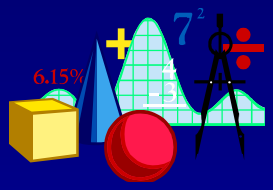
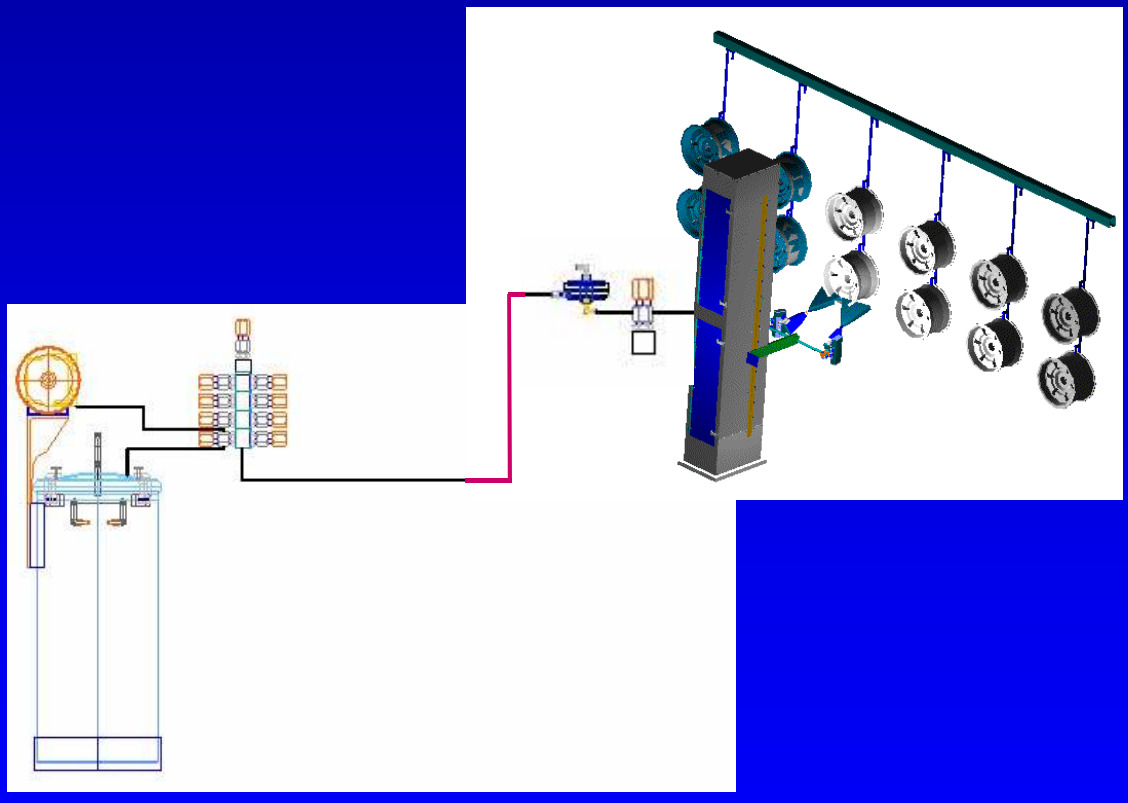
BNH MACHINES, INC.



