	**20**	**76**	0.134	0.061
151	8/4	0.80	20	MP9 L/R			0.262	0.119
156	8 UHP	0.91	23	H9L				
0.393	**10**							
	10/4	0.83	21	MP9	**25**	**95**	0.464	0.210
0.50	**13**							
	13/2	1.08	27	P 8	**40**	**151**	0.396	0.180
	13/4	1.16	29	TM 16			0.591	0.268

P 15k psi/1034 bar
MP 20k psi/1379 bar
H Above 20k psi/1379 bar

Number denotes X/16 in.
Example: MP9 = 9/16 Medium Pressure

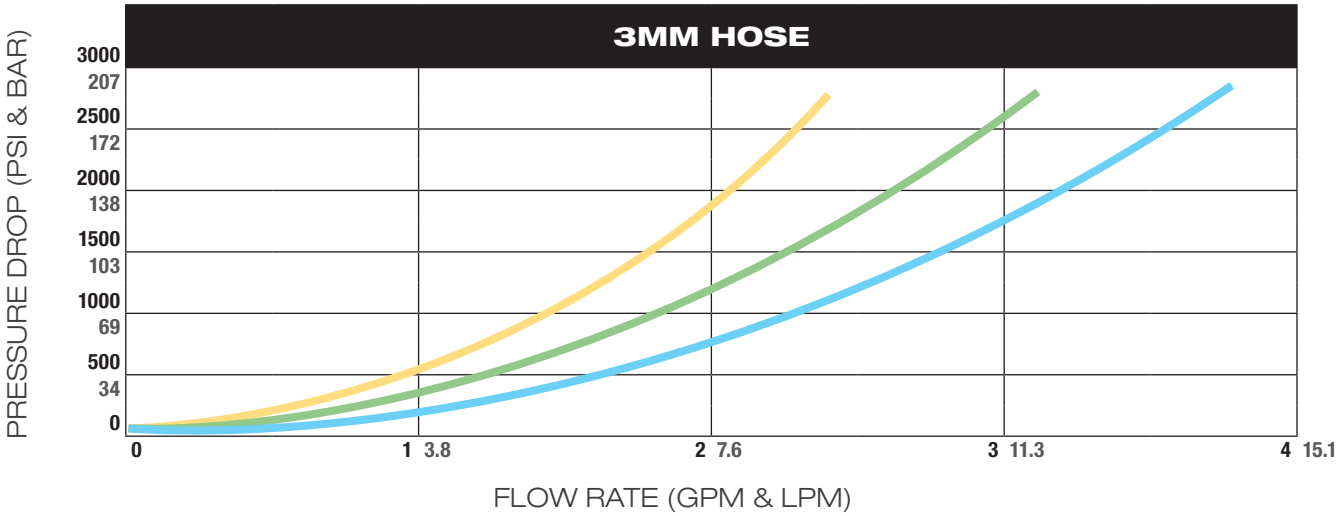
$$\textbf{PULLING DISTANCE} = \frac{\textbf{TOOL PULL - TOOL WEIGHT}}{\textbf{HOSE WEIGHT PER FT X 1.2}}$$

