STUDIO DESIGN CHALLENGES:

CREATING A SAFE AND PRACTICAL SPACE

MAY 14, 2015

AIC

This slideshow was originally presented by architects and engineers from EwingCole's Cultural Practice at the Health & Safety Committee/Conservators in Private Practice Lunchtime Lecture at the American Institute for Conservation's 43nd Annual Meeting on May 14th, 2015.

STATEMENT OF PROBLEM

ACCESS TO COLLECTIONS VS. PRESERVATION

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ACCESS TO COLLECTIONS VS. PRESERVATION

OVERVIEW

1. IDENTIFY HAZARDS
2. SUGGEST DESIGN SOLUTIONS FOR HOME STUDIOS
   - ADJACENCIES
   - CHEMICAL STORAGE
   - FIRE PROTECTION
   - CONVERSATION GROUP 1
   - VENTILATION
   - CONVERSATION GROUP 2
3. ROUNTABLE DISCUSSION

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HAZARDS

Waller - Risk Management Approach: Collection preservation issues involve four basic steps:

1. Identifying all risks to collections,
2. Assessing the magnitude of each risk,
3. Identifying possible mitigation strategies, and
4. Evaluating the costs and benefits associated with each strategy.

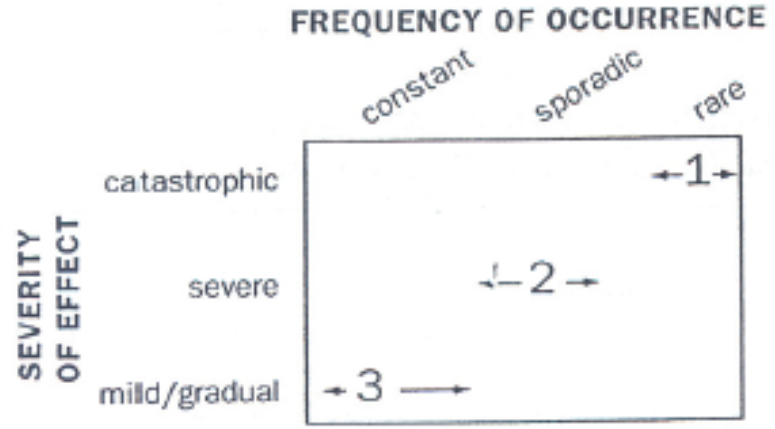


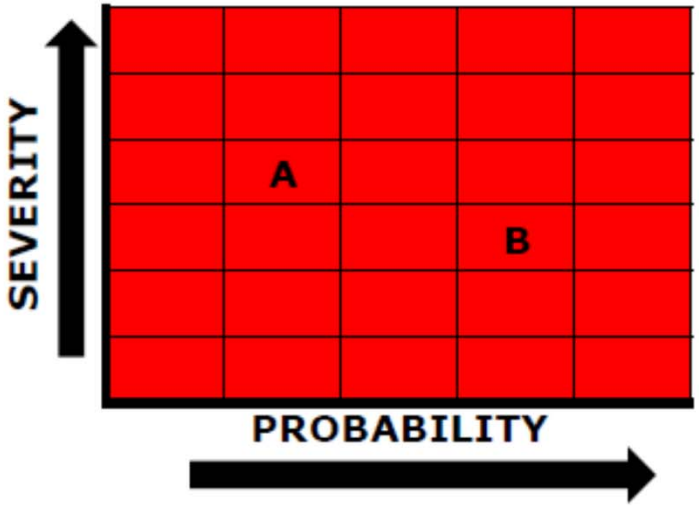
Figure I. The ranges of frequency and severity of the types of risk(1, 2, and 3).

Table 2. Calculation of magnitude of risk and severity.

Magnitude of Risk	=	*Probability (or extent)*	x	*Severity*			
				(Severity	=	*Fraction susceptible*	x *Loss in value)*
Magnitude of Risk	=	*Probability (or extent)*	x	*Fraction susceptible*	x	*Loss in value*	

HAZARDS		Likelihood of Occurrence (1-5)	multiplied by	Severity of Damage (1-5)	equals	Risk Rating	Comments
3.	**INTERIOR**						
3a.	attack or infestation by wildlife (rodents, bats, or birds) or insects		X		**equals**	0	
3b.	chemical spill		X		**equals**	0	
3c.	collections storage shelf failure		X		**equals**	0	

Likelihood of Occurrence	Severity of Damage	Risk Rating	Comments
1 = Not likely **2** = Possible **3** = Quite possible **4** = Likely **5** = Very likely	**1** = No damage **2** = Slight (minor damage requiring in-house clean-up or repair; operations continue to function; small monetary investment) **3** = Moderate (damage requiring extra labor; operations may need to be suspended; moderate monetary investment to return to regular operations) **4** = Severe (damage requiring outside services and vendors; temporary suspension of operations; signficant monetary investment) **5** = Very severe (damage resulting in total loss; indefinite closure of institution)	Higher the number, higher the risk Ratings of **16-25** will fill with red Ratings of **6-15** will fill with yellow Ratings of **1-5** will fill with green	Note information about previous occurrences, response times, or additional insights.



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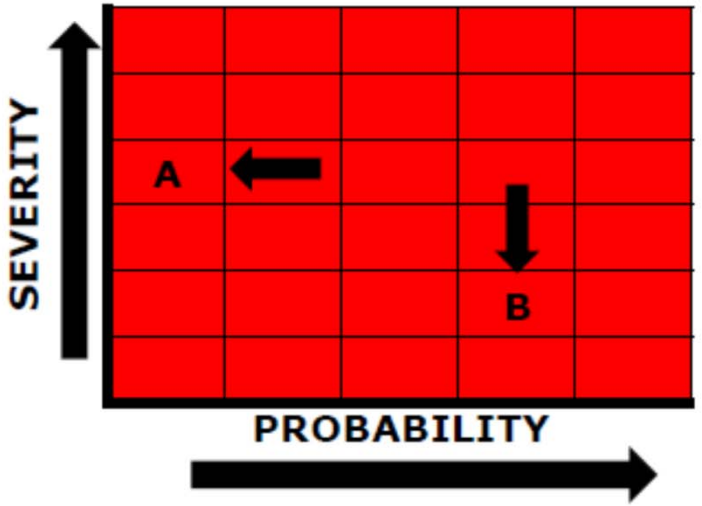