Analyzing
Automatic Color Change



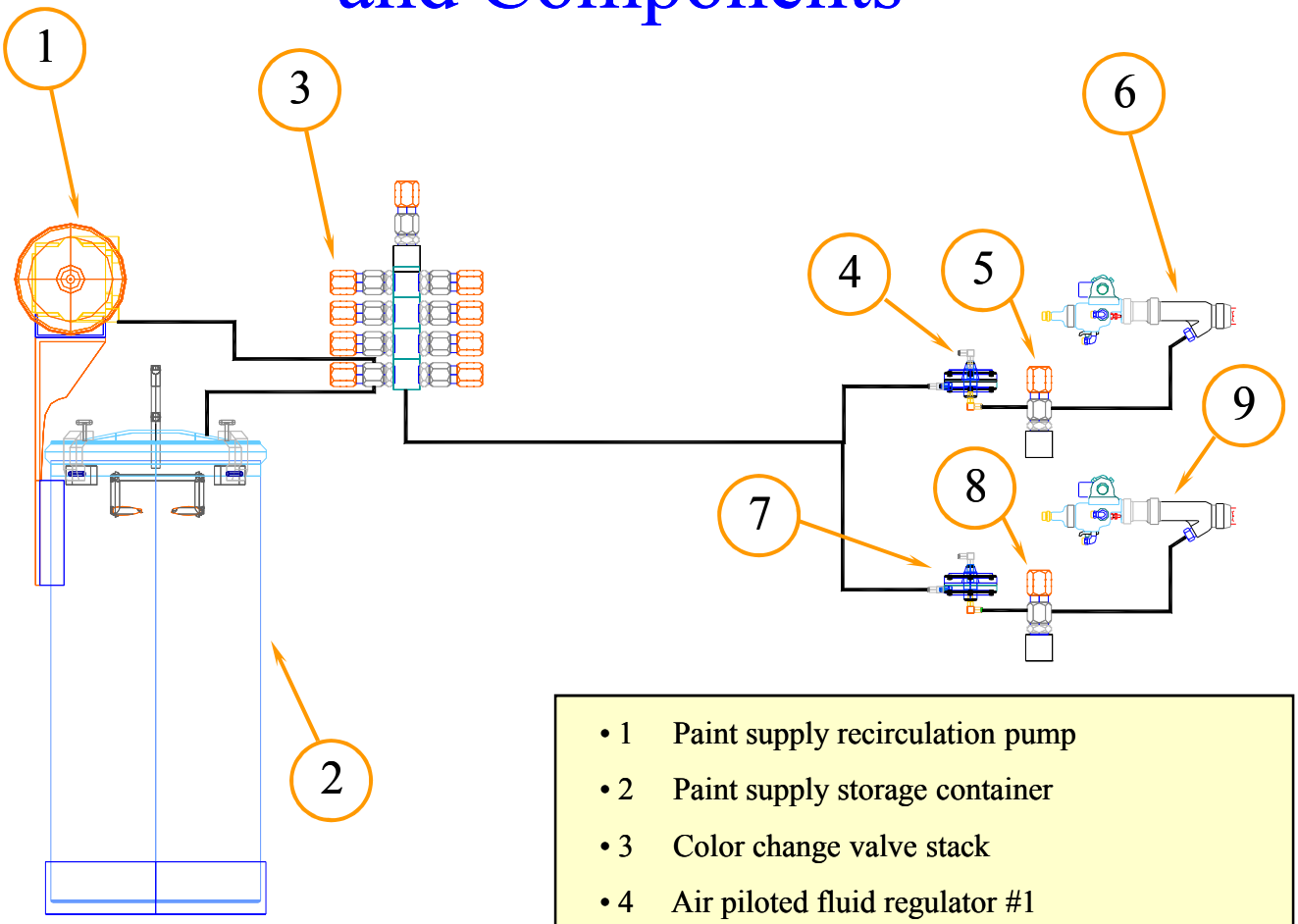
BNH

BNH MACHINES, INC.
413 Dale Avenue
Mancelona, Michigan 49659

Ph (231) 587-5322 **Fax (231) 587-8014**

Website BNHMACHINES.COM

Fluid Supply Circuit and Components



- 1 Paint supply recirculation pump
- 2 Paint supply storage container
- 3 Color change valve stack
- 4 Air piloted fluid regulator #1
- 5 Air piloted dump valve #1
- 6 Electrostatic air spray gun #1
- 7 Air piloted fluid regulator #2
- 8 Air piloted dump valve #2
- I Electrostatic air spray gun #2

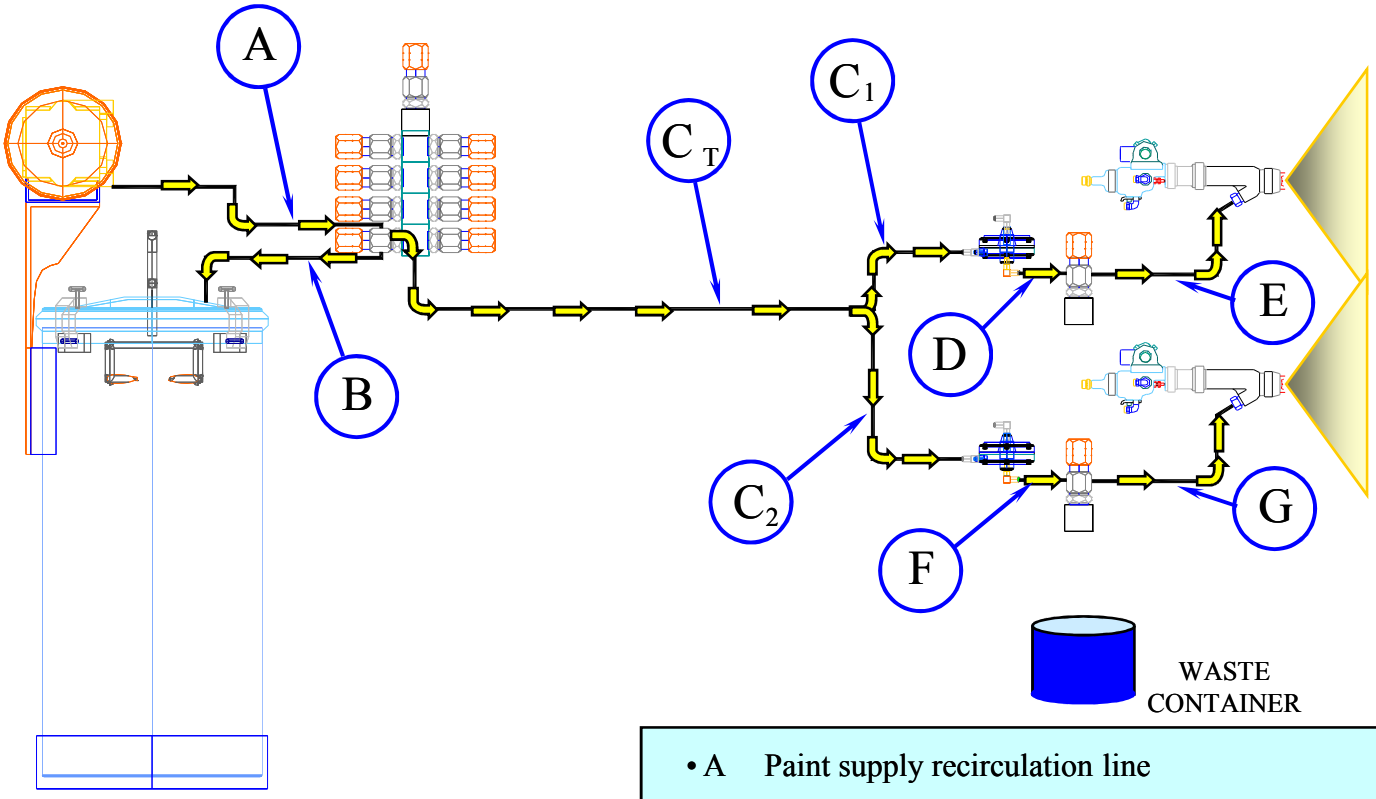
BNH MACHINES, INC.
413 Dale Avenue
Mancelona, Michigan 49659

