Musings on Capture Velocity

A Pump Jockey's Perilous Journey

October 3, 2019

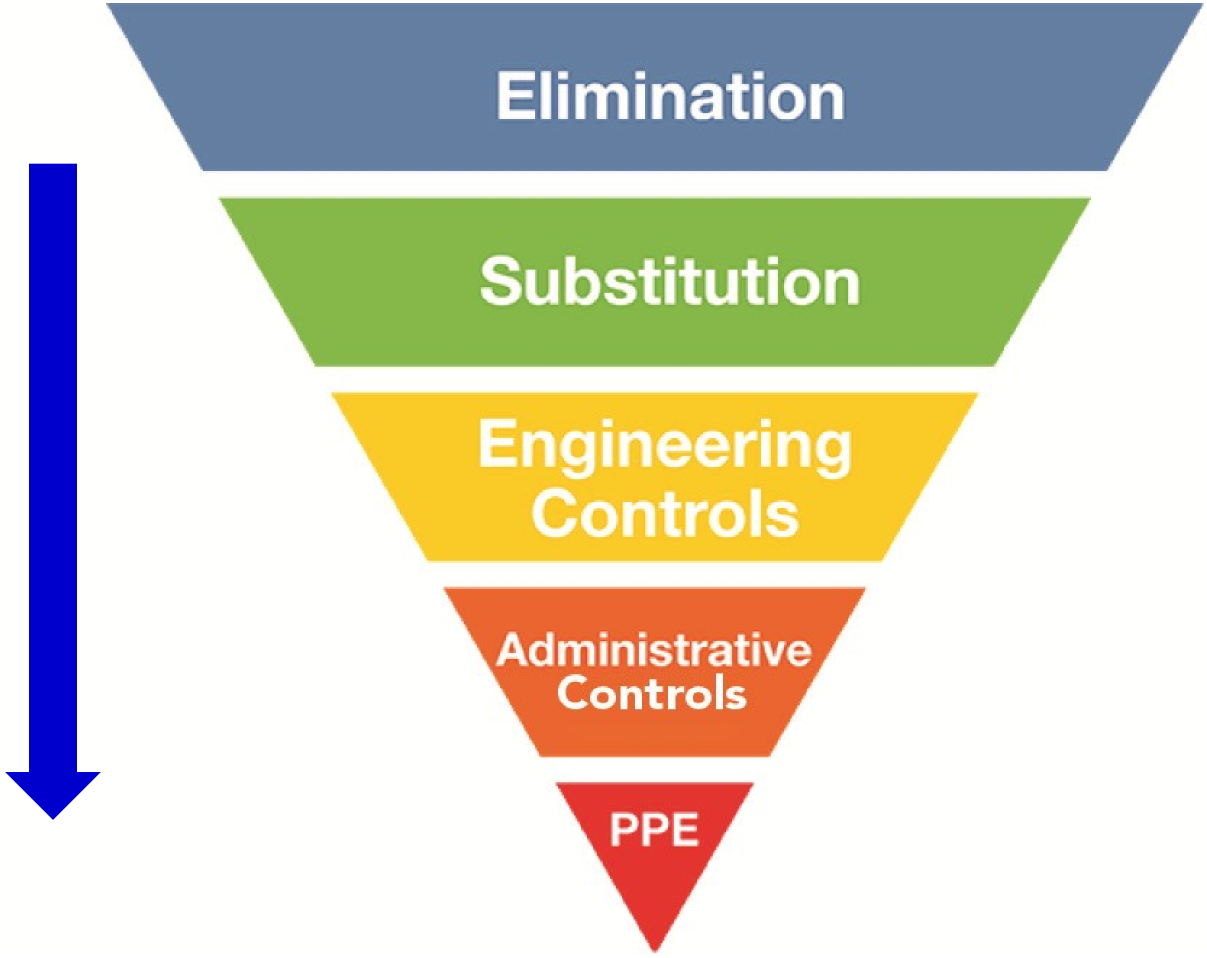
Connecticut River Valley Section, AIHA

Rick Supples, Applied Improvement Technologies

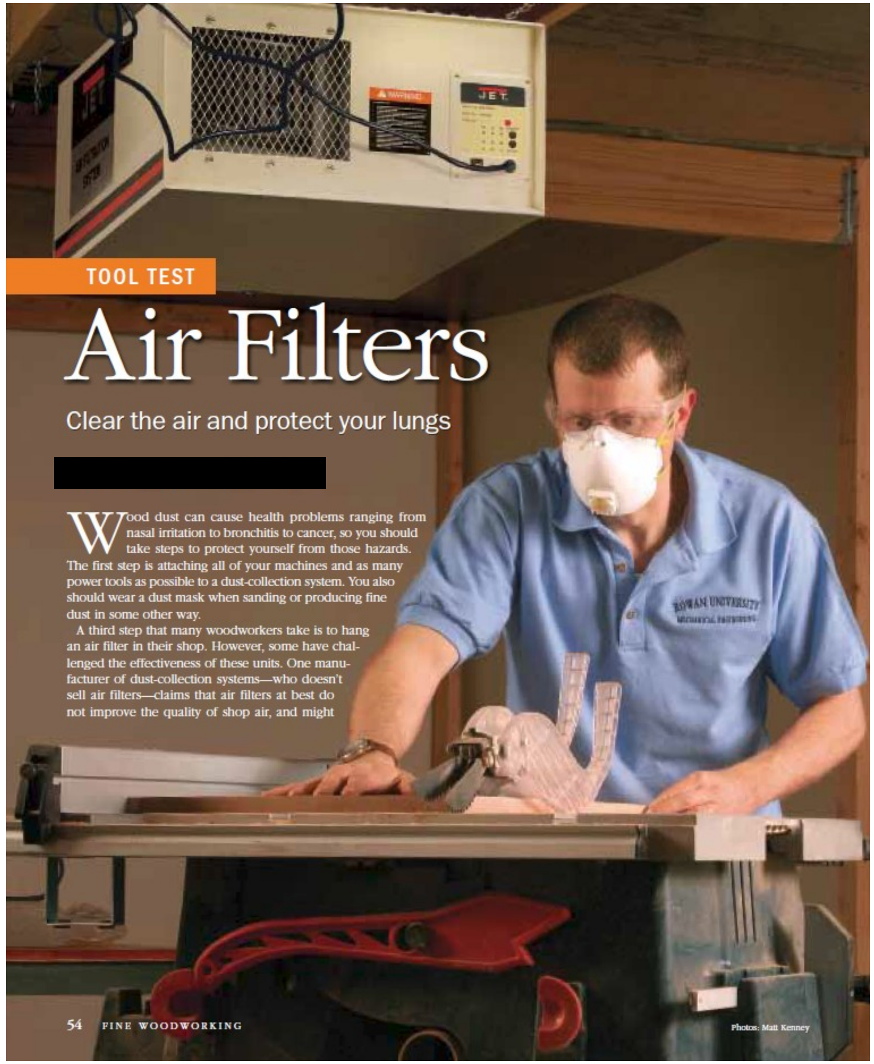
Overview

- ESEAP
- Good Intentions…Poor Results
- Scenario
- Capture Velocity – Working Definition
- Collecting Field Measurements
- ACGIH Capture Velocity Guidelines
- Capture Velocity – Hands-on calculations
- Making System Improvements
- Q&A

Hierarchy of Controls



Good Intentions… Not So Good Consequences



TOOL TEST

Air Filters

Clear the air and protect your lungs

[redacted]