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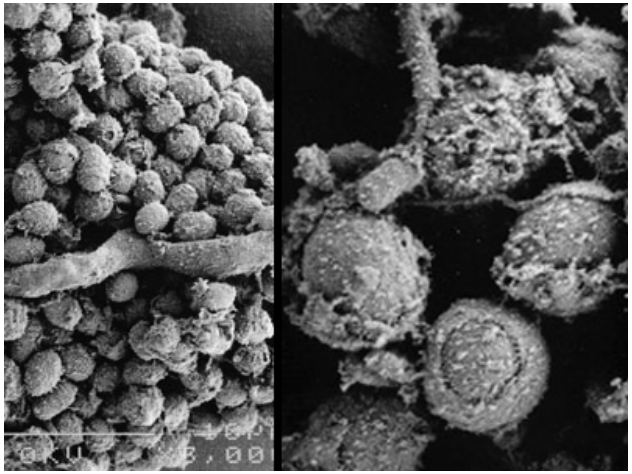

Biologicals
mold spores

Particulates
asbestos

Chemicals
holy moly


FLAMMABLE LIQUID
3
UN CLASS 3

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HAZARDS

INCOMPATIBLES

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HAZARDS

INCOMPATIBLES


HAZARDOUS MATERIALS CLASSIFICATION
HEALTH HAZARD
4-Deadly
3-Extreme danger
2-Hazardous
1-Slightly hazardous
0-Normal material
FIRE HAZARD
Flash Points
4-Below 73 F
3-Below 100 F
2-Below 200 F
1-Above 200 F
0-Will not burn
3
2
1
W
SPECIFIC HAZARD
Oxidizer OXY
Acid ACID
Alkali ALK
Corrosive COR
Use NO WATER W
Radiation Hazard
INSTABILITY
4-May detonate
3-Shock and heat may detonate
2-Violent chemical change
1-Unstable if heated
0-Stable

$300 from Grainger

$75 from IKEA

DIY Storage cabinets

Wooden cabinets constructed in the following manner shall be acceptable:

- The bottom, sides, and top shall be constructed of exterior grade plywood that is at least 1 in. thick and of a type that will not break down or delaminate under fire conditions.
- All joints shall be rabbetted and shall be fastened in two directions with wood screws.
- Where more than one door is used, there shall be a rabbetted overlap of not less than 1 in.
- Doors shall be equipped with a means of latching, and hinges shall be constructed and mounted in such a manner as to not lose their holding capacity when subjected to fire exposure.
- A raised sill or pan capable of containing a 2 in. depth of liquid shall be provided at the bottom of the cabinet to retain spilled liquid within the cabinet.

PREPAREDNESS


Kimberly-Clark
PURPLE NITRILE


plum

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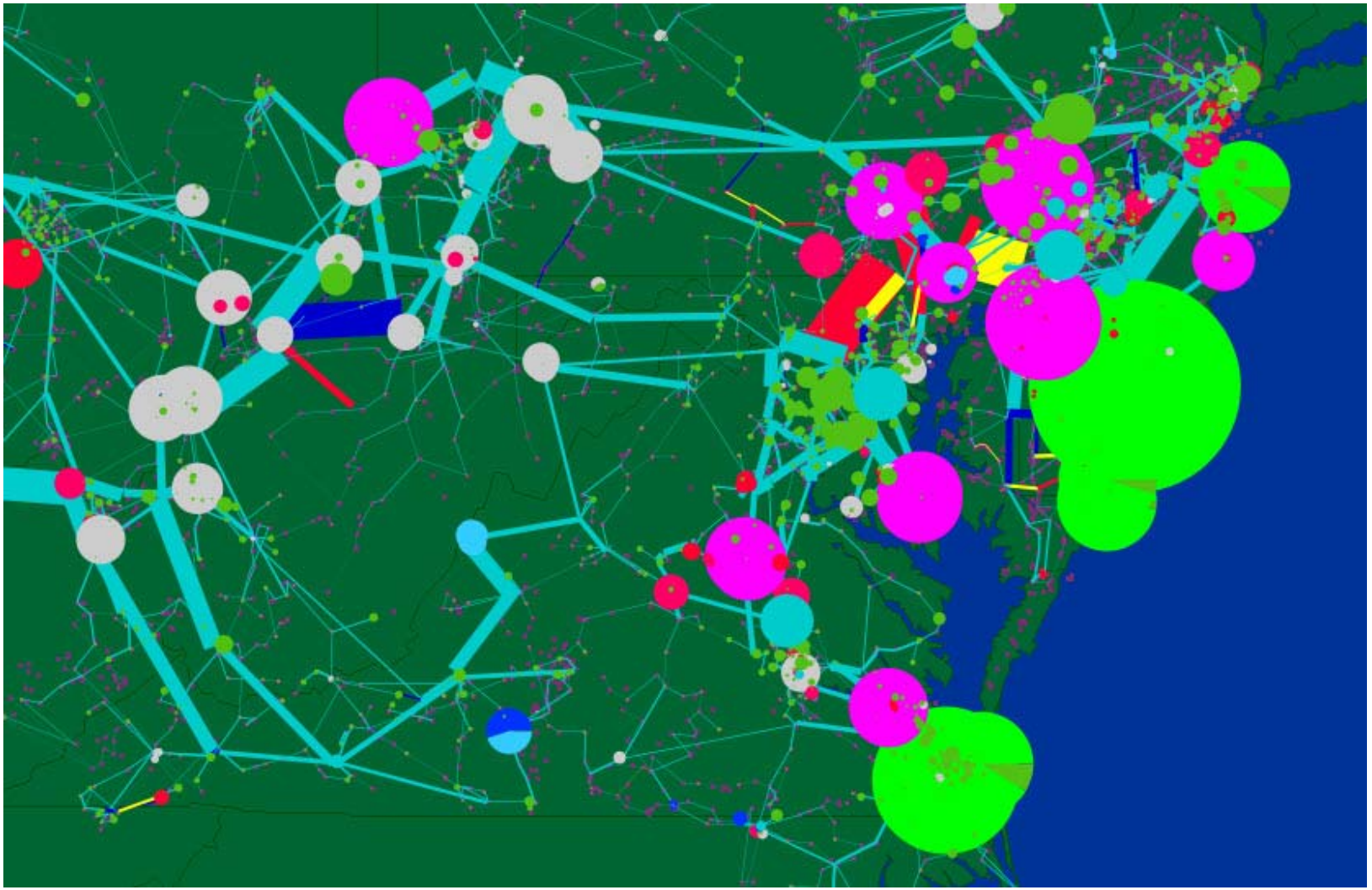
CONTAINMENT