Ph (231) 587-5322 **Fax (231) 587-8014**

Website BNHMACHINES.COM

Fluid Flow Diagram

(shown while spray gun is on)



- A Paint supply recirculation line
- B Paint return recirculation line
- C_T Paint supply to fluid regulator #1 and #2
- D Paint supply to dump valve #1
- E Paint supply to spray gun #1
- F Paint supply to dump valve #2
- G Paint supply to spray gun #2

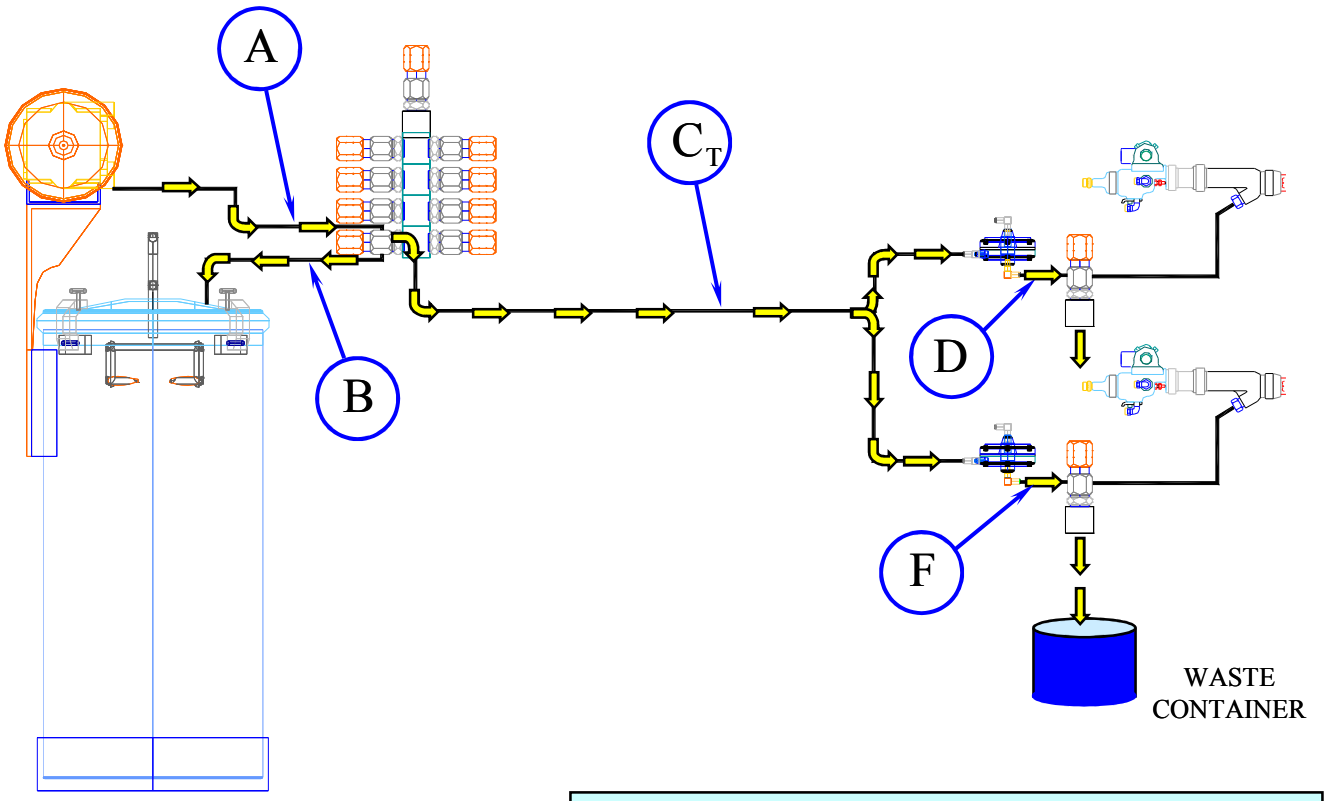
BNH MACHINES, INC.
413 Dale Avenue
Mancelona, Michigan 49659

Ph (231) 587-5322 Fax (231) 587-8014

Website BNHMACHINES.COM

Fluid Flow Diagram

(shown while dump valve is on)



- A Paint supply recirculation line
- B Paint return recirculation line
- C T Paint supply to fluid regulators
- D Paint supply to dump valve #1
- F Paint supply to dump valve #2