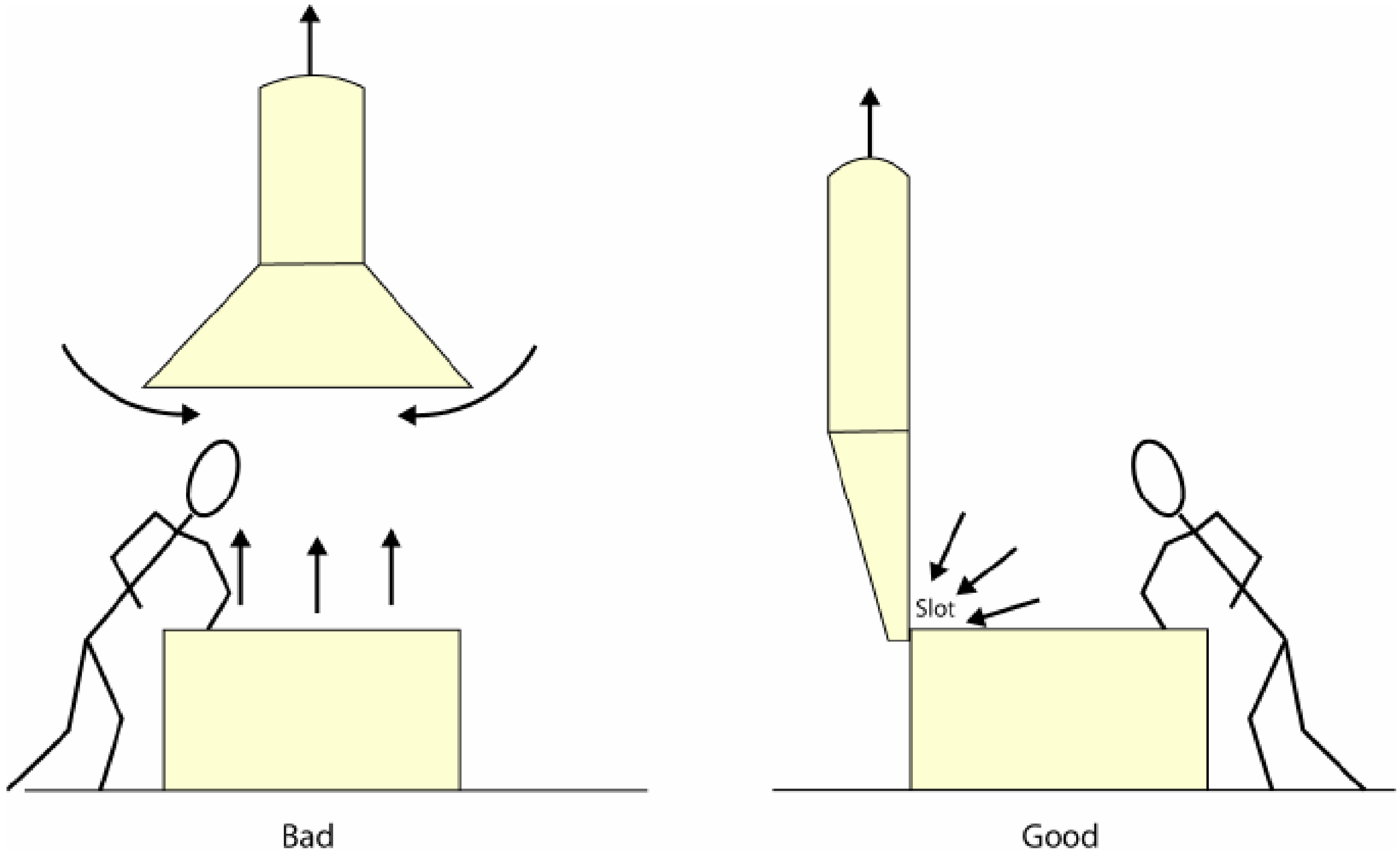
Wood dust can cause health problems ranging from nasal irritation to bronchitis to cancer, so you should take steps to protect yourself from those hazards. The first step is attaching all of your machines and as many power tools as possible to a dust-collection system. You also should wear a dust mask when sanding or producing fine dust in some other way.

A third step that many woodworkers take is to hang an air filter in their shop. However, some have challenged the effectiveness of these units. One manufacturer of dust-collection systems—who doesn't sell air filters—claims that air filters at best do not improve the quality of shop air, and might

54 FINE WOODWORKING

Photos: Matt Kenney

Rick Supples, Applied Improvement Technologies



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Scenario

Employee is applying special coating per military specification using HVLP spray gun on workbench with rear draft multi-slotted hood. Fixture is vibrated to distribute compound to all surfaces of part.

Sample results = 1.5x's over the TLV.