SECONDARY



FAILURE OF INFRASTRUCTURE

PJM GRID

FAILURE OF INFRASTRUCTURE

PORTABLE RECIRCULATING LEV

FAILURE OF INFRASTRUCTURE

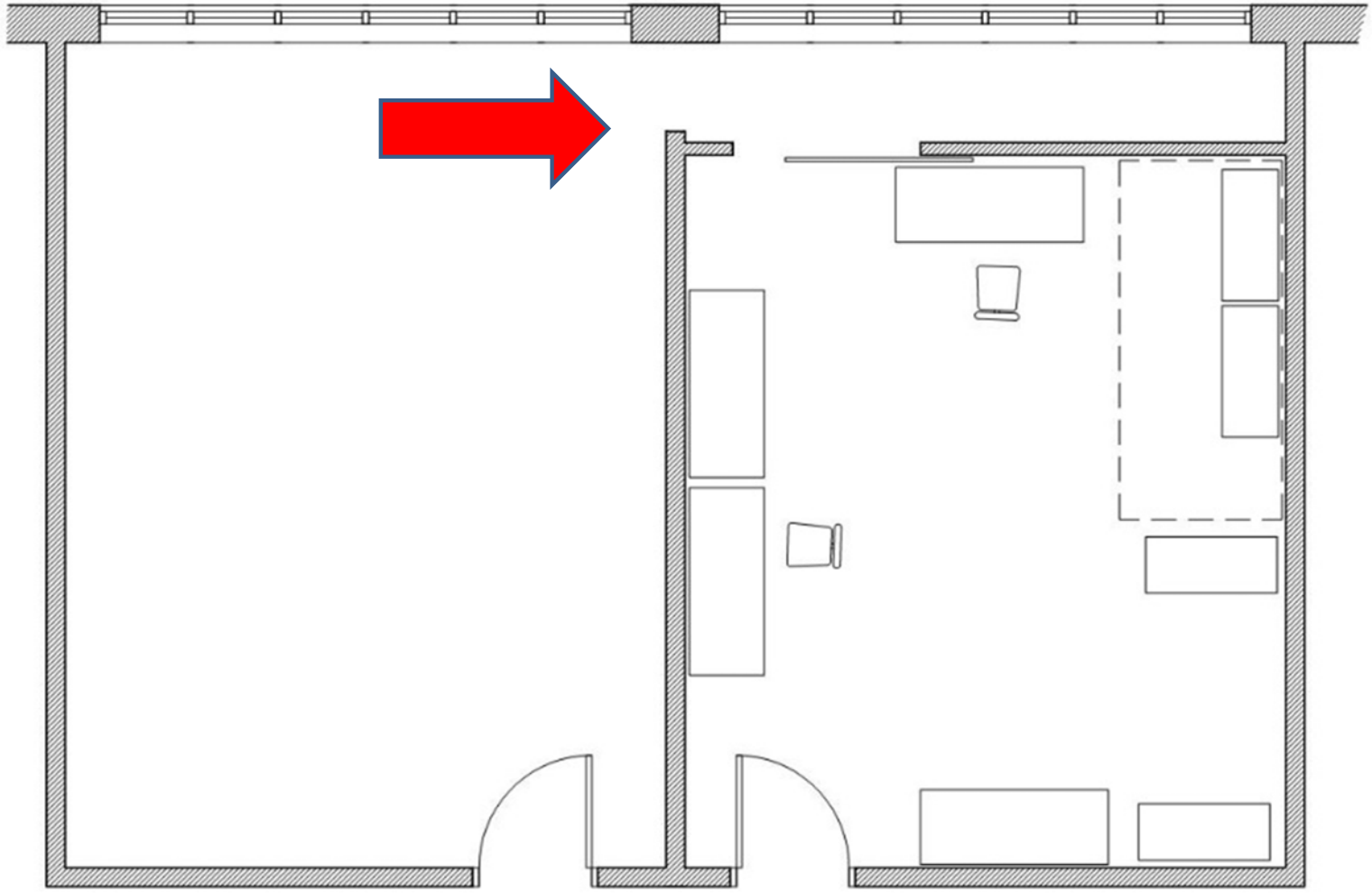
PORTABLE RECIRCULATING LEV

THEFT

RISK OF VIOLENCE

THEFT

RISK OF VIOLENCE



THEFT

RISK OF VIOLENCE

WORKSPACE DESIGN

PASSIVE STRATEGIES

- Hidden in plain sight
- Outside of 100-year floodplain
- Distance from facility with catastrophic potential
- Above the basement
- Hydrant within 300’
- Police, Fire, EMS response times