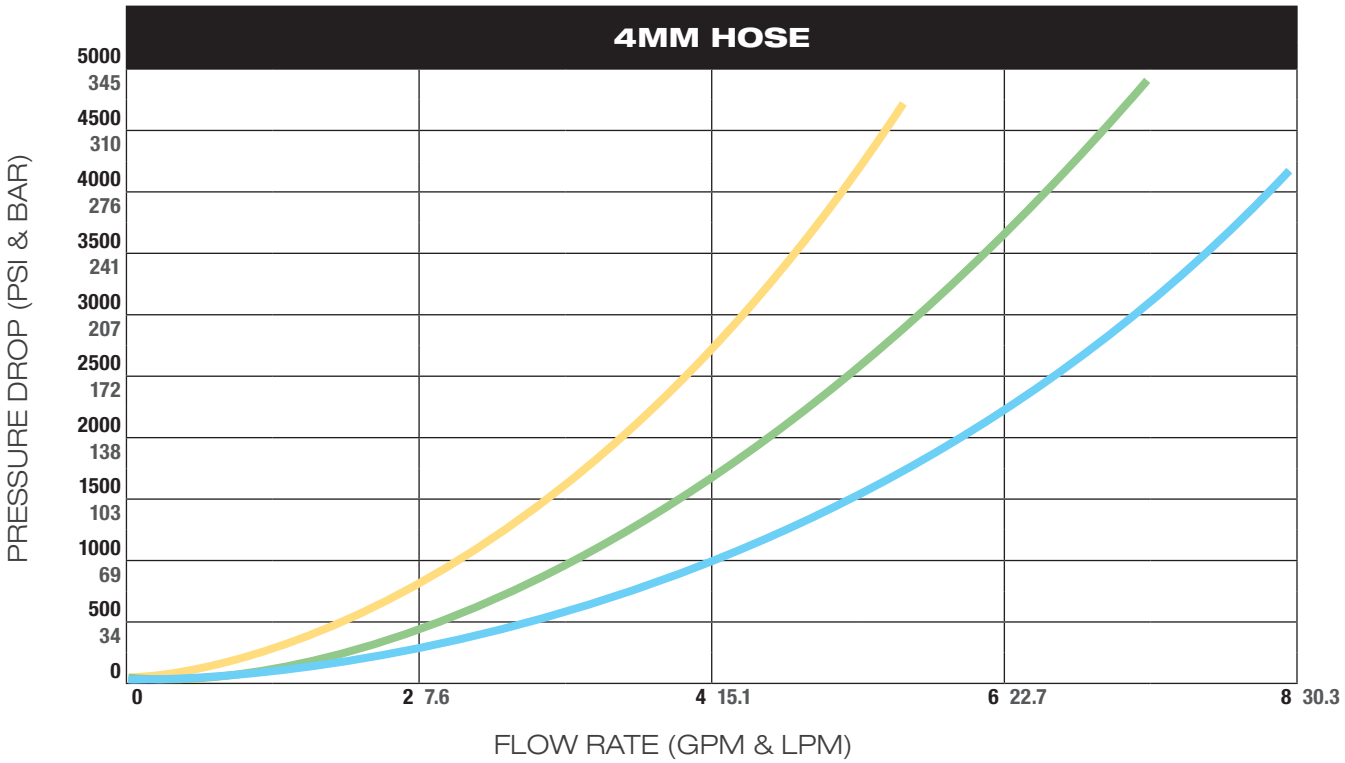
HOSE PRESSURE DROP

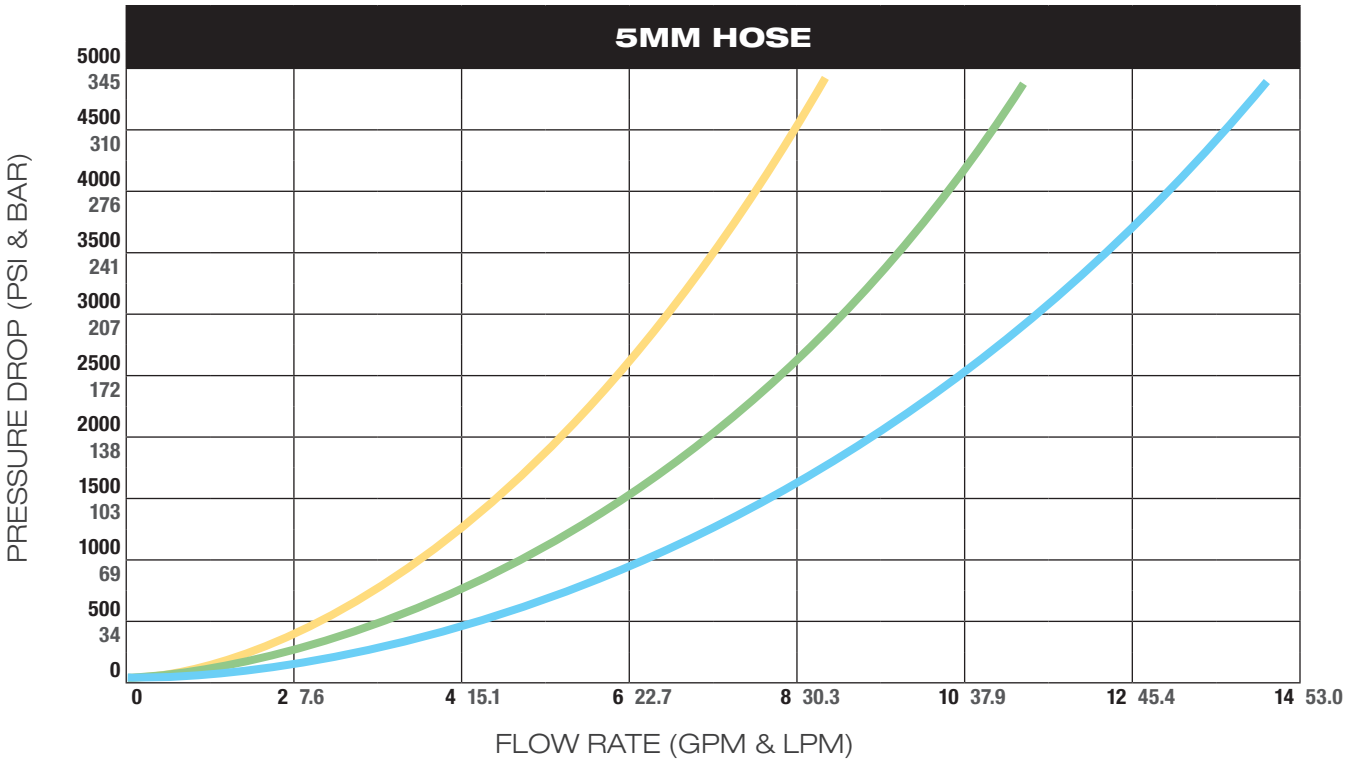
100 ft
30.5 m

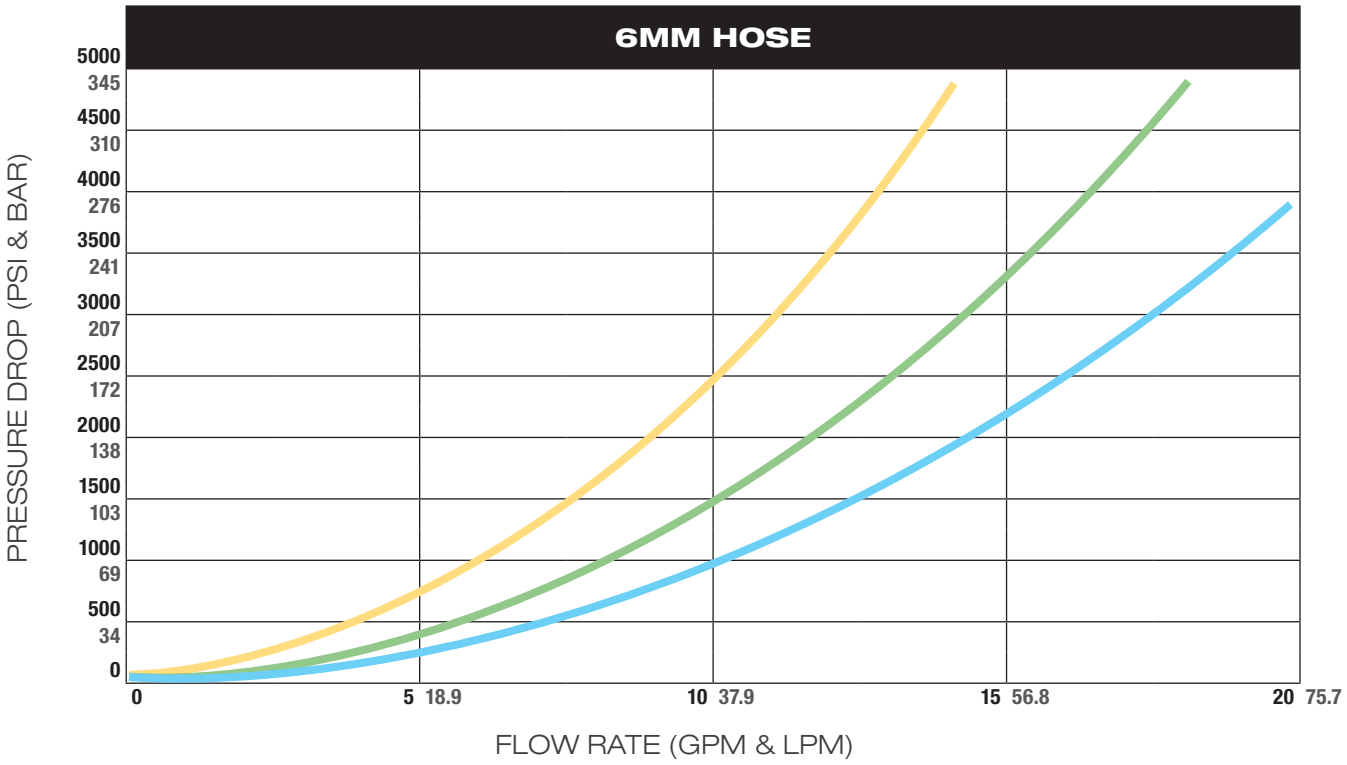
50 ft
15.2 m

25 ft
7.6 m



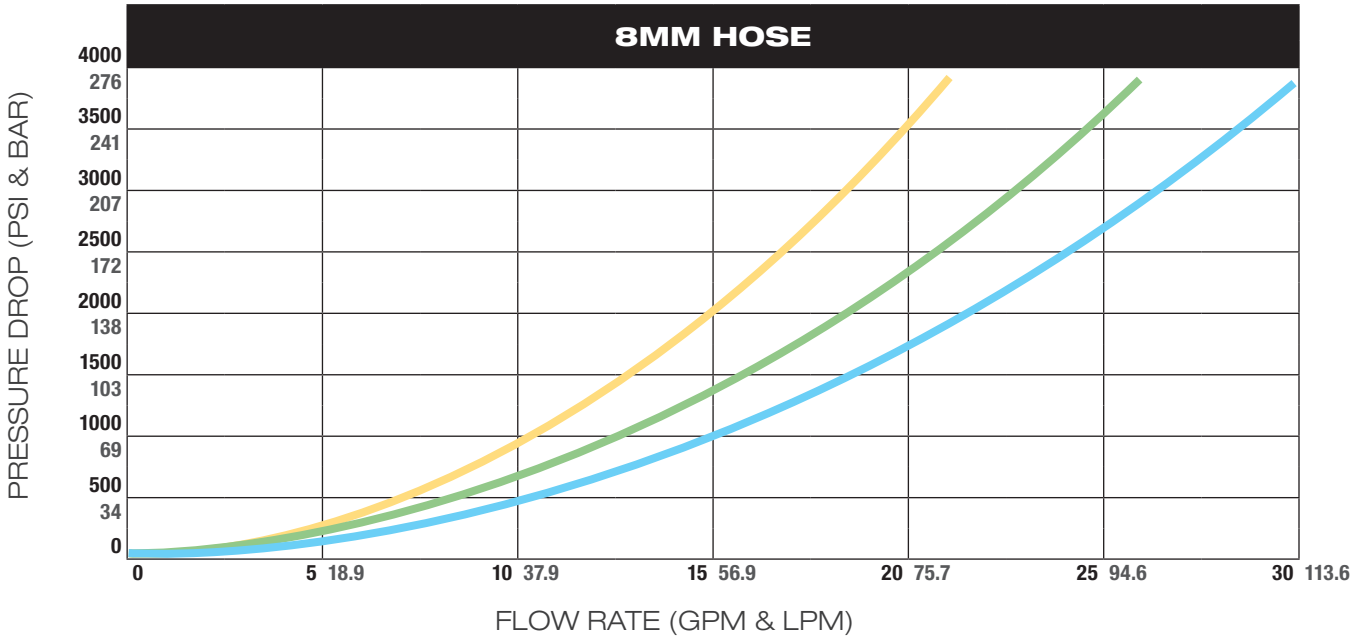


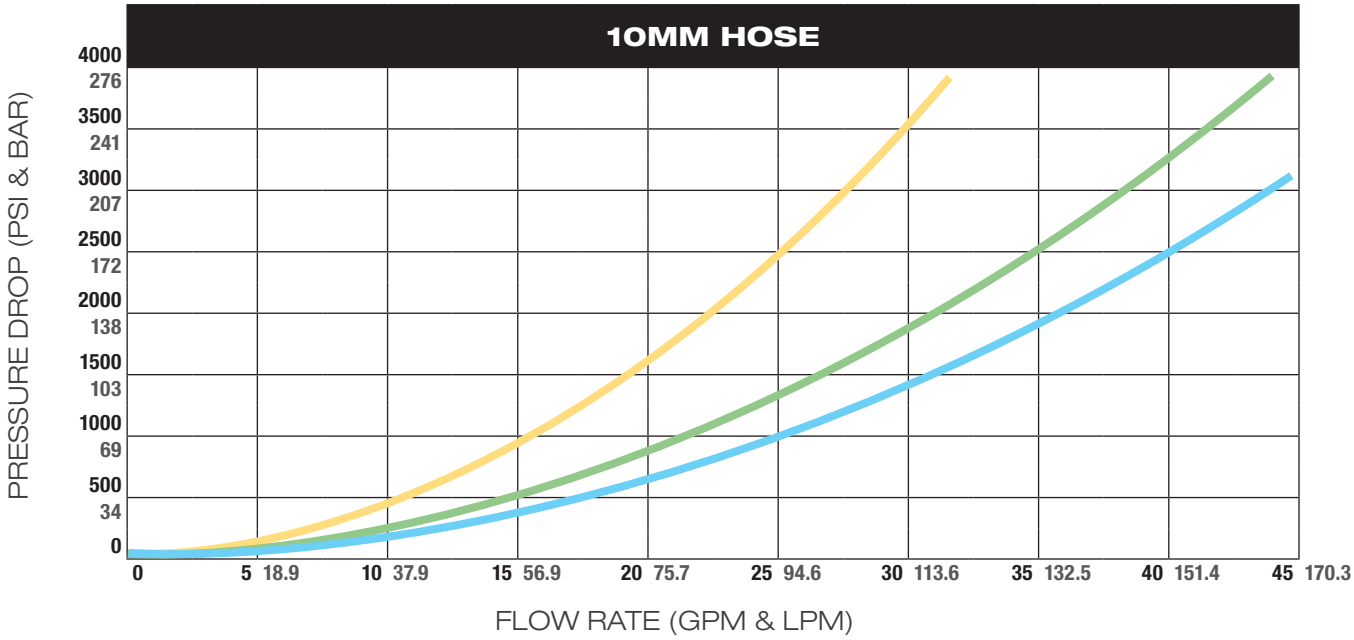

5MM HOSE
PRESSURE DROP (PSI & BAR)
5000 345
4500 310
4000 276
3500 241
3000 207
2500 172
2000 138
1500 103
1000 69
500 34
0
0
2 7.6
4 15.1
6 22.7
8 30.3
10 37.9
12 45.4
14 53.0
FLOW RATE (GPM & LPM)

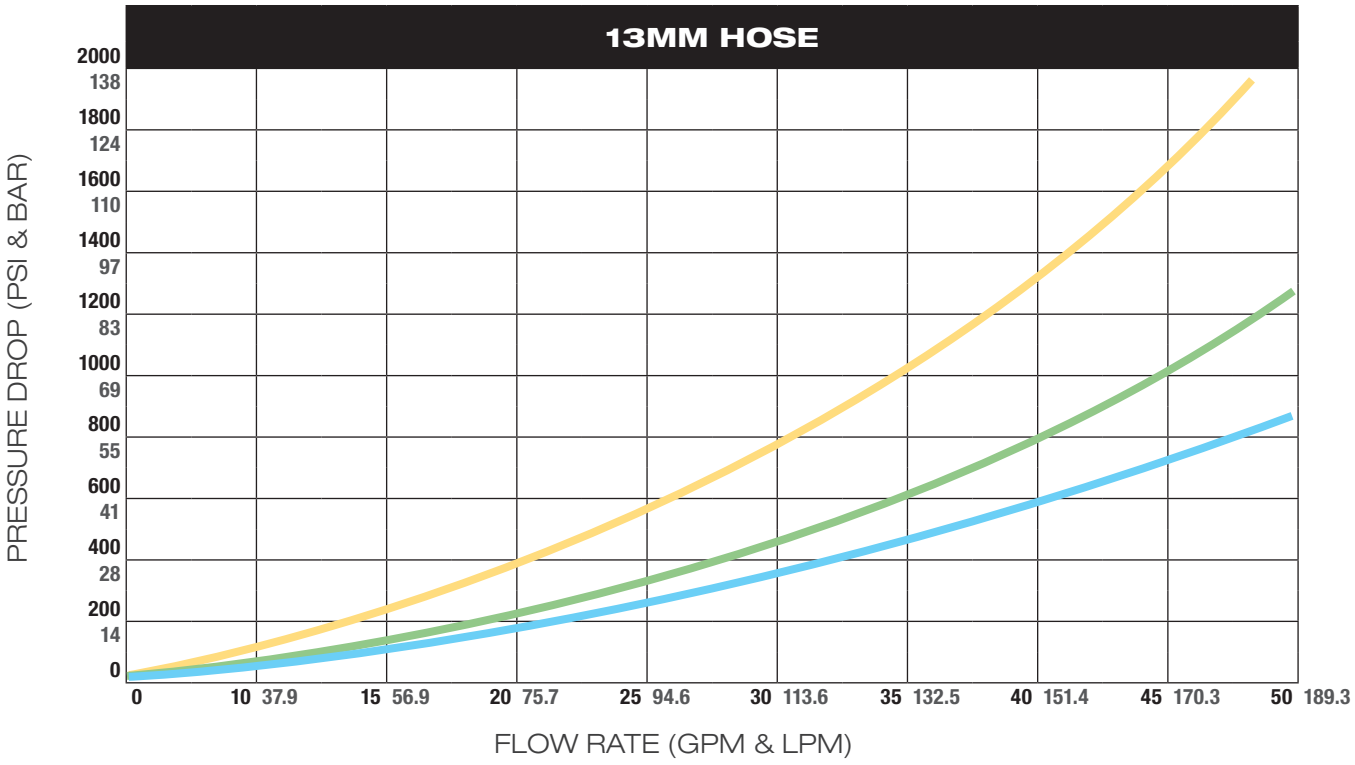

6MM HOSE
PRESSURE DROP (PSI & BAR)
5000 345
4500 310
4000 276
3500 241
3000 207
2500 172
2000 138
1500 103
1000 69
500 34
0
0
5 18.9
10 37.9
15 56.8
20 75.7
FLOW RATE (GPM & LPM)