BNH MACHINES, INC.
413 Dale Avenue
Mancelona, Michigan 49659

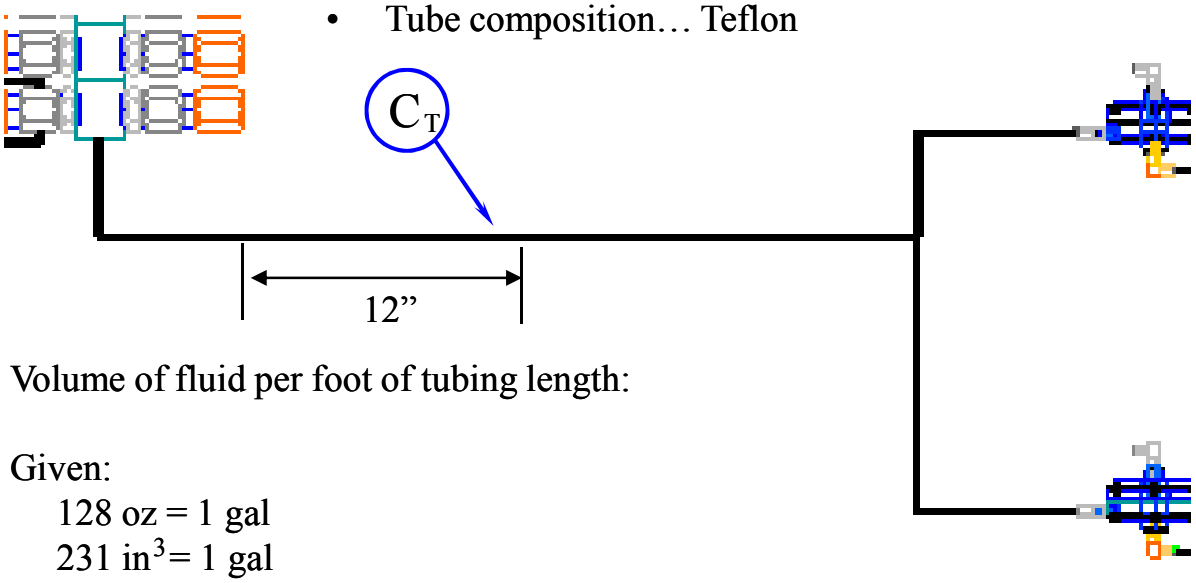
Ph (231) 587-5322 Fax (231) 587-8014

Website BNHMACHINES.COM

Paint Supply Line to Fluid Regulator Analysis

Existing Fluid line "C_T" specifications:

- .25" O.D.
- .1875 I.D.
- Tube composition… Teflon



Volume of fluid per foot of tubing length:

Given:

128 oz = 1 gal

231 in^3 = 1 gal

Tube I.D. = .1875 in

V = Volume of tube section 12" long in cubic inches per foot

L = Length of tube in inches

D = Tube inner diameter

$V = (D/2)^2 \times 3.141 \times L$

$V = (.1875/2)^2 \times 3.141 \times 12$

$V = .331\ in^3$ per foot of tubing

Therefore: One 12" section of tubing holds a volume of:
$.331\ in^3$ = .183 oz = .0014 gal = 5.42 cc

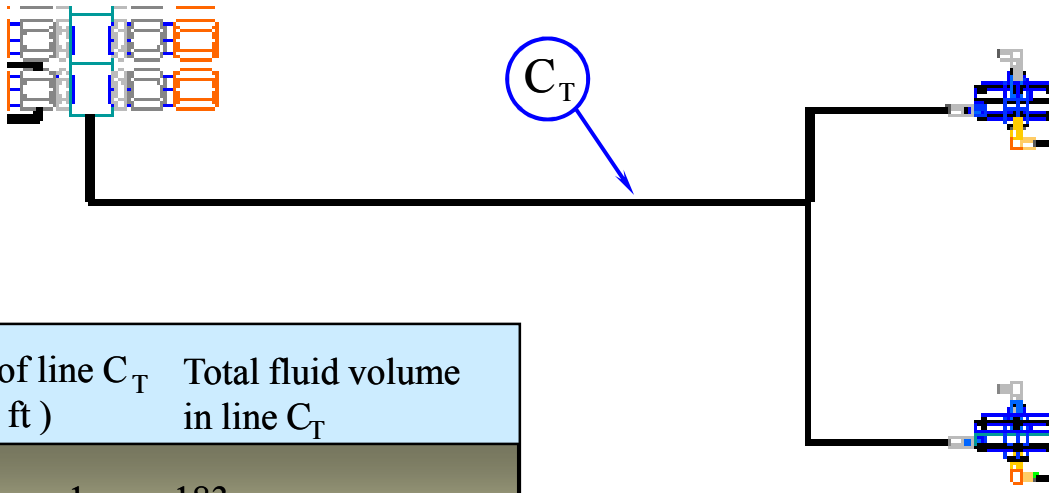
BNH MACHINES, INC.
413 Dale Avenue
Mancelona, Michigan 49659

Ph (231) 587-5322 Fax (231) 587-8014

Website BNHMACHINES.COM

Paint Supply Line to Fluid Regulator "C" Analysis (continued)

Total volume of lost paint in line " C_T" per color change based upon length of line " C_T" :



Length of line C_T in feet (ft)	Total fluid volume in line C_T
1	.183 oz
5	.915 oz
10	1.18 oz
15	2.74 oz
20	3.66 oz
25	4.57 oz
30	5.49 oz
35	6.40 oz

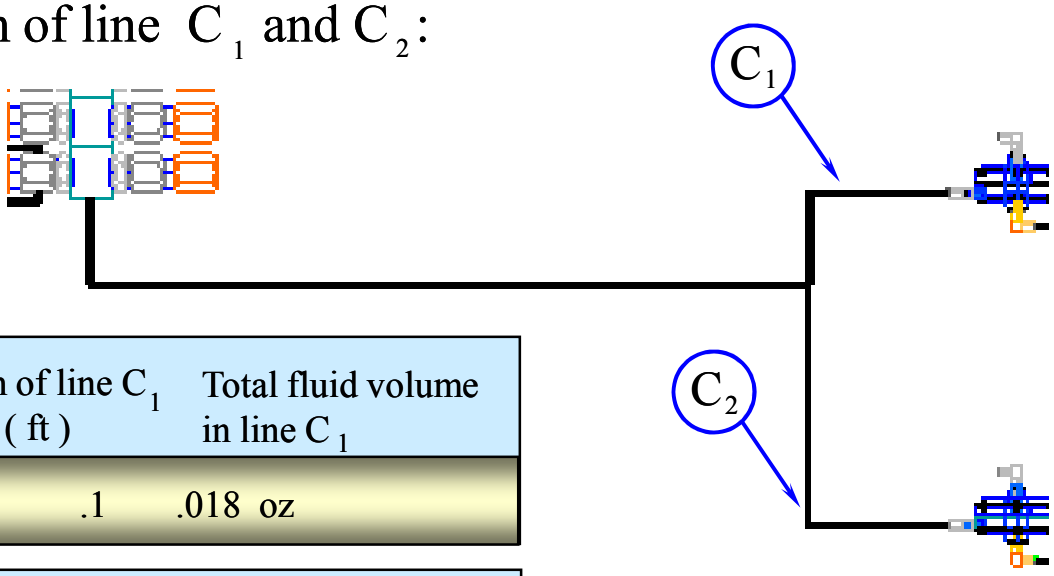
BNH MACHINES, INC.
413 Dale Avenue
Mancelona, Michigan 49659