ACTIVE STRATEGIES

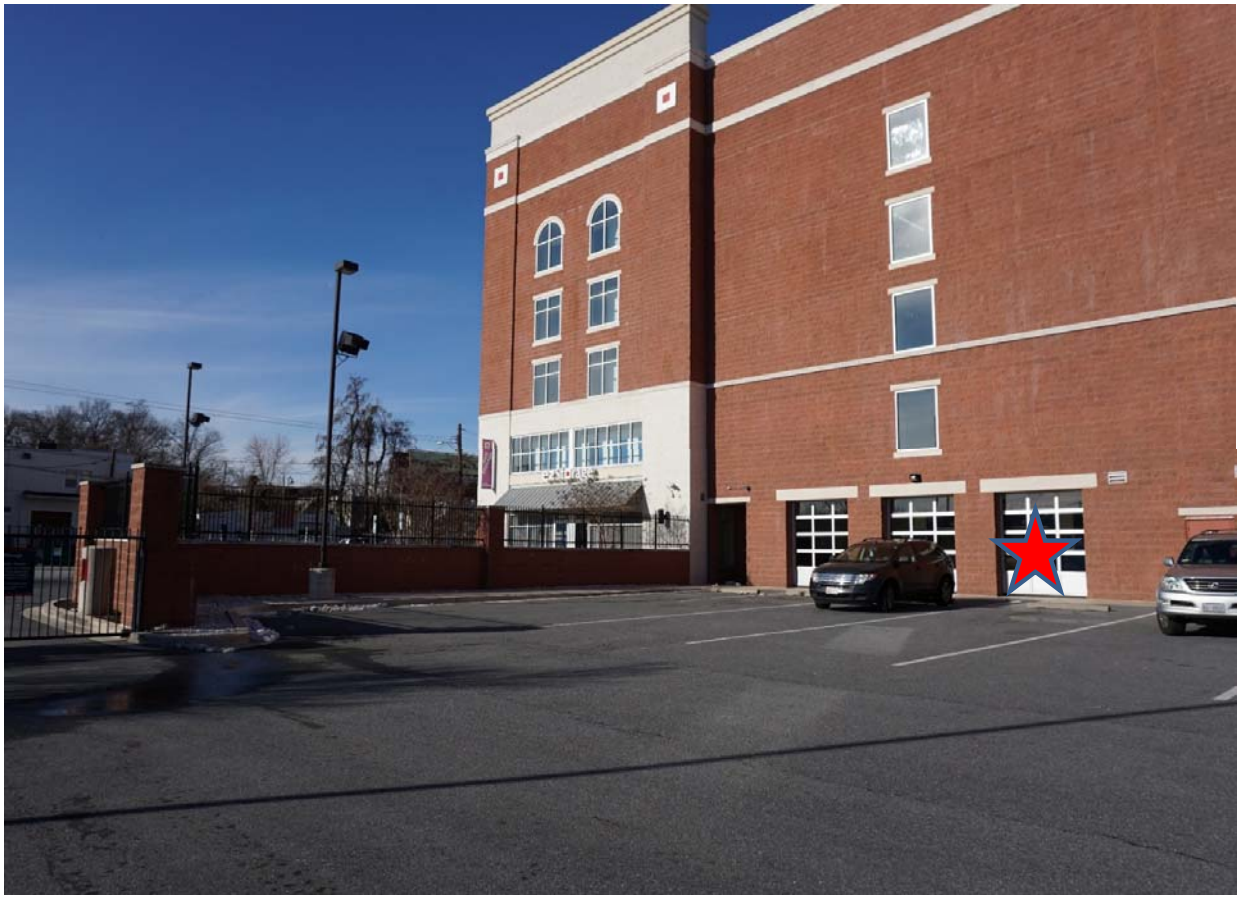
- Security system
- Fire alarm & suppression systems
- Independent HVAC system