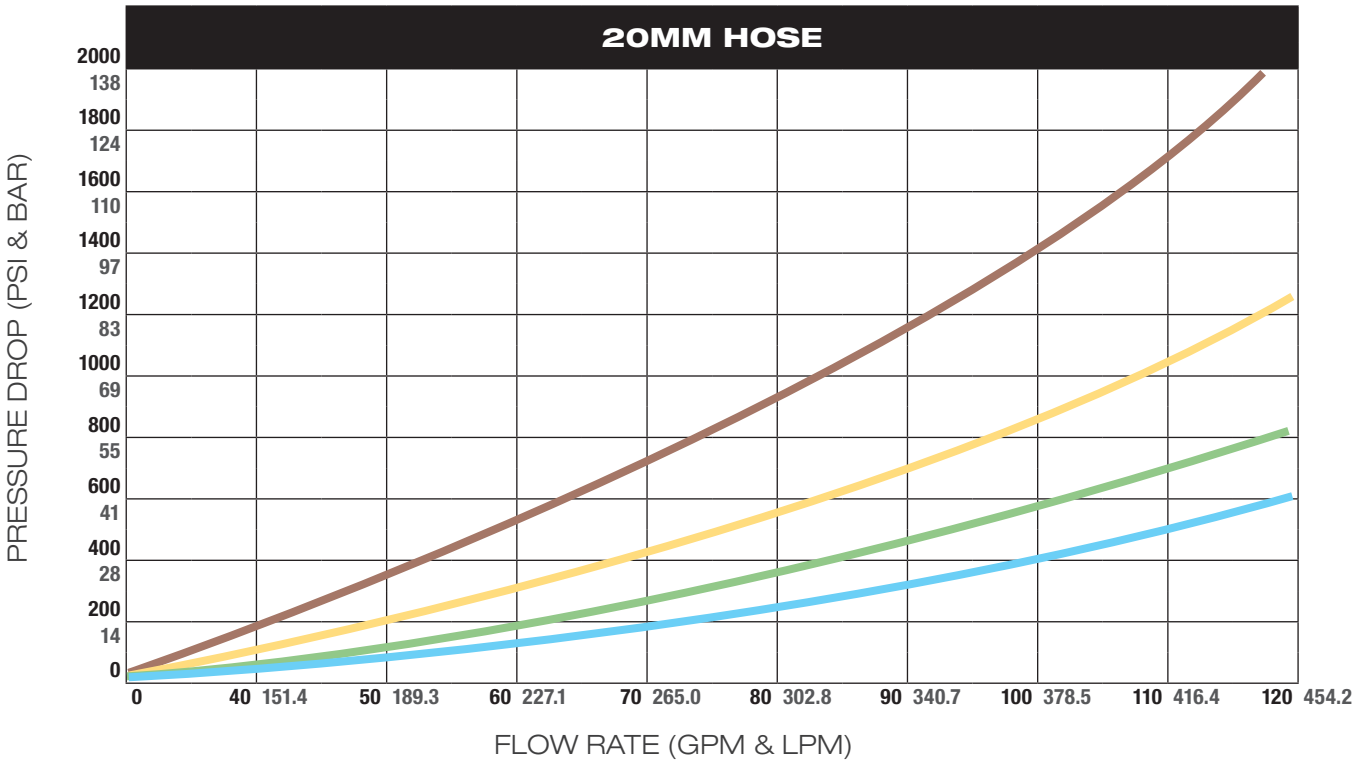
HOSE PRESSURE DROP

200 ft 61.0 m
100 ft 30.5 m
50 ft 15.2 m
25 ft 7.6 m

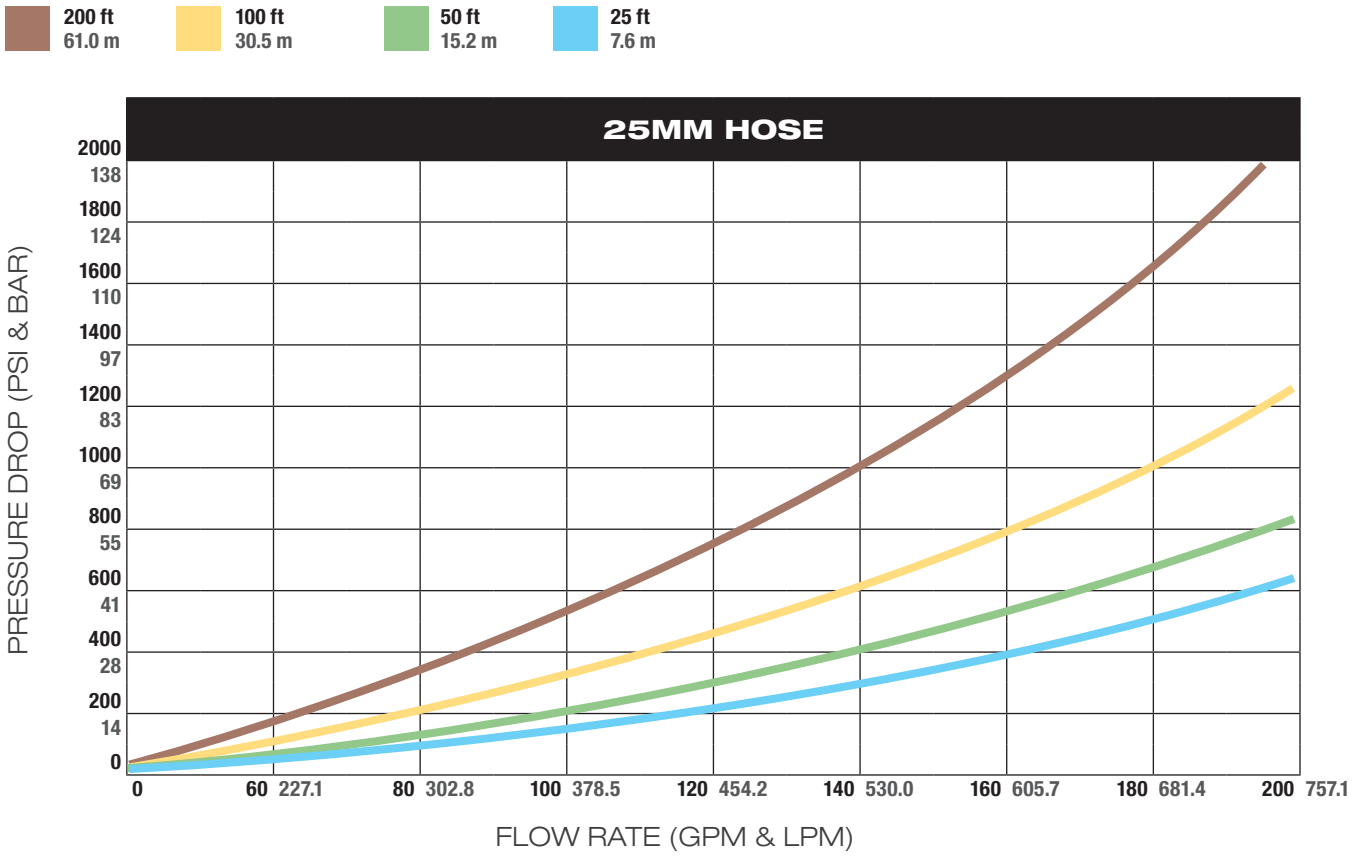





13MM HOSE
PRESSURE DROP (PSI & BAR)
2000 138
1800 124
1600 110
1400 97
1200 83
1000 69
800 55
600 41
400 28
200 14
0
0 10 37.9 15 56.9 20 75.7 25 94.6 30 113.6 35 132.5 40 151.4 45 170.3 50 189.3
FLOW RATE (GPM & LPM)

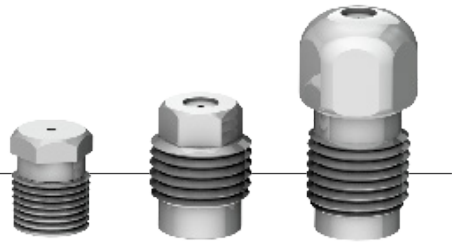

20MM HOSE
PRESSURE DROP (PSI & BAR)
2000 138
1800 124
1600 110
1400 97
1200 83
1000 69
800 55
600 41
400 28
200 14
0
0 40 151.4 50 189.3 60 227.1 70 265.0 80 302.8 90 340.7 100 378.5 110 416.4 120 454.2
FLOW RATE (GPM & LPM)

HOSE PRESSURE DROP



ATTACK TIPS

StoneAge Attack Tips are the highest quality, longest lasting nozzles available for low and medium pressure applications (up to 22k psi/1500 bar). Flow straighteners correct turbulence, ensuring excellent jetting results.