Ph (231) 587-5322 Fax (231) 587-8014

Website BNHMACHINES.COM

Paint Supply Line to Fluid Regulator "C" Analysis (continued)

Total volume of lost paint in line per color change based upon length of line C_1 and C_2:



Length of line C_1 in feet (ft)	Total fluid volume in line C_1
.1	.018 oz

Length of line C_2 in feet (ft)	Total fluid volume in line C_2
.5	.091 oz

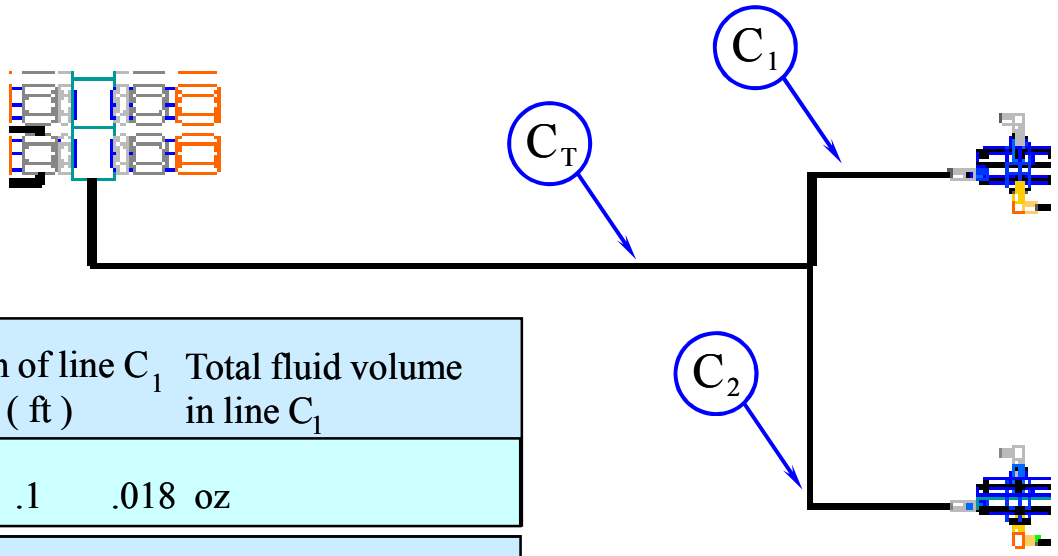
Base upon a single supply pump and line, on Machine #1 for Guns #1 and #2 the length of C_1 and C_2 has been minimized by mounting the regulators and dump valves on the gun bar.

BNH MACHINES, INC.
413 Dale Avenue
Mancelona, Michigan 49659

Ph (231) 587-5322 Fax (231) 587-8014

Website BNHMACHINES.COM

Total wasted paint with present system due to color change with supply line length of 35’



Length of line C_1 in feet (ft)	Total fluid volume in line C_1
.1	.018 oz

Length of line C_2 in feet (ft)	Total fluid volume in line C_2
.5	.091 oz

Length of line C_T in feet (ft)	Total fluid volume in line C_T
35	6.40 oz

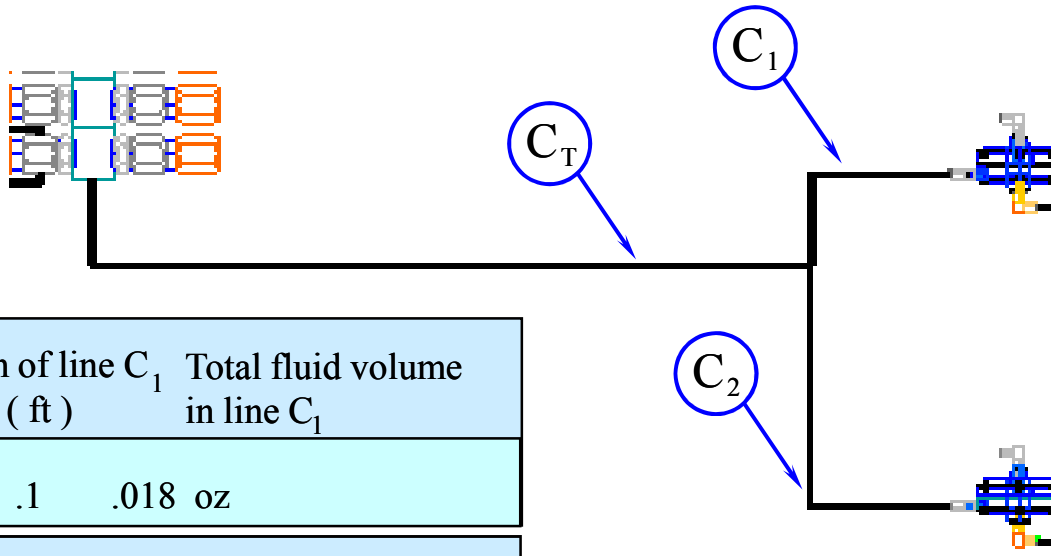
$$C_1 + C_2 + C_T = .018 + .091 + 6.40 = 6.51 \text{ oz}$$