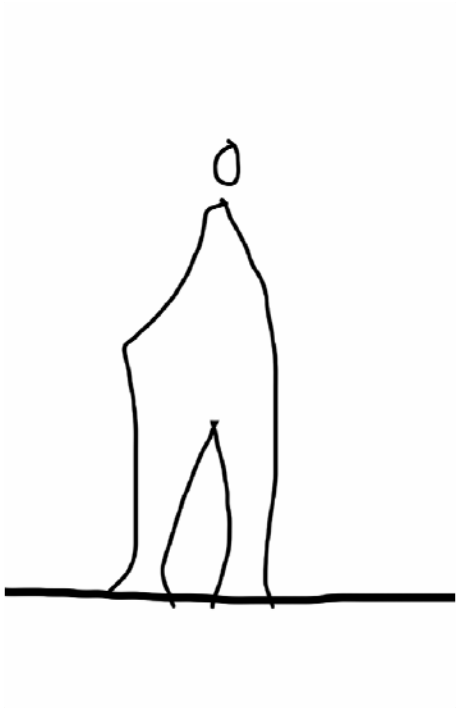
UNDERSTANDING THE BUILDING TYPE

DETACHED HOME

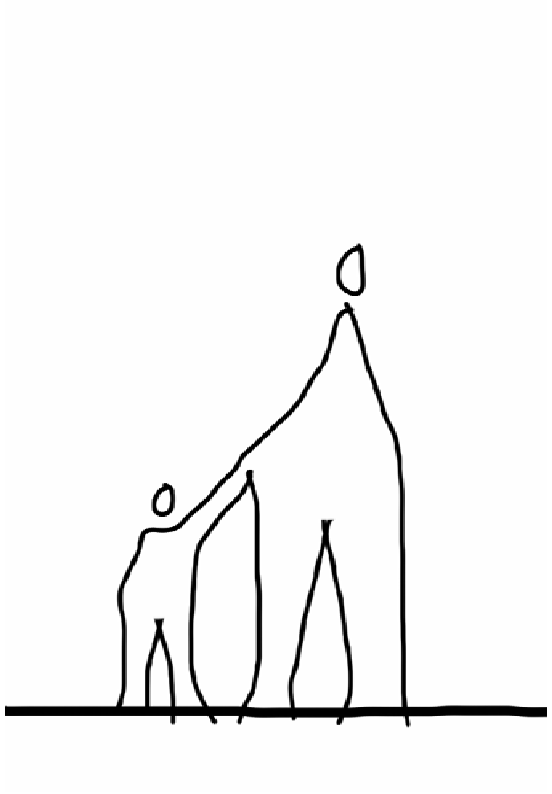
UNDERSTANDING THE BUILDING TYPE

MULTI-FAMILY DWELLING

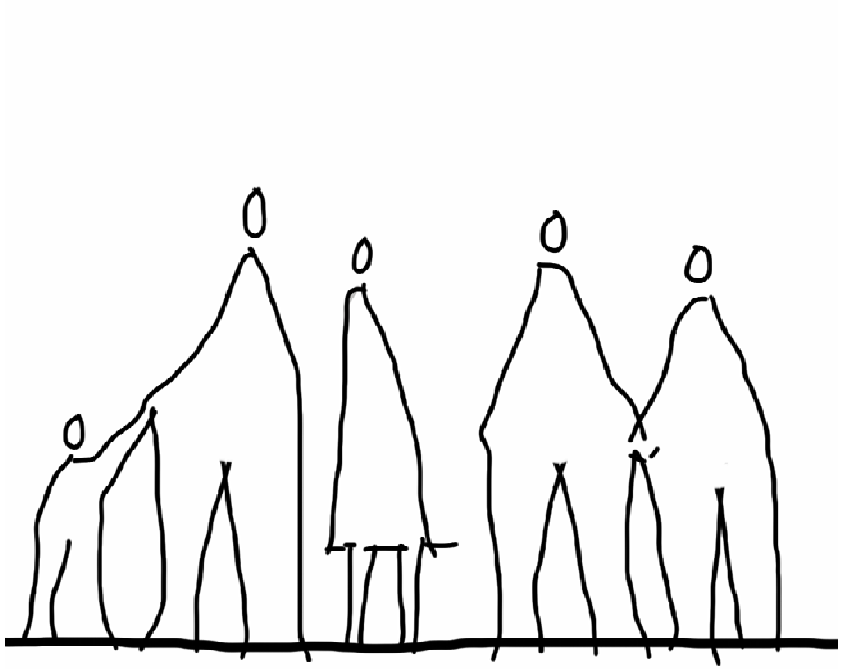




Conservator



Conservator and Kid



Conservator and Neighbors

ADJACENCIES

Window / Door Test
FIRE PROTECTIVE