AP2
1/8 NPT

APF4
1/4 NPT
Flush mount

AP4
1/4 NPT

NOZZLE FLOW CHART

PRESSURE (PSI & BAR)

FLOW (GPM & L/MIN)

Nozzle Size in.	Nozzle Size mm	2,000 140		4,000 280		6,000 410		8,000 550		10,000 700		12,000 830		14,000 970		15,000 1000		16,000 1100		18,000 1200		20,000 1400		22,000 1500		#
.018	0.46	0.4	2	0.6	2	0.7	3	0.8	3	0.9	3	1.0	4	1.0	4	1.1	4	1.1	4	1.2	5	1.2	5	1.3	5	0.6
.020	0.51	0.5	2	0.7	3	0.8	3	1.0	4	1.1	4	1.2	5	1.3	5	1.3	5	1.5	6	1.5	6	1.5	6	1.6	6	0.7
.022	0.56	0.6	2	0.8	3	1.0	4	1.2	5	1.3	5	1.4	5	1.5	6	1.6	6	1.6	6	1.7	6	1.8	7	1.9	7	0.8
.024	0.61	0.7	3	1.0	4	1.2	5	1.4	5	1.6	6	1.7	6	1.8	7	1.9	7	2.0	8	2.1	8	2.2	8	2.3	9	1.0
.026	0.66	0.8	3	1.2	5	1.4	5	1.6	6	1.8	7	2.0	8	2.1	8	2.2	8	2.3	9	2.4	9	2.6	10	2.7	10	1.1
.029	0.74	1.0	4	1.4	5	1.7	6	2.0	8	2.3	9	2.5	10	2.7	10	2.8	11	2.9	11	3.0	11	3.2	12	3.4	13	1.4
.032	0.81	1.2	5	1.7	6	2.1	8	2.5	10	2.8	11	3.0	11	3.3	13	3.4	13	3.5	13	3.7	14	3.9	15	4.1	16	1.7
.035	0.89	1.5	6	2.1	8	2.6	10	3.0	11	3.3	13	3.6	14	3.9	15	4.0	15	4.2	16	4.4	17	4.7	18	4.9	19	2.1
.038	0.97	1.7	6	2.5	10	3.0	11	3.5	13	3.9	15	4.3	16	4.6	18	4.8	18	4.9	19	5.2	20	5.5	21	5.7	22	2.5
.042	1.07	2.1	8	3.0	11	3.7	14	4.2	16	4.7	18	5.2	20	5.6	21	5.8	22	6.0	23	6.4	24	6.7	26	7.0	27	3.0
.047	1.19	2.7	10	3.8	14	4.6	18	5.3	20	5.9	22	6.5	25	7.0	27	7.3	28	7.5	29	8.0	30	8.4	32	8.8	34	3.8
.052	1.32	3.3	13	4.6	18	5.6	21	6.5	25	7.3	28	8.0	30	8.6	33	8.9	34	9.2	35	9.8	37	10	38	11	42	4.6
.057	1.45	3.9	15	5.5	21	6.8	26	7.8	30	8.7	33	9.6	37	10	38	11	42	11	42	12	46	12	46	13	50	5.5
.063	1.60	4.8	18	6.8	26	8.3	32	9.6	37	11	42	12	46	13	50	13	50	14	53	14	53	15	57	16	61	6.8
.069	1.78	5.7	22	8.1	31	9.9	38	12	46	13	50	14	53	15	57	16	61	16	61	17	65	18	69	19	72	8.1
.075	1.91	6.8	26	9.6	37	12	46	13	50	15	57	17	65	18	69	19	72	19	72	20	76	21	80	23	88	9.6
.082	2.08	7.2	27	10	38	13	50	14	53	16	61	18	69	19	72	20	76	20	76	22	83	23	88	24	91	10
.090	2.29	8.7	33	12	46	15	57	17	65	19	72	21	80	23	88	24	91	25	95	26	98	27	102	29	110	12
.098	2.49	10	38	15	57	18	69	21	80	23	88	25	95	27	102	28	106	29	110	31	117	33	125	34	129	15
.106	2.69	12	46	17	65	21	80	24	91	27	102	29	110	32	121	33	125	34	129	36	136	38	144	40	151	17
.115	2.92	14	53	20	76	25	95	28	106	32	121	35	132	37	140	39	148	40	151	42	159	45	170	47	178	20
.125	3.18	17	65	24	91	29	110	33	125	37	140	41	155	44	167	46	174	47	178	50	189	53	201	55	208	24
.135	3.43	20	76	28	106	34	129	39	148	44	167	48	182	52	197	53	201	55	208	58	220	62	235	65	246	28
.145	3.68	23	88	32	121	39	148	45	170	50	189	55	208	60	227	62	235	64	242	68	257	71	269	75	284	32
.155	3.94	26	98	36	136	45	170	51	193	57	216	63	238	68	257	70	265	73	276	77	291	81	307	85	322	36
.165	4.19	29	110	41	155	50	189	58	220	65	246	71	269	77	291	80	303	82	310	87	329	92	348	97	367	41

For the most accurate nozzle selection, use the StoneAge Jetting App:
JETTING.STONEAGETOOLS.COM

CARBIDE ATTACK TIPS

Carbide nozzles are a good selection for lower quality water or dirty water applications. They offer a high quality jet and great erosion resistance.

CNP2
1/8 NPT

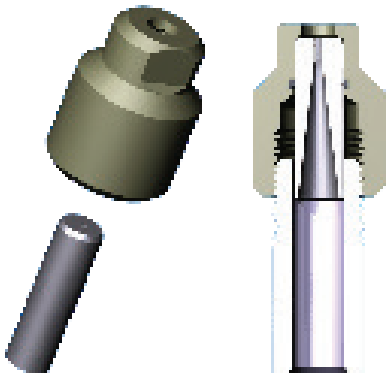
NOZZLE FLOW CHART

FLOW (GPM & L/MIN)			PRESSURE (PSI & BAR)																																		Cd
Nozzle Size			2,000		4,000		6,000		8,000		10,000		12,000		14,000		15,000		16,000		18,000		20,000		22,000													
in.	mm		140		280		410		550		700		830		970		1000		1100		1200		1400		1500													
.018	0.46	0.4	2	0.6	2	0.7	3	0.8	3	0.9	3	1.0	4	1.0	4	1.1	4	1.1	4	1.2	5	1.2	5	1.3	5												0.6
.020	0.51	0.5	2	0.7	3	0.8	3	1.0	4	1.1	4	1.2	5	1.3	5	1.3	5	1.5	6	1.5	6	1.5	6	1.6	6												0.7
.022	0.56	0.6	2	0.8	3	1.0	4	1.2	5	1.3	5	1.4	5	1.5	6	1.6	6	1.6	6	1.7	6	1.8	7	1.9	7												0.8
.024	0.61	0.7	3	1.0	4	1.2	5	1.4	5	1.6	6	1.7	6	1.8	7	1.9	7	2.0	8	2.1	8	2.2	8	2.3	9												1.0
.026	0.66	0.8	3	1.2	5	1.4	5	1.6	6	1.8	7	2.0	8	2.1	8	2.2	8	2.3	9	2.4	9	2.6	10	2.7	10												1.1
.029	0.74	1.0	4	1.4	5	1.7	6	2.0	8	2.3	9	2.5	10	2.7	10	2.8	11	2.9	11	3.0	11	3.2	12	3.4	13												1.4
.032	0.81	1.2	5	1.7	6	2.1	8	2.5	10	2.8	11	3.0	11	3.3	13	3.4	13	3.5	13	3.7	14	3.9	15	4.1	16												1.7
.035	0.89	1.5	6	2.1	8	2.6	10	3.0	11	3.3	13	3.6	14	3.9	15	4.0	15	4.2	16	4.4	17	4.7	18	4.9	19												2.1
.038	0.97	1.7	6	2.5	10	3.0	11	3.5	13	3.9	15	4.3	16	4.6	18	4.8	18	4.9	19	5.2	20	5.5	21	5.7	22												2.5
.042	1.07	2.1	8	3.0	11	3.7	14	4.2	16	4.7	18	5.2	20	5.6	21	5.8	22	6.0	23	6.4	24	6.7	26	7.0	27												3.0
.047	1.19	2.7	10	3.8	14	4.6	18	5.3	20	5.9	22	6.5	25	7.0	27	7.3	28	7.5	29	8.0	30	8.4	32	8.8	34												3.8
.052	1.32	3.3	13	4.6	18	5.6	21	6.5	25	7.3	28	8.0	30	8.6	33	8.9	34	9.2	35	9.8	37	10	38	11	42												4.6
.057	1.45	3.9	15	5.5	21	6.8	26	7.8	30	8.7	33	9.6	37	10	38	11	42	11	42	12	46	12	46	13	50												5.5
.063	1.60	4.8	18	6.8	26	8.3	32	9.6	37	11	42	12	46	13	50	13	50	14	53	14	53	15	57	16	61												6.8
.069	1.78	5.7	22	8.1	31	9.9	38	12	46	13	50	14	53	15	57	16	61	16	61	17	65	18	69	19	72												8.1
.075	1.91	6.8	26	9.6	37	12	46	13	50	15	57	17	65	18	69	19	72	19	72	20	76	21	80	23	88												9.6
.082	2.08	8.1	31	12	46	14	53	16	61	18	69	20	76	21	80	22	84	23	88	24	91	26	99	27	103												12
.090	2.29	9.8	37	14	53	17	65	20	76	22	84	24	91	26	99	27	103	28	107	29	111	31	118	32	122												14
.098	2.49	12	46	16	61	20	76	23	88	26	99	28	107	31	118	32	122	33	126	35	133	37	141	38	145												16
.106	2.69	14	53	19	72	23	88	27	103	30	114	33	126	36	137	37	141	38	145	41	156	43	164	45	171												19
.115	2.92	16	61	23	88	28	107	32	122	36	137	39	149	42	160	44	168	45	171	48	183	50	191	53	202												23
.125	3.18	17	65	27	103	33	126	38	145	42	160	46	175	50	191	52	198	53	202	56	213	60	229	62	236												27
.135	3.43	22	84	31	118	38	145	44	168	49	187	54	206	58	221	60	229	62	236	66	252	69	263	73	278												31
.145	3.68	25	95	36	137	44	168	51	194	57	217	62	236	67	255	69	263	72	274	76	290	80	305	84	320												36
.155	3.94	29	111	41	156	50	191	58	221	65	248	71	271	77	293	79	301	82	313	87	332	92	351	96	366												41
.165	4.19	33	126	46	175	57	217	66	252	73	278	80	305	87	332	90	343	93	354	98	373	104	396	109	415												46

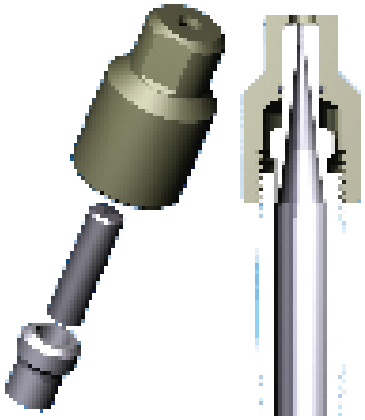
For the most accurate nozzle selection, use the StoneAge Jetting App:
JETTING.STONEAGETOOLS.COM

OC8 CARBIDE NOZZLES

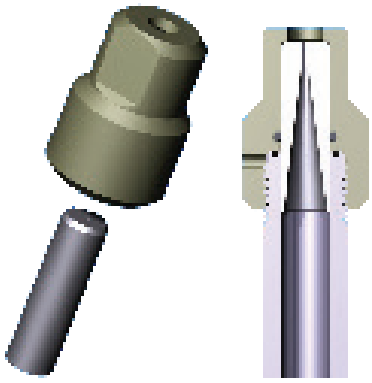
We recommend using our OC8 Holders and OC8 Carbide Inserts where filtration is poor, abrasive solids are present or for very high flow applications. Replaceable carbide inserts are available in large orifice diameters to handle high flows and contain a long taper to provide excellent jet quality.