BNH MACHINES, INC.
413 Dale Avenue
Mancelona, Michigan 49659

Ph (231) 587-5322 Fax (231) 587-8014

Website BNHMACHINES.COM

Total wasted paint with present system due to color change with supply line length of 15’



Length of line C_1 in feet (ft)	Total fluid volume in line C_1
.1	.018 oz

Length of line C_2 in feet (ft)	Total fluid volume in line C_2
.5	.091 oz

Length of line C_T in feet (ft)	Total fluid volume in line C_T
15	2.74 oz

$$C_1 + C_2 + C_T = .018 + .091 + 2.74 = 2.85 \text{ oz}$$

BNH MACHINES, INC.
413 Dale Avenue
Mancelona, Michigan 49659

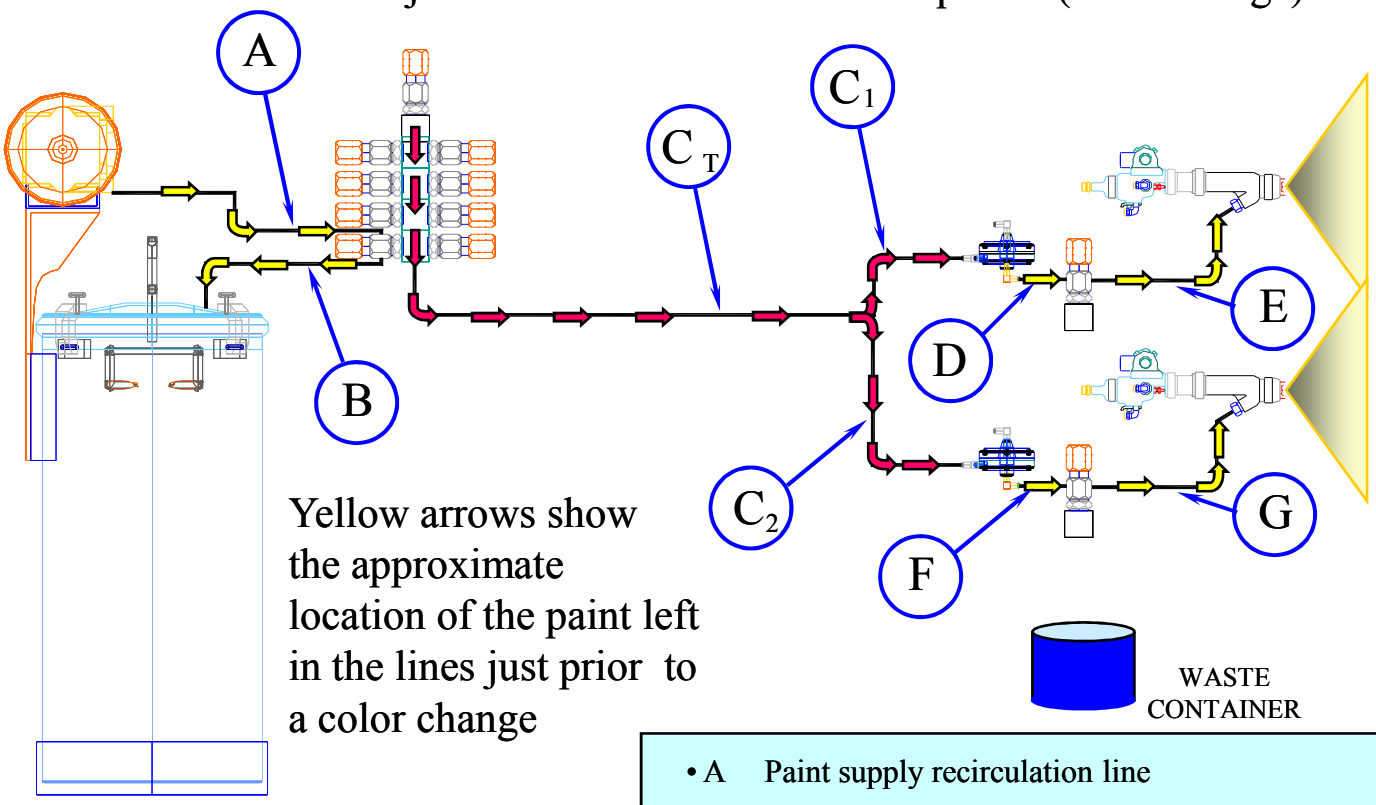
Ph (231) 587-5322 Fax (231) 587-8014

Website BNHMACHINES.COM

Analog Control with Soft Air Push

(shown while spray gun is on)

Red arrows show the location of the air or solvent push that occurs just before a flush and a fill sequence (color change)



Yellow arrows show the approximate location of the paint left in the lines just prior to a color change

- A Paint supply recirculation line
- B Paint return recirculation line
- C_T Paint supply to fluid regulator #1 and #2
- D Paint supply to dump valve #1
- E Paint supply to spray gun #1
- F Paint supply to dump valve #2
- G Paint supply to spray gun #2