NFPA 257/252

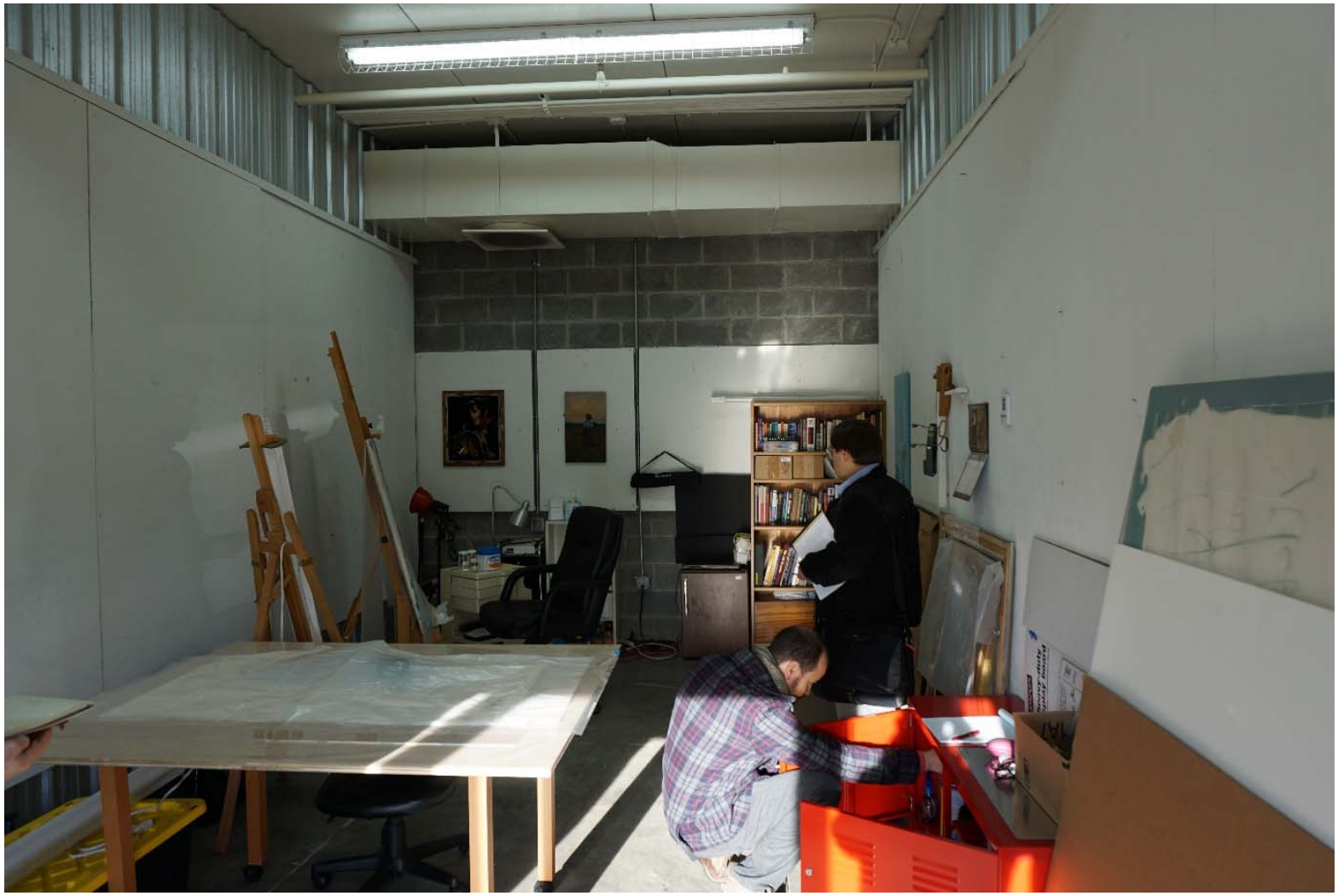
Contains flame and smoke

45 minutes and under

Wall Test
FIRE RESISTIVE
ASTM E119/NFPA 251

Contains flame and smoke AND
blocks radiant heat for applications

over 45 minutes



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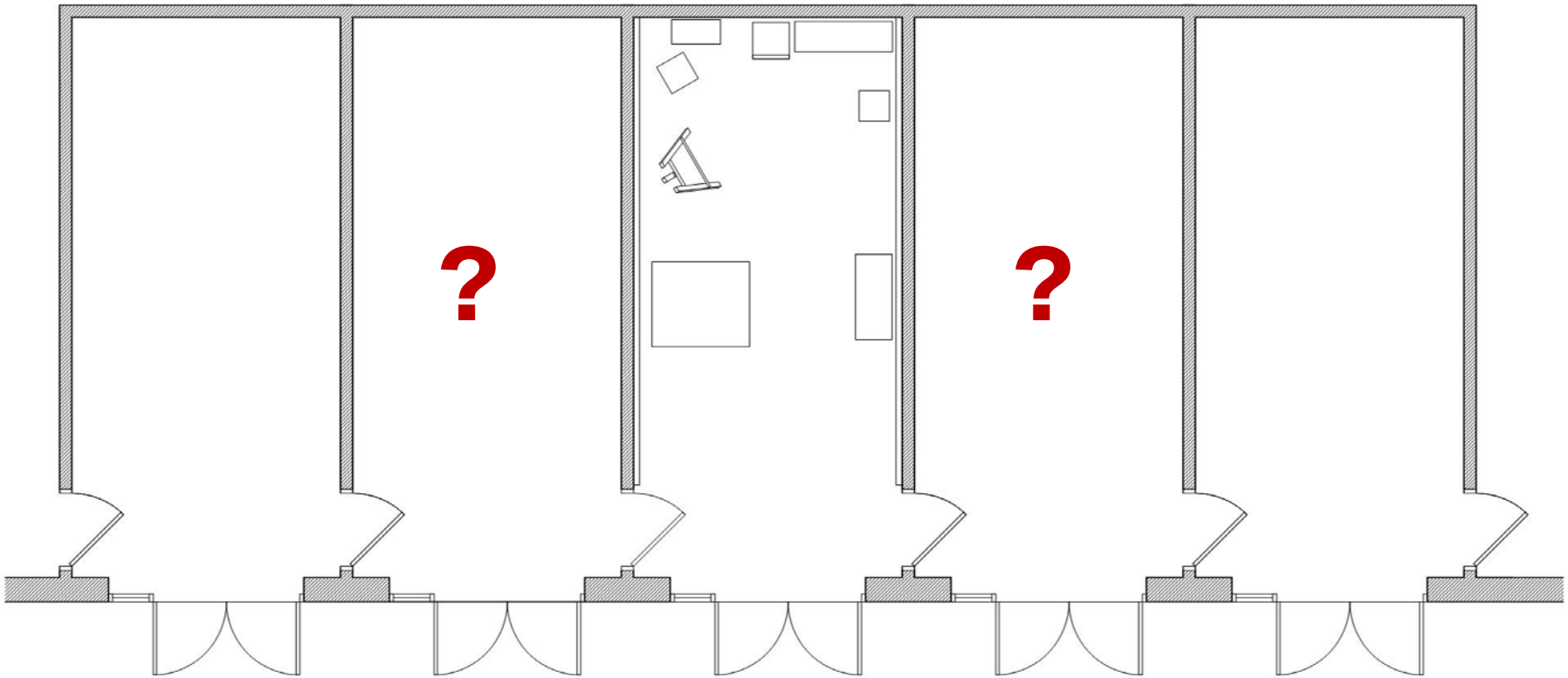
ADJACENCIES