The **OC8 P8** Holder and OC Carbide Inserts for 15K psi, 1/2 NPT female connection.



The **OC8 P12** Holder and OC Carbide Inserts for 15K psi, 3/4 NPT female connection.



The **OC8 G12** Holder and OC Carbide Inserts for 22K psi, G12 female connection.

NOZZLE FLOW CHART

FLOW (GPM & L/MIN) — **PRESSURE (PSI & BAR)**

Nozzle Size in.	Nozzle Size mm	2,000 140		4,000 280		6,000 410		8,000 550		10,000 700		12,000 830		14,000 970		15,000 1000		16,000 1100		18,000 1200		20,000 1400		22,000 1500		Cd
.063	1.60	4.8	18	6.7	26	8.2	31	9.5	36	11	42	12	46	13	50	13	50	14	53	14	53	15	57	16	61	7
.075	1.91	6.8	26	9.6	37	12	46	14	53	15	57	17	65	18	69	19	72	19	72	20	76	21	80	22	84	10
.085	2.16	8.7	33	12	46	15	57	17	65	19	72	21	80	23	88	24	91	25	95	26	99	28	107	129	492	12
.095	2.41	11	42	15	57	19	72	22	84	24	91	27	103	29	111	30	114	31	118	33	126	33	126	36	137	15
.105	2.67	13	50	19	72	23	88	27	103	30	114	33	126	35	133	36	137	38	145	40	152	42	160	44	168	19
.125	3.18	19	72	27	103	33	126	38	145	42	160	46	175	50	191	52	198	53	202	56	213	60	229	62	236	27
.145	3.68	25	95	36	137	44	168	50	191	57	217	62	236	67	255	69	263	72	274	76	290	80	305	84	320	36
.165	4.19	33	126	46	175	56	213	66	252	73	278	80	305	87	332	90	343	93	354	98	373	104	396	109	415	46
.175	4.45	37	141	52	198	64	244	74	282	82	313	90	343	98	373	101	385									52
.190	4.83	43	164	61	232	75	286	87	332	97	370	106	404	115	438	119	454									61
.200	5.08	48	183	68	259	83	316	96	366	108	412	118	450	127	484	132	503									68
.215	5.46	56	213	79	301	96	366	111	423	124	473															78
.235	5.97	66	252	94	358	115	438	133	507	149	568															94
.250	6.35	75	286	106	404	130	495	150	572	168	640															106

For the most accurate nozzle selection, use the StoneAge Jetting App:
JETTING.STONEAGETOOLS.COM

OCV & OCIH CARBIDE NOZZLES

We recommend using carbide nozzle tips where filtration is poor, abrasive solids are present, or for very high flow.

OCV & OCIH
1/4 NPT

NOZZLE FLOW CHART

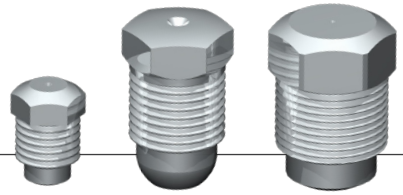
PRESSURE (PSI & BAR)

FLOW (GPM & L/MIN)

Nozzle Size		2,000		4,000		6,000		8,000		10,000		12,000		14,000		16,000		18,000		20,000		#
in.	mm	140		280		410		550		700		830		970		1100		1200		1400		
.024	0.61	0.7	3	1.0	4	1.2	4.5	1.4	5	1.6	6	1.7	6	1.8	7	2.0	8	2.1	8	2.2	8	1.0
.028	0.71	0.9	3	1.3	5	1.6	5	1.9	7	2.1	8	2.3	9	2.5	10	2.7	10	2.8	11	3.0	11	0.7
.031	0.79	1.2	5	1.6	6	2.0	8	2.3	9	2.6	10	2.8	11	3.1	12	3.3	13	3.5	13	3.7	14	1.6
.036	0.91	1.7	6	2.4	9	3.0	11	3.4	13	3.8	14	4.2	16	4.5	17	4.8	18	5.1	19	5.4	20	2.4
.039	0.99	1.8	7	2.6	10	3.2	12	3.7	14	4.1	16	4.5	17	4.9	19	5.2	20	5.5	21	5.8	22	2.6
.043	1.09	2.2	8	3.2	12	3.9	15	4.5	17	5.0	19	5.5	21	5.9	22	6.3	24	6.7	25	7.0	26	3.2
.047	1.19	2.7	10	3.8	14	4.6	18	5.3	20	6.0	23	6.5	25	7.0	26	7.5	28	8.0	30	8.4	32	3.8
.055	1.40	3.6	14	5.2	20	6.3	24	7.3	28	8.1	31	8.9	34	9.6	36	10	38	11	42	12	45	5.2
.062	1.57	4.6	18	6.5	25	8.0	30	9.3	35	10	38	11	42	12	45	13	49	14	53	15	57	6.5
.067	1.70	5.4	20	7.6	29	9.4	36	11	42	12	45	13	19	14	53	15	57	16	61	17	64	7.6
.073	1.85	6.4	24	9.1	34	11	42	13	49	14	53	16	61	17	64	18	68	19	72	20	76	9.1
.078	1.98	7.3	28	10	38	13	49	15	57	16	61	18	68	19	72	21	79	22	83	23	87	10
.089	2.26	9.5	36	14	53	16	61	19	72	21	79	23	87	25	95	27	102	29	110	30	114	14
.093	2.36	10	38	15	57	18	68	21	79	23	87	26	98	28	106	30	114	31	117	33	125	15
.106	2.69	14	53	19	72	23	87	27	102	30	114	33	125	36	136	38	144	41	155	43	163	19
.125	3.18	19	72	27	102	33	125	38	144	42	159	46	174	50	189	53	201	56	212	60	227	27
.140	3.56	24	91	33	125	41	155	47	178	53	201	58	220	62	235	67	254	71	269	75	284	33
.155	3.94	29	110	40	151	49	185	57	216	64	242	70	265	76	288	83	314	88	333	93	352	41

For the most accurate nozzle selection, use the StoneAge Jetting App:
JETTING.STONEAGETOOLS.COM

SAPPHIRE NOZZLES



OS4 1/4-28 NF | **OS6** 3/8-24 NF | **OS7** 7/16-20 NF

NOZZLE FLOW CHART

PRESSURE (PSI & BAR)

FLOW (GPM & L/MIN)

Nozzle Size		20,000	1400	22,000	1500	24,000	1700	26,000	1800	28,000	1900	30,000	2100	32,000	2200	34,000	2300	36,000	2500	38,000	2600	40,000	2800	Availability		
in.	mm																							OS4	OS6	OS7
.009	0.23	0.2	1	0.2	1	0.2	1	0.3	1	0.3	1	0.3	1	0.3	1	0.3	1	0.3	1	0.3	1	0.3	1		•	
.010	0.25	0.3	1	0.3	1	0.3	1	0.3	1	0.3	1	0.3	1	0.4	2	0.4	2	0.4	2	0.3	1	0.4	2	•	•	
.011	0.28	0.3	1	0.4	2	0.4	2	0.4	2	0.4	2	0.4	2	0.4	2	0.4	2	0.5	2	0.5	2	0.5	2		•	•
.012	0.30	0.4	2	0.4	2	0.4	2	0.4	2	0.5	2	0.5	2	0.5	2	0.5	2	0.5	2	0.6	2	0.6	2	•	•	•
.013	0.33	0.5	2	0.5	2	0.5	2	0.5	2	0.6	2	0.6	2	0.6	2	0.6	2	0.6	2	0.6	2	0.7	3	•	•	•
.014	0.36	0.5	2	0.6	2	0.6	2	0.6	2	0.6	2	0.7	3	0.7	3	0.7	3	0.7	3	0.7	3	0.8	3	•	•	•
.015	0.38	0.6	2	0.7	3	0.7	3	0.7	3	0.7	3	0.8	3	0.9	3	0.8	3	0.8	3	0.9	3	0.9	3	•	•	•
.016	0.41	0.7	3	0.7	3	0.8	3	0.8	3	0.8	3	0.9	3	0.9	3	0.9	3	1.0	4	1.0	4	1.0	4	•	•	•
.017	0.43	0.8	3	0.8	3	0.9	3	0.9	3	0.9	3	1.0	4	1.0	4	1.0	4	1.1	4	1.1	4	1.1	4	•	•	•
.018	0.46	0.9	3	0.9	3	1.0	4	1.0	4	1.1	4	1.1	4	1.1	4	1.2	5	1.2	5	1.2	5	1.3	5	•	•	•
.019	0.48	1.0	4	1.0	4	1.1	4	1.1	4	1.2	5	1.2	5	1.3	5	1.3	5	1.3	5	1.4	5	1.4	5	•	•	•
.020	0.51	1.1	4	1.2	5	1.2	5	1.3	5	1.3	5	1.4	5	1.4	5	1.4	5	1.5	6	1.5	6	1.6	6	•	•	•
.021	0.53	1.2	5	1.3	5	1.3	5	1.4	5	1.4	5	1.5	6	1.5	6	1.6	6	1.6	6	1.7	6	1.7	6	•	•	•
.022	0.56	1.3	5	1.4	5	1.5	6	1.5	6	1.6	6	1.6	6	1.7	6	1.7	6	1.8	7	1.8	7	1.9	7	•	•	•
.023	0.58	1.5	6	1.5	6	1.6	6	1.7	6	1.7	6	1.7	6	1.8	7	1.9	7	1.9	7	2.0	8	2.0	8	•	•	•
.024	0.61	1.6	6	1.7	6	1.7	6	1.8	7	1.9	7	1.9	7	2.0	8	2.1	8	2.1	8	2.2	8	2.2	8	•	•	•
.025	0.64	1.7	6	1.8	7	1.9	7	2.0	8	2.0	8	2.1	8	2.2	8	2.2	8	2.3	9	2.4	9	2.4	9	•	•	•
.026	0.66	1.9	7	1.9	7	2.0	8	2.1	8	2.2	8	2.3	9	2.3	9	2.4	9	2.5	10	2.6	10	2.6	10	•	•	
.027	0.69	2.0	8	2.1	8	2.2	8	2.3	9	2.4	9	2.5	10	2.5	10	2.6	10	2.7	10	2.8	11	2.8	11	•	•	
.028	0.71	2.2	8	2.3	9	2.4	9	2.5	10	2.6	10	2.5	10	2.7	10	2.8	11	2.9	11	3.0	11	3.1	12	•	•	•
.031	0.79	2.6	10	2.8	11	2.9	11	3.0	11	3.1	12	3.2	12	3.3	13	3.4	13	3.5	13	3.6	14	3.7	14	•	•	•
.033	0.84	3.0	11	3.1	12	3.3	13	3.4	13	3.5	13	3.7	14	3.8	14	3.9	15	4.0	15	4.1	16	4.2	16			•
.034	0.86	3.2	12	3.3	13	3.5	13	3.6	14	3.8	14	3.9	15	4.0	15	4.2	16	4.3	16	4.4	17	4.5	17	•	•	
.035	0.89	3.4	13	3.5	13	3.7	14	3.8	14	4.0	15	4.1	16	4.3	16	4.4	17	4.5	17	4.6	18	4.8	18	•		•