BNH MACHINES, INC.
413 Dale Avenue
Mancelona, Michigan 49659

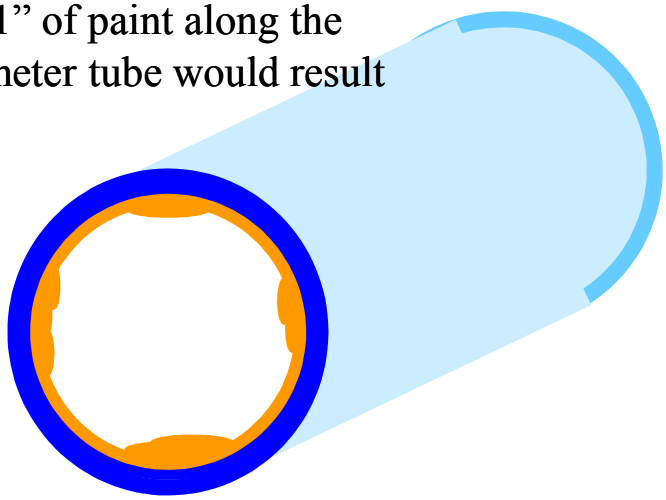
Ph (231) 587-5322 Fax (231) 587-8014

Website BNHMACHINES.COM

Waste due to paint line Skinning

During a soft air or solvent push most of the paint is used to spray the part. Due to the characteristics of most coatings a small amount of material clings to the inner walls of the paint tubing. We will provide an estimate for the paint loss due to this effect (skinning).

A complete skinning of 1 mil or .001" of paint along the inside surface of a .1875" inner diameter tube would result in a total volume of:



Volume of fluid per foot of tubing length:

Given:

128 oz = 1 gal
231 in = 1 gal
Tube I.D. = .1875 in

V = Volume of tube section 12" long in cubic inches per foot
L = Length of tube in inches
D = Tube inner diameter

$V = (D/2)^2 \times 3.141 \times L$

$V = (.1875/2)^2 \times 3.141 \times 12$
$V = .331\ in^3$ per foot of tubing

$V_s = (.1855/2)^2 \times 3.141 \times 12$
$V_s = .324\ in^3$ per foot of tubing

$$V - V_s = .331 - .324 = .007\ in^3/ft = .004\ oz/ft$$

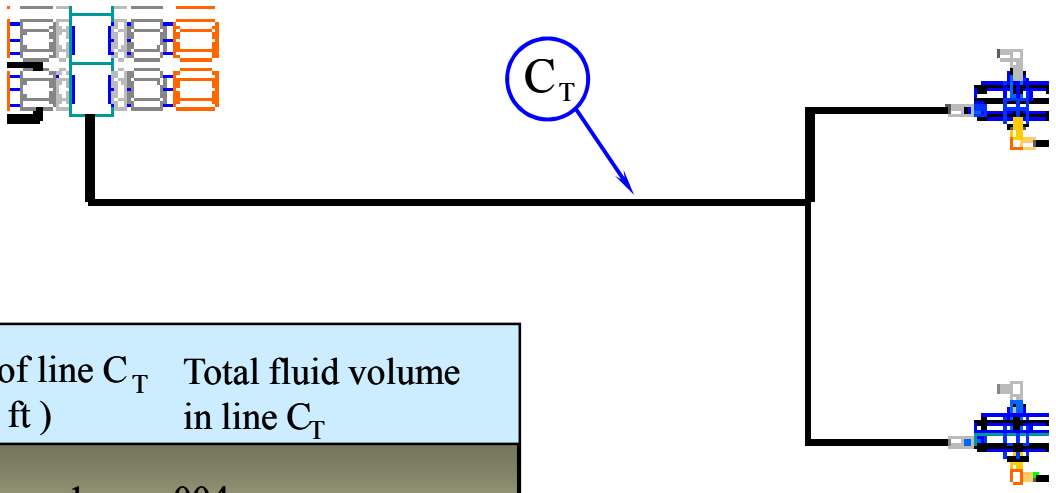
BNH MACHINES, INC.
413 Dale Avenue
Mancelona, Michigan 49659

Ph (231) 587-5322 Fax (231) 587-8014

Website BNHMACHINES.COM

Waste due to paint line Skinning (continued)

Total volume of lost paint in line " C_T " per color change based upon length of line " C_T " due to skinning :



Length of line C_T in feet (ft)	Total fluid volume in line C_T
1	.004 oz
5	.020 oz
10	.040 oz
15	.060 oz
20	.080 oz
25	.100 oz
30	.120 oz
35	.140 oz

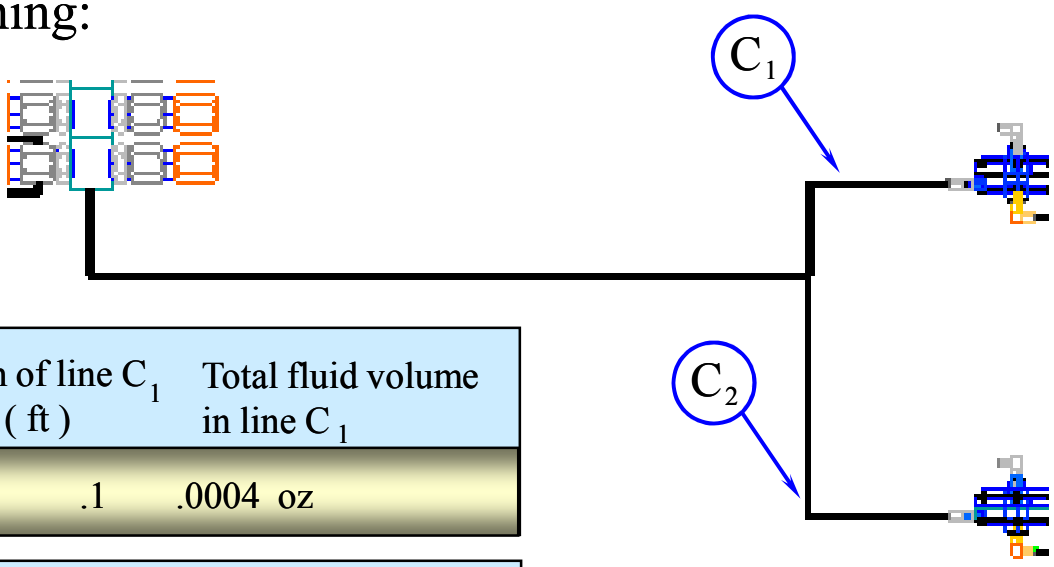
BNH MACHINES, INC.
413 Dale Avenue
Mancelona, Michigan 49659