Capture velocity (V_c) measured at point of generation (~19 in) = 80 fpm

Required V_c = 150 fpm

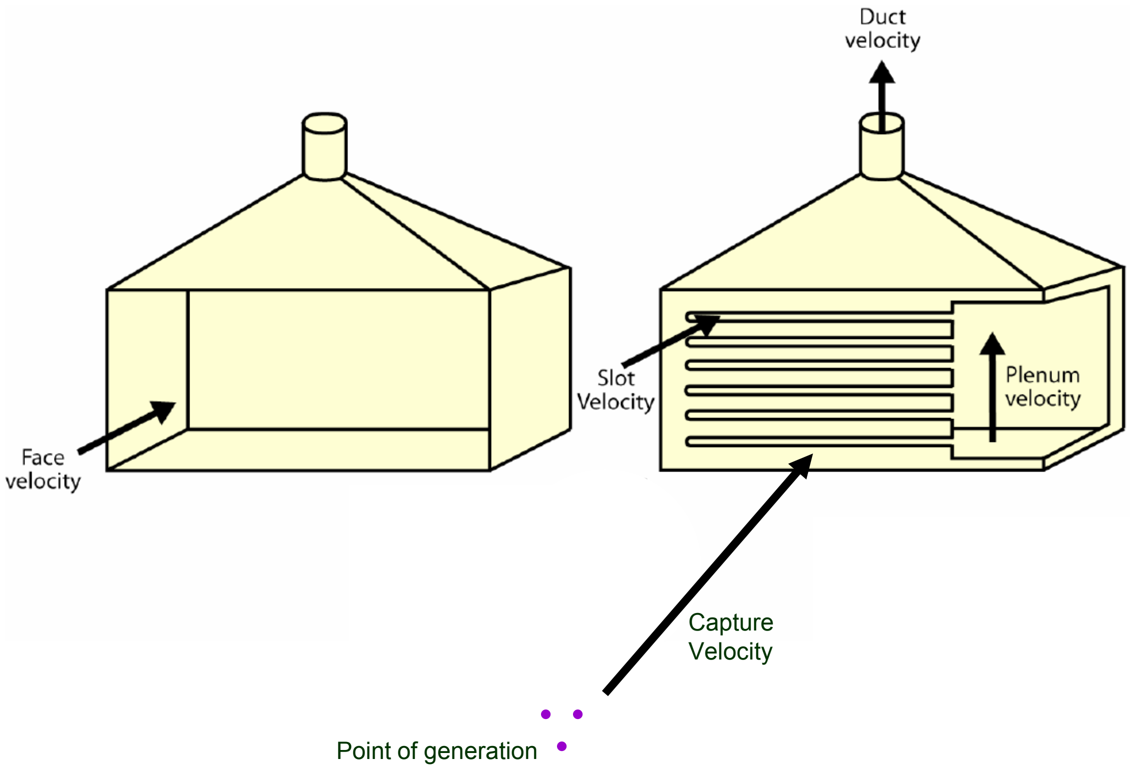

IVT Engineering
NOTICE

Capture Velocity

Air velocity at any point in front of the hood necessary to overcome opposing air currents and to capture the contaminant at point of generation causing it to flow into the hood

Entrainment

Velocity Comes in Different Flavors



Capture Velocity Field Measurements

1. Preferred Method: At point of generation (Qualitative & Quantitative)

2. Model capture velocity – we'll revisit later

Capture Velocity Guidelines

Condition of Dispersion of Contaminant	Examples	Capture Velocity, fpm
A. Released with practically no velocity into quiet air.	Evaporation from tanks, degreasing, etc.	50 - 100
B. Released at low velocity into moderately still air.	Spray booths; intermittent container filling; low speed conveyor transfers; welding; plating; pickling	100 - 200
C. Active generation into zone of rapid air motion.	Spray painting in shallow booths; barrel filling; conveyor loading; crushers	200 - 500
D. Released at high initial velocity into zone of very rapid air motion.	Grinding; abrasive blasting, tumbling	500 - 2000

In each category above, a range of capture velocity is shown. The proper choice of values depends on several factors:

Lower End of Range

1. Room air currents minimal or favorable to capture
2. Contaminants of low toxicity or nuisance value only
3. Intermittent, low production.
4. Large hood--large air mass in motion

Upper End of Range

1. Disturbing room air currents
2. Contaminants of high toxicity
3. High production, heavy use
4. Small hood--local control only

Inhalables – Particle à la mode

Competitors for Capture Velocity

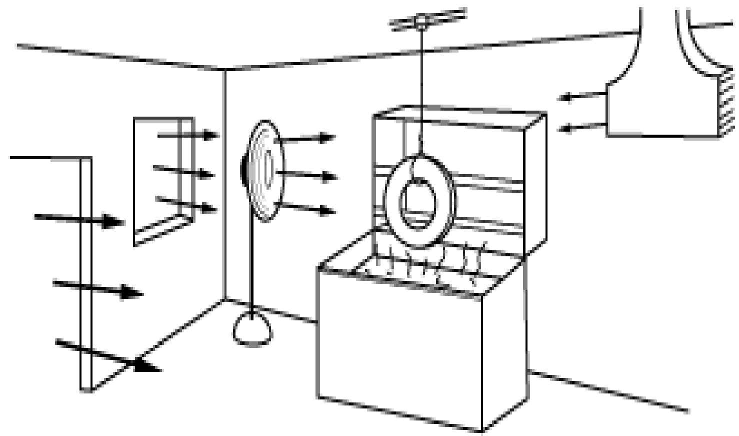
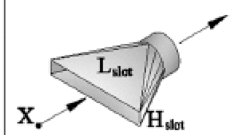
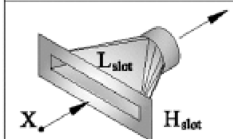
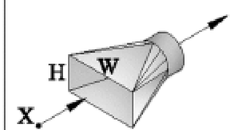
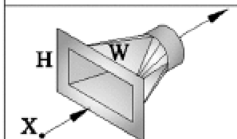
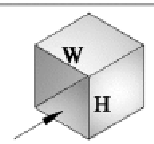
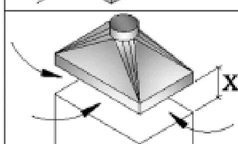
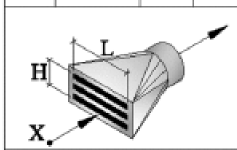
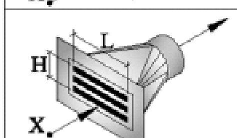
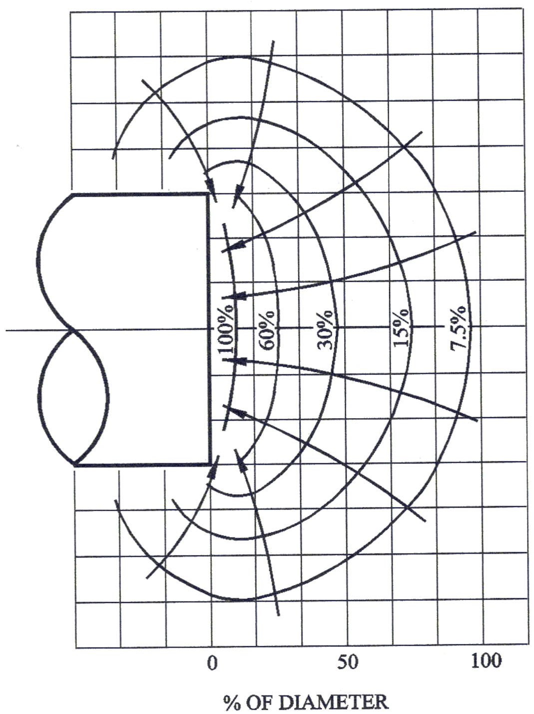
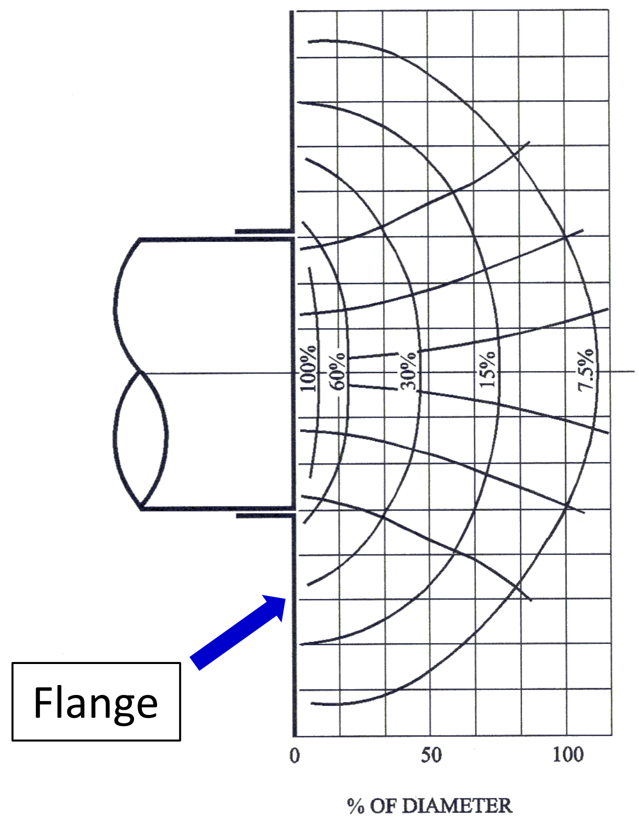