ADJACENCIES

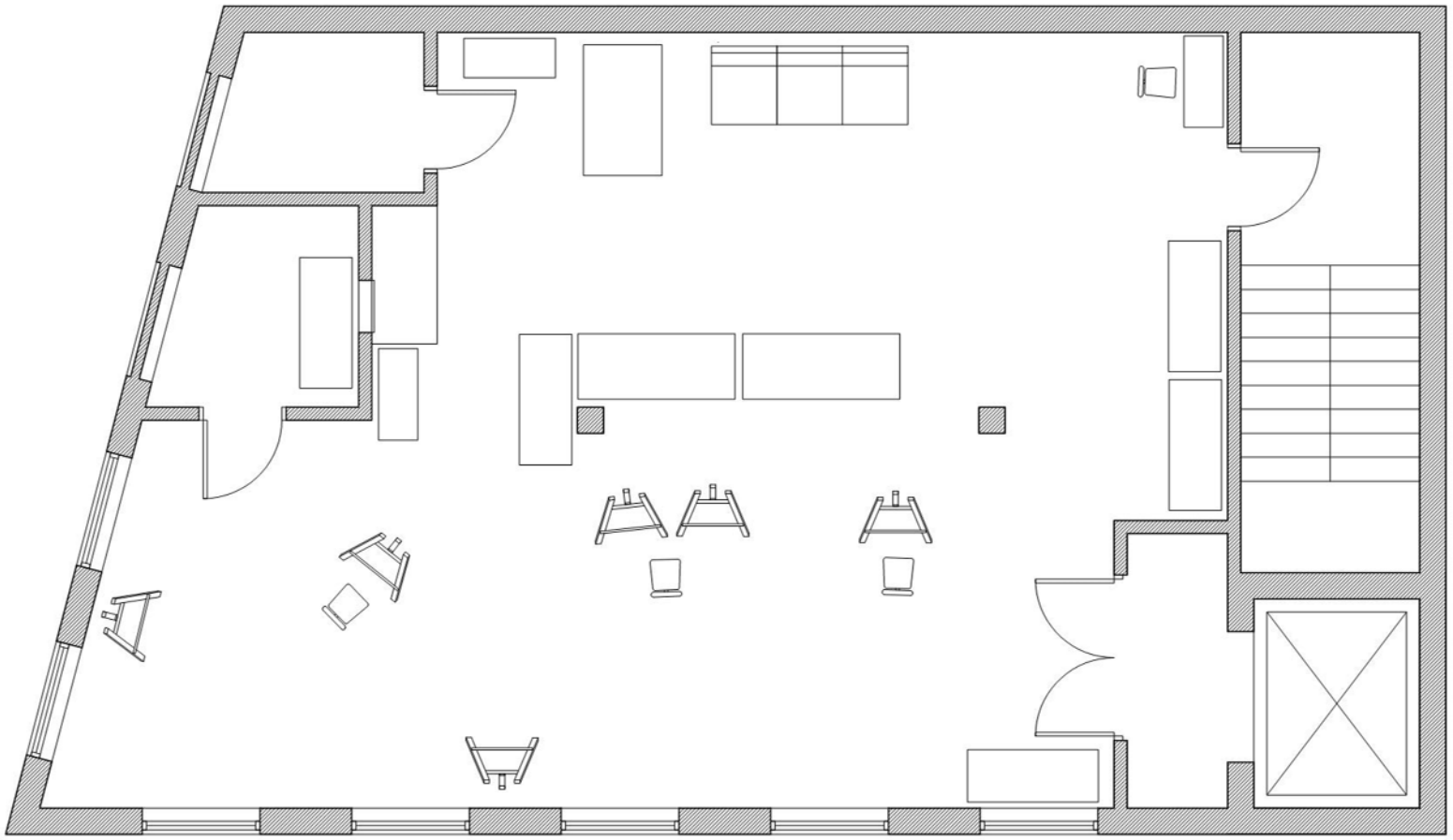


ADJACENCIES

FIRE SEPARATION

ADJACENCIES

ADJACENCIES



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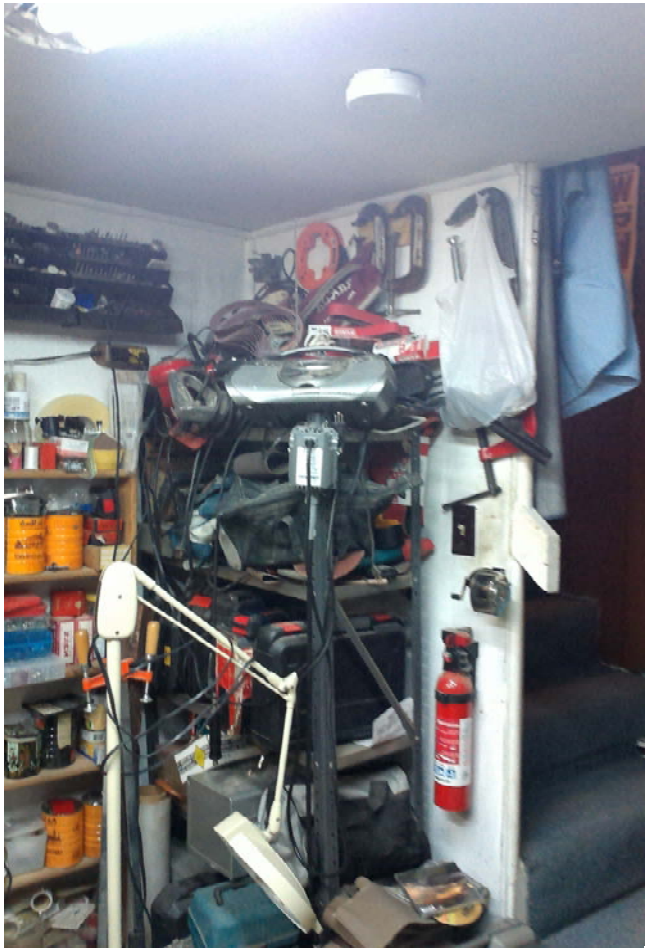
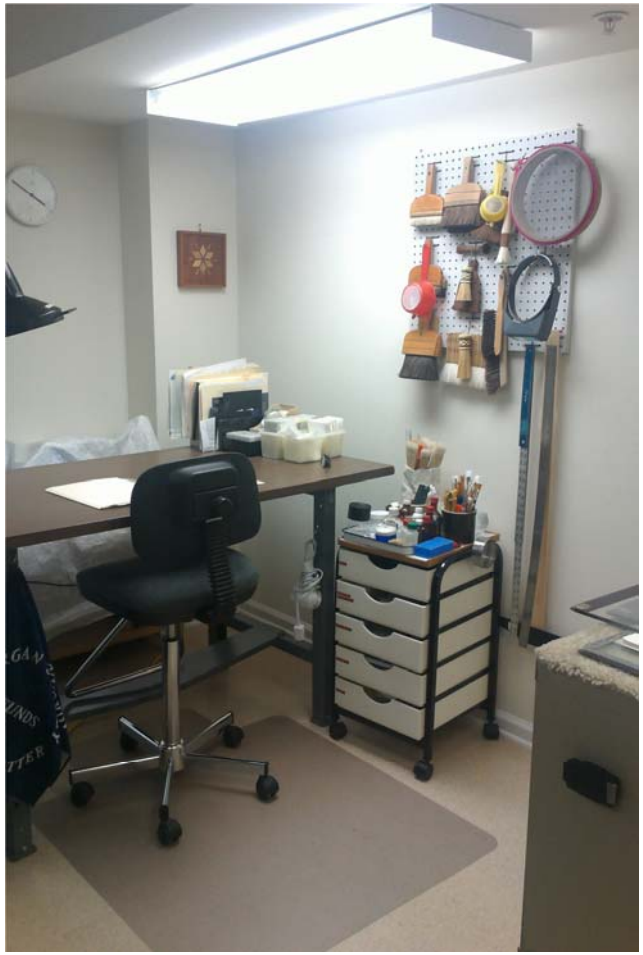
ADJACENCIES