Ph (231) 587-5322 Fax (231) 587-8014

Website BNHMACHINES.COM

Waste due to paint line Skinning (continued)

Total volume of lost paint in line per color change based upon length of line C_1 and C_2 due to skinning:



Length of line C_1 in feet (ft)	Total fluid volume in line C_1
.1	.0004 oz

Length of line C_2 in feet (ft)	Total fluid volume in line C_2
.5	.002 oz

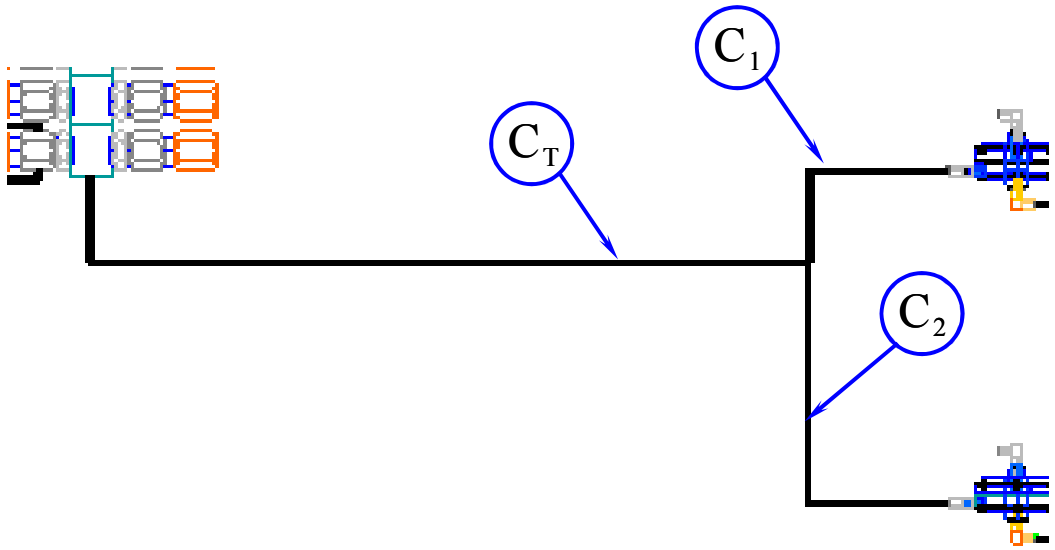
Base upon a single supply pump and line, on Machine #1 for Guns #1 and #2 the length of C_1 and C_2 has been minimized by mounting the regulators and dump valves on the gun bar.

BNH MACHINES, INC.
413 Dale Avenue
Mancelona, Michigan 49659

Ph (231) 587-5322 Fax (231) 587-8014

Website BNHMACHINES.COM

Total wasted paint during color change with supply line length of 35’ and 15’ compared to Soft Air Push



Length of line $C_T + C_1 + C_2$	Total fluid volume lost without push	Total fluid volume lost with push
35.6 ft	6.51 oz	.142 oz

Length of line $C_T + C_1 + C_2$	Total fluid volume lost without push	Total fluid volume lost with push
15.6 ft	2.85 oz	.062 oz

BNH MACHINES, INC.
413 Dale Avenue
Mancelona, Michigan 49659

Ph (231) 587-5322 Fax (231) 587-8014

Website BNHMACHINES.COM

Conclusions

By implementing Soft Air Push on 35.6' long paint supply line C a paint **savings** of **6.36 oz** could be achieved on each color change per machine.

By shortening the supply line C from 35.6' to 15.6' a paint **savings** of **3.66 oz** per color change could be achieved on each color change per machine.

By shortening the supply line C from 35' to 15' and implementing Soft Air Push a paint **savings** of **6.45 oz** could be achieved on each color change per machine.

Soft air push on a 35.6' line saves almost twice as much paint per color change over shortening the paint supply line from 15.6' to 35.6'alone.

BNH MACHINES, INC.
413 Dale Avenue
Mancelona, Michigan 49659

Ph (231) 587-5322 **Fax (231) 587-8014**

Website BNHMACHINES.COM

Units and Conversions

To convert from	To	Multiply by:
Cubic centimeters	Cubic inches	.06102
Cubic centimeters	Fluid ounces	.033814
Cubic centimeters	Gallons	.0002642
Cubic inches	Cubic centimeters	16.387
Cubic inches	Fluid ounces	.554
Cubic inches	Gallons	.004329
Fluid ounces	Cubic centimeters	29.5735
Fluid ounces	Cubic inches	1.804
Fluid ounces	Gallons	.0078125
Gallons	Cubic centimeters	3785.43
Gallons	Cubic inches	231
Gallons	Fluid ounces	128

BNH

BNH MACHINES, INC.
413 Dale Avenue
Mancelona, Michigan 49659

Ph (231) 587-5322 **Fax (231) 587-8014**

Website BNHMACHINES.COM