TABLE 6-3. Summary of Hood Airflow Equations

HOOD TYPE	DESCRIPTION	ASPECT RATIO, H/L	AIRFLOW
	Slot	0.2 or less	$Q = 3.7\ LV_xX$
	Flanged slot	0.2 or less	$Q = 2.6\ LV_xX$
	Plain opening	0.2 or greater and round	$Q = V_x(10X^2 + A_f)$ $A_f = WH$
	Flanged opening $W_f \geq \sqrt{A_f}$	0.2 or greater and round	$Q = 0.75V_X(10X^2 + A_f)$ $A_f = WH$
	Booth	To suit work	$Q = VA = V_fWH$
	Canopy	To suit work	$Q = 1.4\ PVX$ P = Perimeter of work or tank X = Height above work
	Plain multiple slot opening (2) or more slots	0.2 or greater	$Q = V_X(10X^2 + A_s)$ $A_s = HL$
	Flanged multiple slot opening (2) or more slots	0.2 or greater	$Q = 0.75V_X(10X^2 + A_s)$ $A_s = HL$

Effects of Flanging





With permission from ACGIH

Field Measurement Method #2

Model V_0

1. Measure duct velocity = 3000 fpm (6” diameter duct)
2. Measure hood face area A = (L X W) or $\frac{\pi d^2}{4}$
3. Q= AV, solve for Q