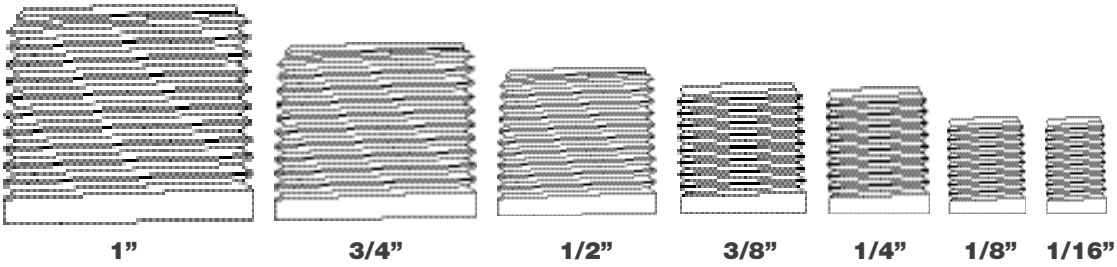
For the most accurate nozzle selection, use the StoneAge Jetting App:
JETTING.STONEAGETOOLS.COM

FITTING SIZE REFERENCE

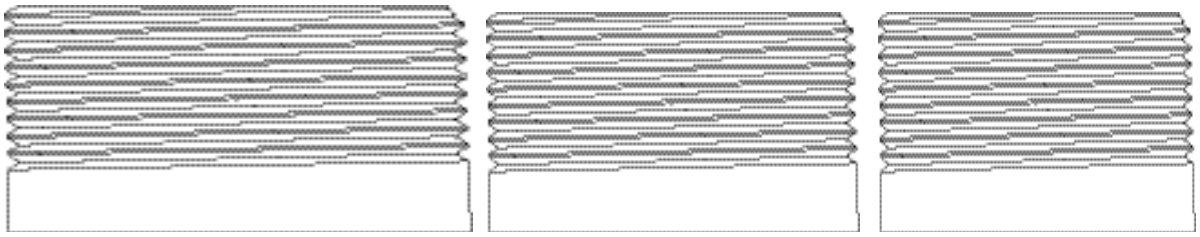
NATIONAL PIPE TAPER (NPT)

ACTUAL SIZE

SINGLE PIECE MALE • ACTUAL SIZE



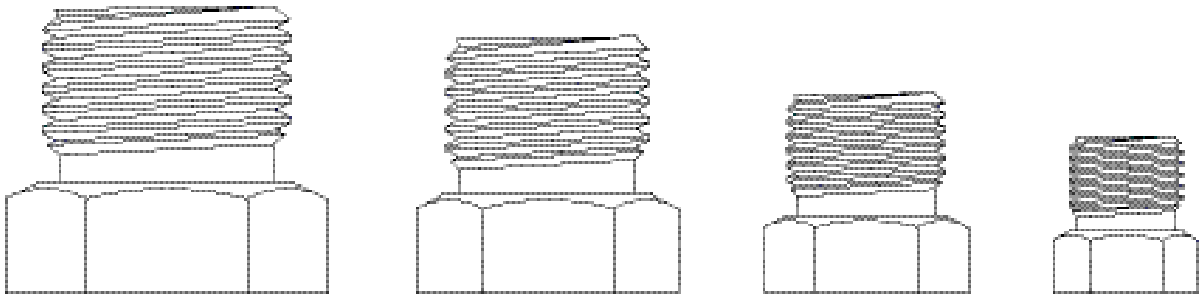
1” 3/4” 1/2” 3/8” 1/4” 1/8” 1/16”



2” • 5,000 PSI 1-1/2” • 8,000 PSI 1-1/4” • 10,000 PSI

TYPE M

SINGLE PIECE MALE • ACTUAL SIZE



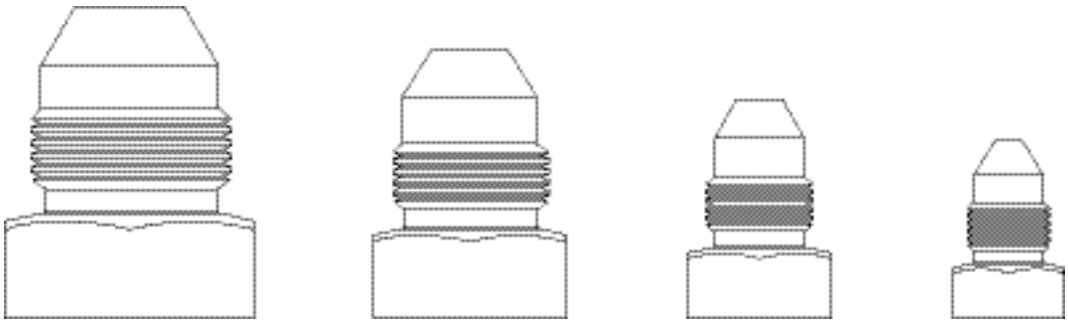
1-5/16” 1” 3/4” 9/16”

FITTING SIZE REFERENCE

MEDIUM PRESSURE (MP)

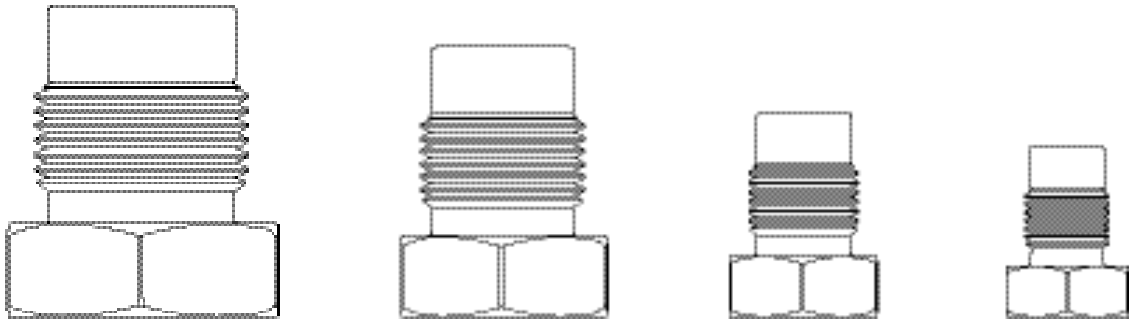
ACTUAL SIZE

SINGLE PIECE MALE • ACTUAL SIZE



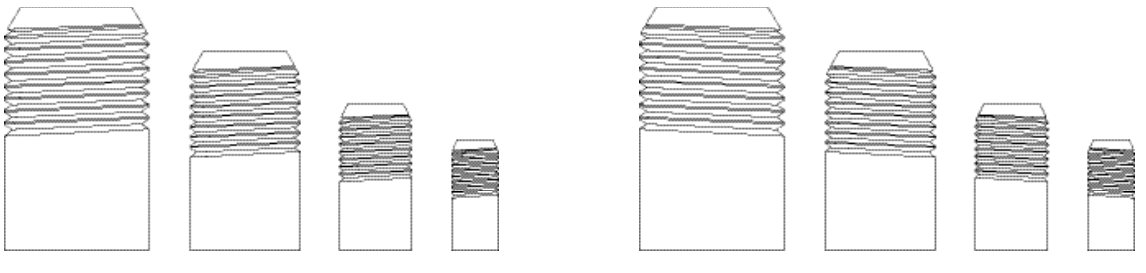
3/4” 9/16” 3/8” 1/4”

GLANDS& COLLARS • ACTUAL SIZE



3/4” 9/16” 3/8” 1/4”

LANCES • ACTUAL SIZE



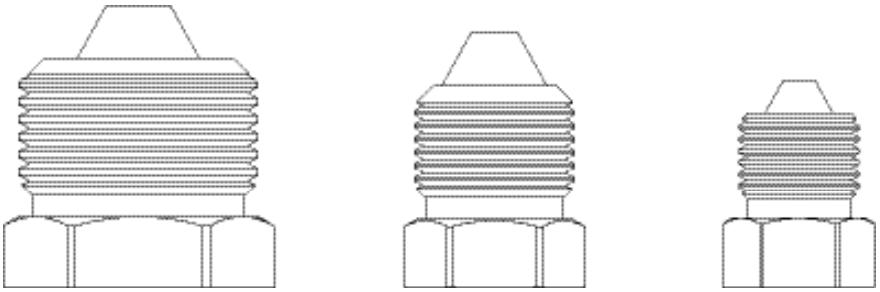
3/4” 9/16” 3/8” 1/4” 3/4” 9/16” 3/8” 1/4”

FITTING SIZE REFERENCE

HIGH PRESSURE (HP)

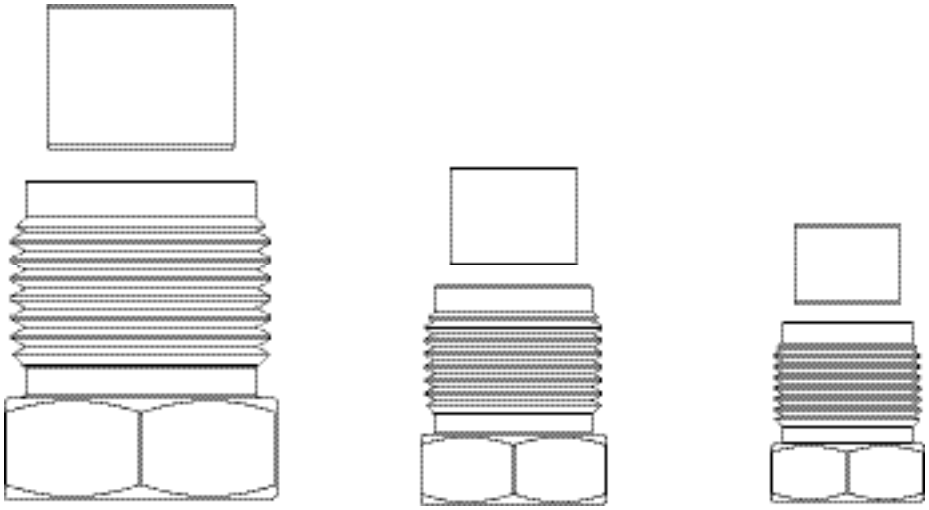
ACTUAL SIZE

SINGLE PIECE MALE • ACTUAL SIZE



9/16” **3/8”** **1/4”**

GLANDS& COLLARS • ACTUAL SIZE



9/16” **3/8”** **1/4”**

LANCES • ACTUAL SIZE

9/16” **3/8”** **1/4”**

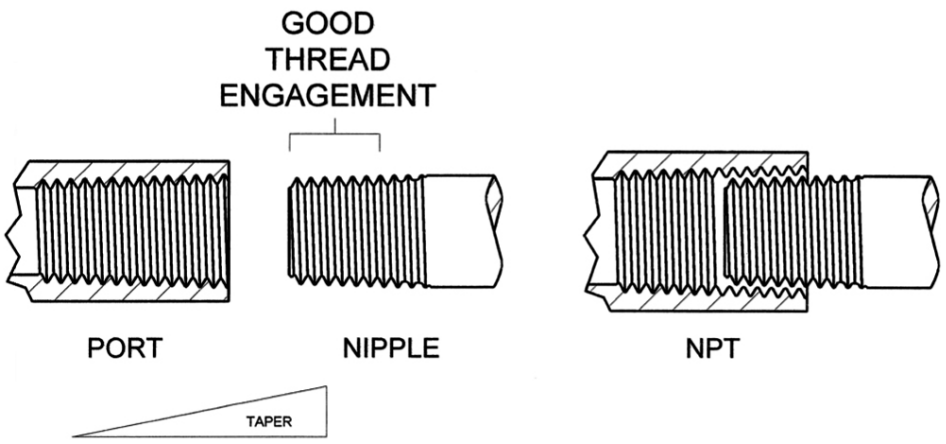
RIGHT-HAND THREADS

9/16” **3/8”** **1/4”**

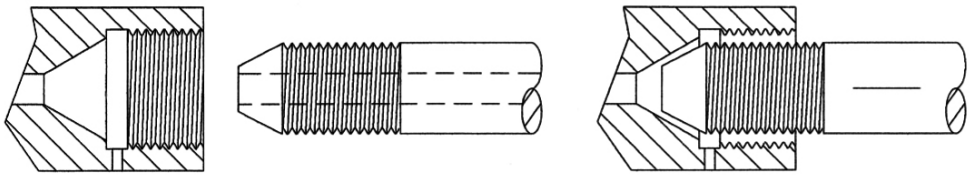
LEFT-HAND THREADS

THREAD ENGAGEMENT

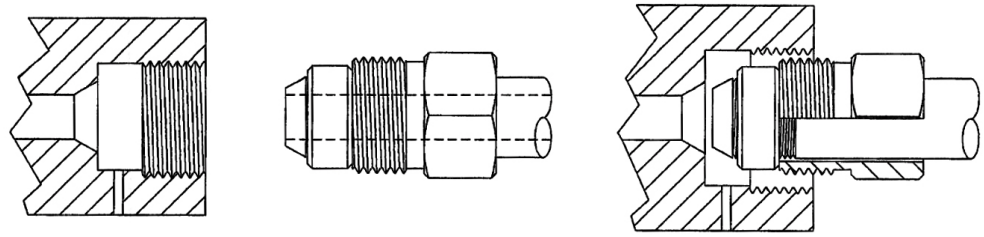
NPT



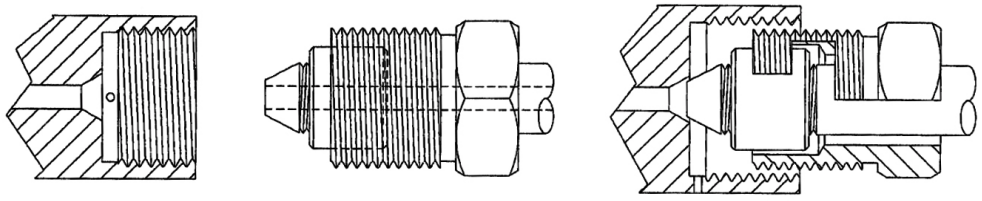
TYPE M



MEDIUM PRESSURE (MP)



HIGH PRESSURE (HP)



TUBE ID SPECIFICATIONS

TUBE ID	Gauge			10		11		12		13		14		15		16	
	Wall			0.134	3.4	0.120	3.1	0.109	2.8	0.095	2.4	0.083	2.1	0.072	1.8	0.065	1.7
	Tube OD			in.	mm												
	5/8"	0.625	**15.9**	0.357	9.1	0.385	9.8	0.407	10.3	0.435	11.0	0.459	11.7	0.481	12.2	0.495	12.6
	3/4"	0.750	**19.1**	0.482	12.2	0.510	12.6	0.532	13.5	0.560	14.2	0.584	14.8	0.606	15.4	0.620	15.7
	7/8"	0.875	**22.2**	0.607	15.4	0.635	16.1	0.657	16.7	0.685	17.4	0.709	18.0	0.731	18.6	0.745	18.9
	1"	1.000	**25.4**	0.732	18.6	0.760	19.3	0.782	19.9	0.810	20.6	0.834	21.2	0.856	21.7	0.870	22.1
	1 1/8"	1.125	**28.6**	0.857	21.8	0.885	22.5	0.907	23.0	0.935	23.7	0.959	24.4	0.981	24.9	0.995	25.3
	1 1/4"	1.250	**37.6**	0.982	24.9	1.010	25.7	1.032	26.2	1.060	26.9	1.084	27.5	1.106	28.1	1.120	28.4
	1 1/2"	1.500	**38.1**	1.232	31.3	1.260	32.0	1.282	32.6	1.310	33.3	1.334	33.9	1.356	34.4	1.370	34.8
	1 3/4"	1.750	**44.5**	1.482	37.6	1.510	38.4	1.532	38.9	1.560	39.6	1.584	40.2	1.606	40.8	1.620	41.1
	2"	2.000	**50.8**	1.732	44.0	1.760	44.7	1.782	45.3	1.810	46.0	1.834	46.6	1.856	47.1	1.870	47.5
	in.		mm														

TUBE ID = OD - (WALL THICKNESS X 2)

TORQUE RECOMMENDATIONS

CONNECTION	THREAD SIZE	RECOMMENDED TORQUE	
High Pressure		ft-lb	Nm
1/4"	9/16" - 18thd	25	34
3/8"	3/4" - 16thd	50	68
9/16"	1 1/8" - 12thd	75	102
Medium Pressure		ft-lb	Nm
1/4"	7/16" - 20thd	20	27
3/8"	9/16" - 18thd	30	41
9/16"	13/16" - 16thd	85	115
3/4"	3/4" NPSM	90	122
1"	1 3/8" - 12thd	125	169
Type "M" Swivel		ft-lb	Nm
A9	9/16" - 18thd	25-30	34-41
A12	3/4" - 16thd	40-50	54-68
A14	7/8" - 14thd	50-60	68-81
A16	1" - 12thd	75-85	102-115
A21	1 5/16" - 12thd	100-120	136-163

STANDARD UNIT ABBREVIATIONS

PRESSURE	FLOW	DISTANCE	WEIGHT	TEMPERATURE
psi = pounds per square inch	gpm = gallons per minute	in. = inches	lb = pounds	°F = degree Fahrenheit
b = bar	l/min = liters per minute	ft = feet	kg = kilograms	°C = degree Celsius
	Cv = flow coefficient	mm = millimeters		
	Cd = discharge coefficient	cm = centimeters		
		m = meters		

THREAD ABBREVIATIONS

NPT = National Pipe Thread	**MP** = Medium Pressure Cone & Thread Connection	**G9** = 9/16 Thread w/ O-ring Groove Face Seal
NPTM = National Pipe Thread Male	**HP** = High Pressure Cone & Thread Connection	**G12** = 3/4 Thread w/ O-ring Groove Face Seal
NPTF = National Pipe Thread Female	**LH** = Left-hand Direct Tube-end Thread Connection	**G16** = 1-12 UNF Thread w/ O-Ring Groove Face Seal
BSPP = British Standard Parallel Pipe	**RH** = Right-hand Direct Tube-end Thread Connection	**K** = 1-1/8 Thread w/ O-ring Groove Face Seal

MEASUREMENT CONVERSIONS

FROM	TO	MULTIPLY BY
meters (m)	feet (ft)	3.281
feet (ft)	meters (m)	0.3048
millimeters (mm)	inches (in.)	0.0394
inches (in.)	millimeters (mm)	25.4
l/min	gpm (US)	0.2642
l/min	gpm (Brit)	0.2200
gpm (US)	l/min	3.785
gpm (Brit)	l/min	4.546
gpm (US)	gpm (Brit)	0.8327
gpm (Brit)	gpm (US)	1.201
bar	psi	14.5
psi	bar	0.0689
kilograms (kg)	pounds (mass) (lb)	2.205
pounds (mass) (lb)	kilograms (kg)	0.4536
newtons (N)	pounds (force) (lb)	0.2248
pounds (force) (lb)	newtons (N)	4.448
kilowatts (kW)	horsepower (hp)	1.341
horsepower (hp)	kilowatts (kW)	0.7457