Example

V = 3000 fpm duct velocity, $A = \frac{\pi (6''/12'')^2}{4} = 0.196\ ft^2$

Q = 588 cfm

For Plain Opening Hood

$$Q = V\,(10X^2 + A)$$

From Vent. Manual
Plain Opening

$$V = \frac{Q}{10X^2 + A}$$

$$V = \frac{588\ ft^3/min}{10(1\ ft)^2 + 0.196\ ft^2}$$

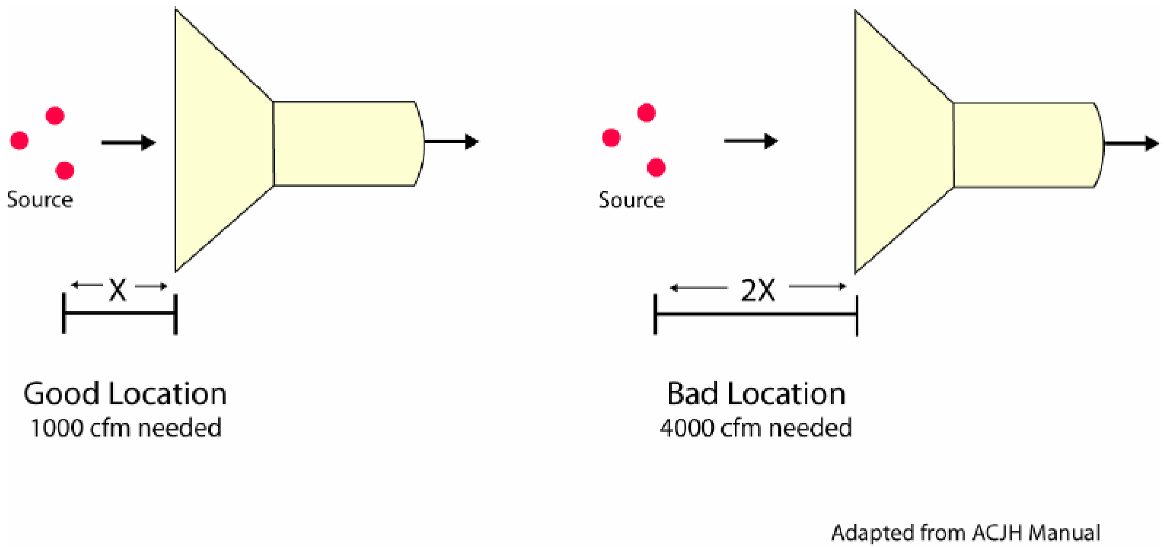
$$V = 58\ fpm$$

X is Sensitive to Change

$$Q = V(10X^2 + A)$$

$$Q = \boxed{}\, X^2 \,\boxed{}$$

X is Sensitive to Change



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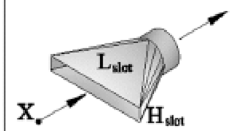
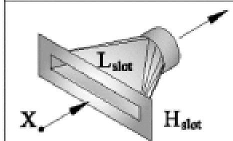
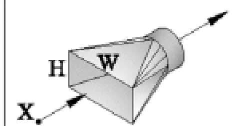
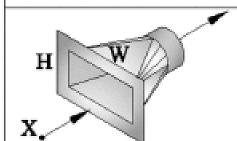
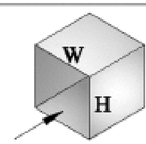
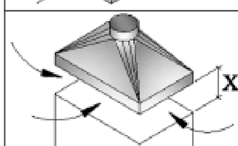
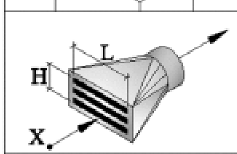
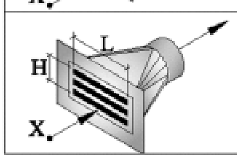
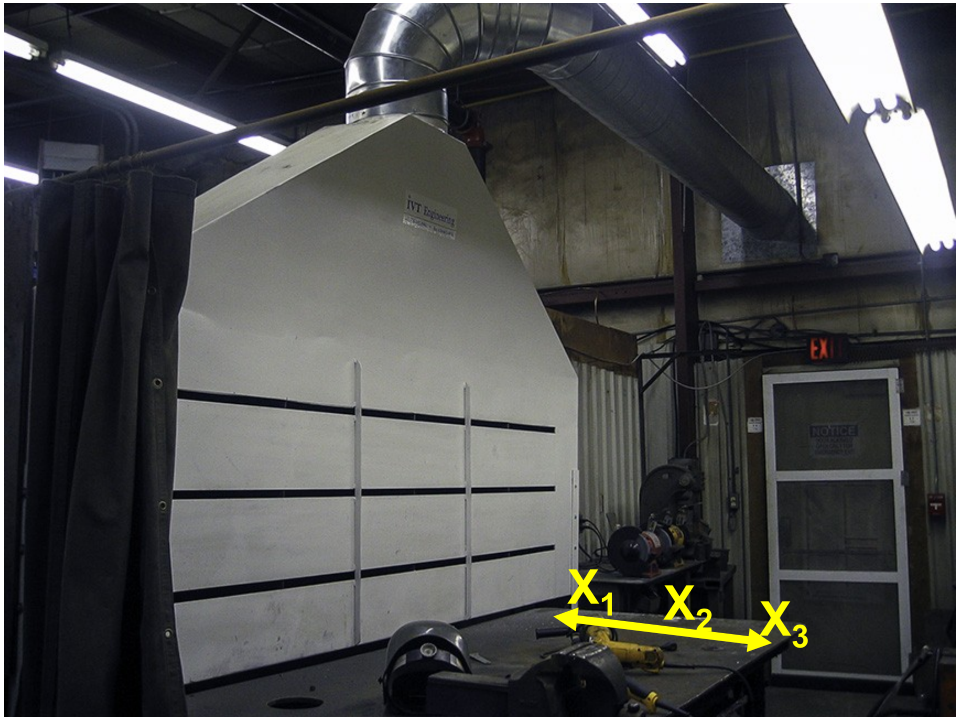
	Slot	0.2 or less	$Q = 3.7\ LV_xX$
	Flanged slot	0.2 or less	$Q = 2.6\ LV_xX$
	Plain opening	0.2 or greater and round	$Q = V_x(10X^2 + A_f)$ $A_f = WH$
	Flanged opening $W_f \geq \sqrt{A_f}$	0.2 or greater and round	$Q = 0.75V_X(10X^2 + A_f)$ $A_f = WH$
	Booth	To suit work	$Q = VA = V_fWH$
	Canopy	To suit work	$Q = 1.4\ PVX$ P = Perimeter of work or tank X = Height above work
	Plain multiple slot opening (2) or more slots	0.2 or greater	$Q = V_X(10X^2 + A_s)$ $A_s = HL$
	Flanged multiple slot opening (2) or more slots	0.2 or greater	$Q = 0.75V_X(10X^2 + A_s)$ $A_s = HL$