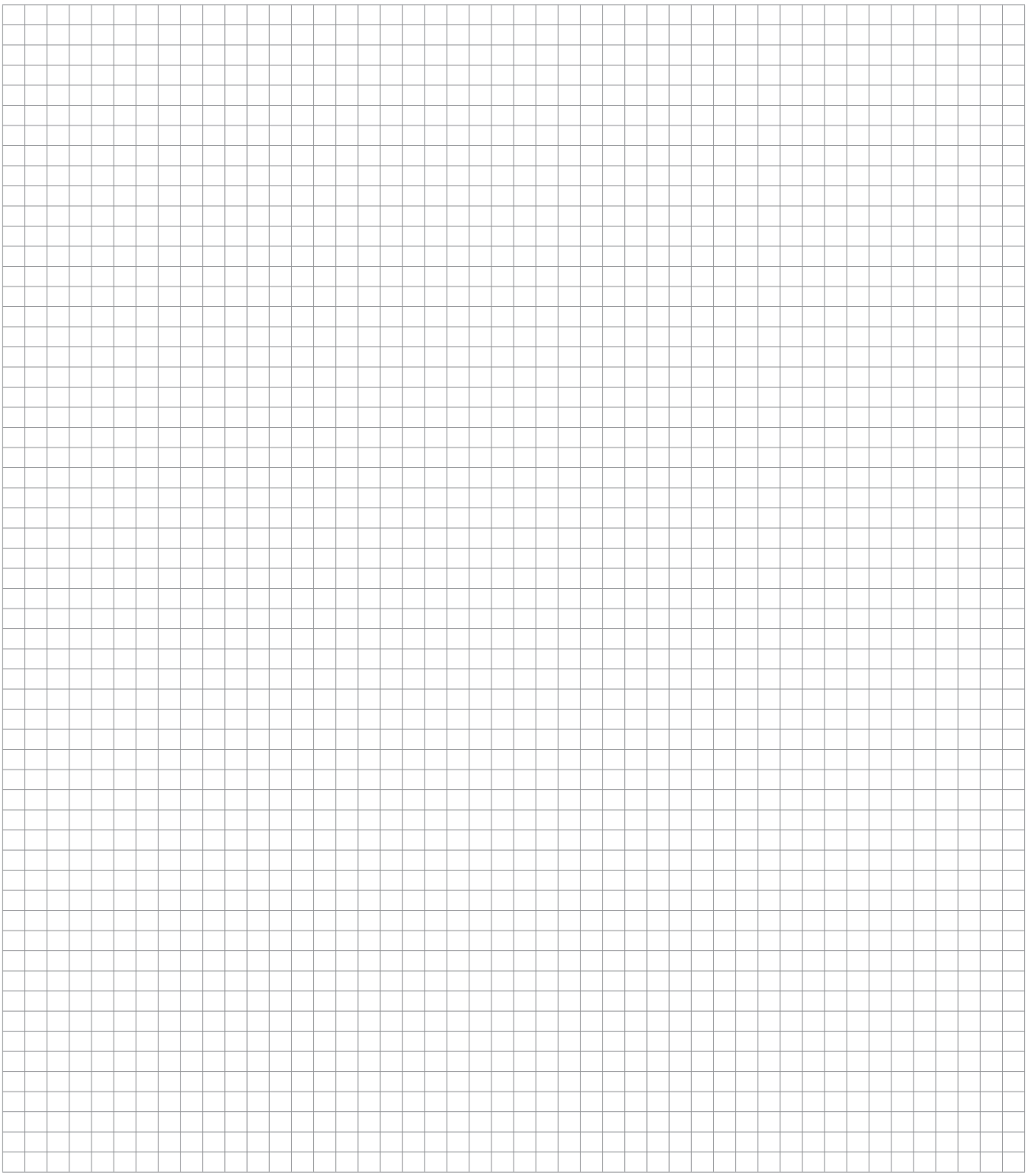
PRESSURE & FLOW EQUATIONS

Q = Flow in gpm	$Q = 29.92 \times d^2 \times P^{1/2} \times Cd$
V = Velocity in ft/sec	$V = 12.186 \times P^{1/2} = Cd \times .4085 \times Q/d^2$
P = Pressure in psi	$P = .00112 \times Q^2/(d^4 \times Cd^2)$
Hp = Horsepower	$Hp = .0174 \times d^2 \times P^{3/2} \times Cd, \approx P \times Q/1714$
Cv = Flow Coefficient	$Cv = Q/\Delta P^{1/2}, = 53 \times (D2.5/L^{1/2})$
ΔP = Pressure Drop	$\Delta P = (Q/Cv)^2$
F = Thrust in lb	$F = \Pi/2 \times d^2 \times P \times Cd, = .052 \times P^{1/2} \times Q, \approx .0018 \times (Q/D)^2 \times Cd$
ΔT = Temp Change ˚F	$\Delta T = \Delta P/337.6$

For all equations:

- L = Tube length in feet
- D = Tube ID in inches
- d = Orifice diameter in inches
- Cd = Discharge Coefficient
    - Cd = 0.90 for long cone orifice
    - Cd = 0.70 for drilled steel orifice
    - Cd = 0.65 for sapphire orifice

NOTES



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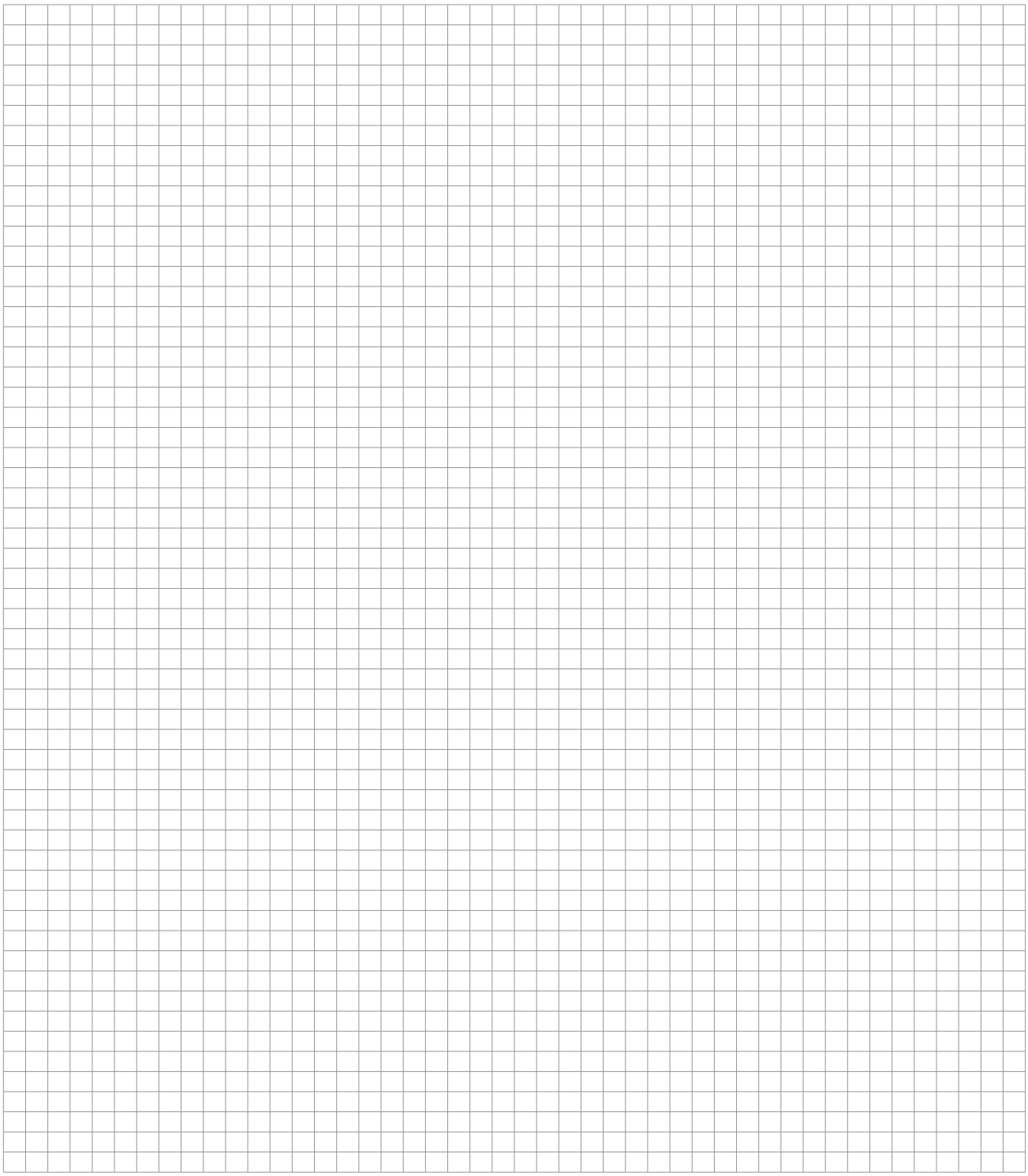

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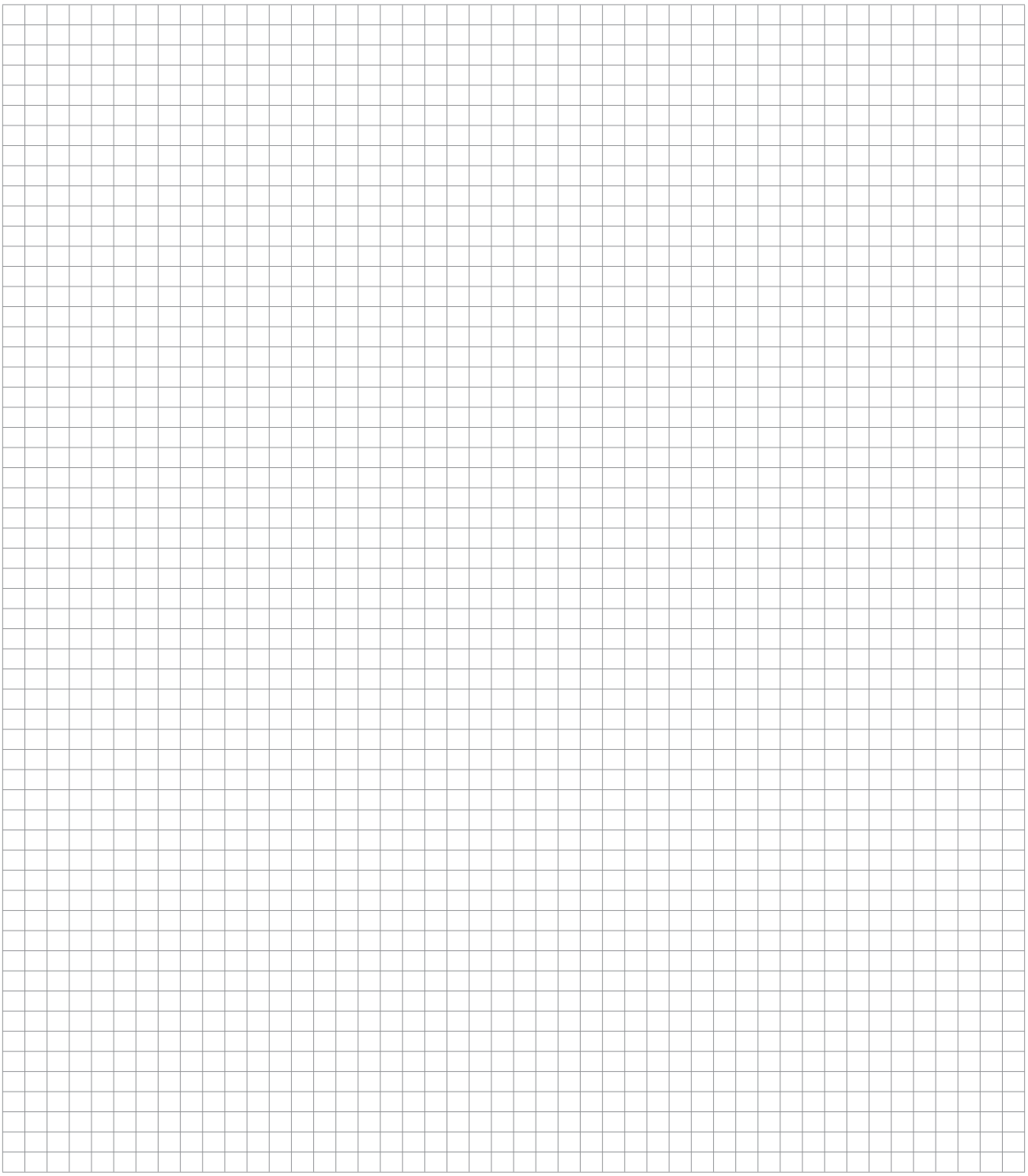

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