Calculations are nice but….

in the field, just where exactly is X?



Making System Improvements

1. Flanges → 3-sided enclosure

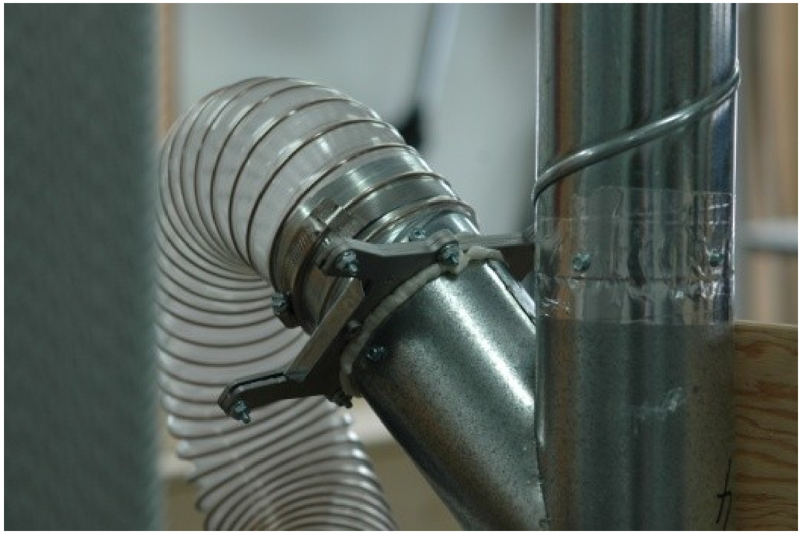
Making System Improvements

1. Flanges → 3-sided enclosure → 4-sided enclosure

Making System Improvements

2. Put all LEV on a PM

3. Check blast gates are open



4. Flex duct hose? Check excessive bending, increases turbulence, SP loss

Making System Improvements

5. Dust Collection System? - Filters could be clogged, fan starves air - i.e. Machining parts – Torit clogs quickly

6. Post PM dip in performance? - check with HVAC if fan in reverse or fan belt slipping

Making System Improvements

7. Install air venturi in ductwork – can be effective for some applications - not all.

8. Increase Q – is adjustable pulley on fan? If no then bigger fan = $

<u>Place accountability on your HVAC contractor for V_c performance!</u>

LEV SPECIFICATION

System will supply a minimum capture velocity of

[   ] fpm at [   ] inches centerline distance

from front of hood face.

Musings on Capture Velocity

Thank You