FIRE PROTECTION





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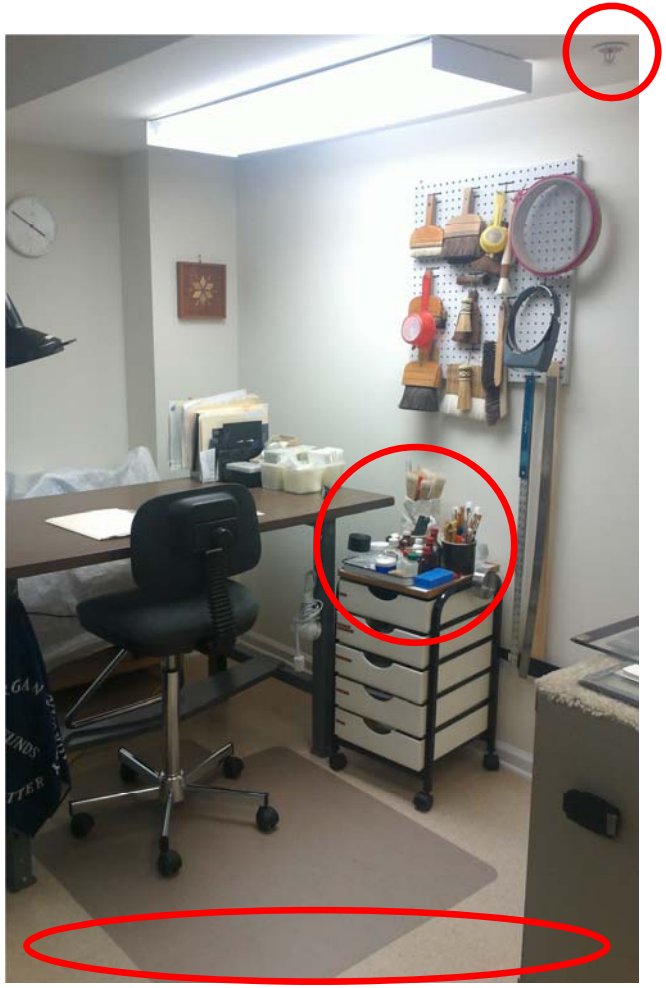
WORKSPACE

FIRE SUPPRESSION



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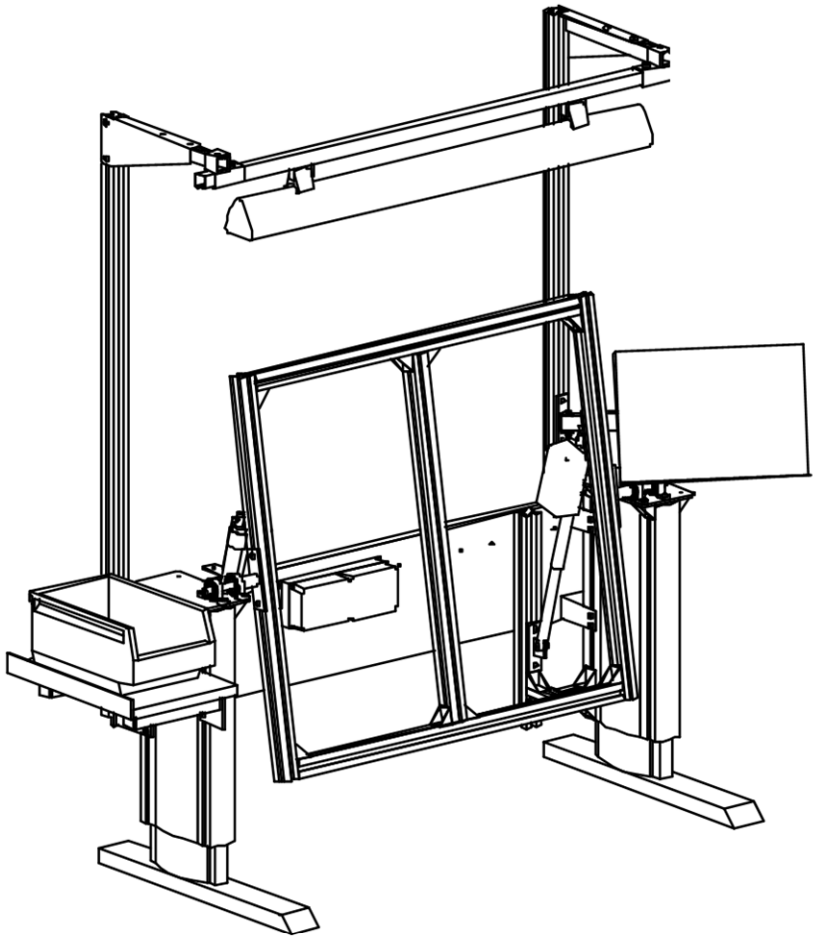
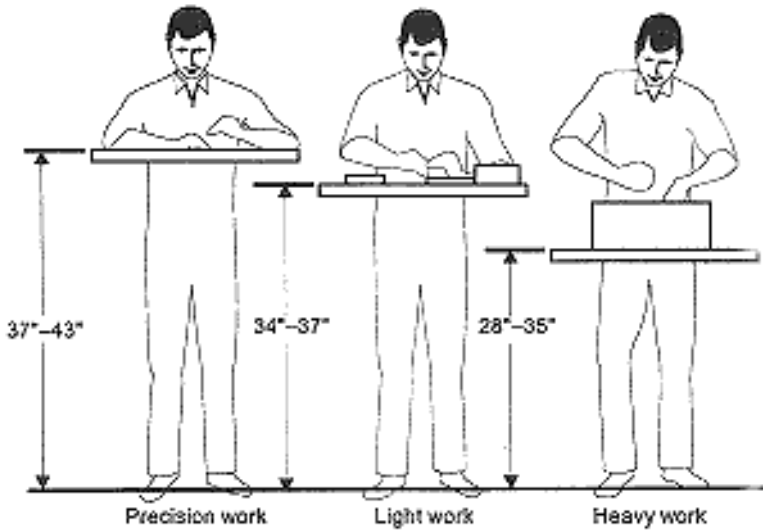
WORKSPACE

FIRE SUPPRESSION

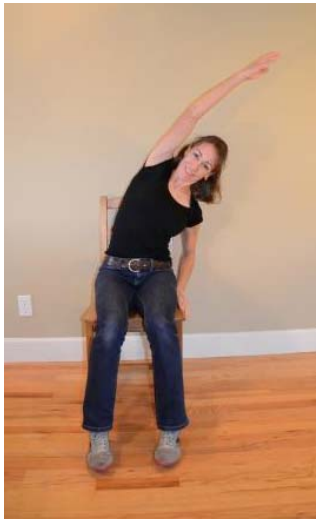
VS

ERGONOMICS




37"–43"
34"–37"
28"–35"
Precision work
Light work
Heavy work











WORKSPACE

STAND UP & STRETCH

BENCHES	Yes	No
Is anti-fatigue matting supplied to increase comfort during standing tasks?	☐	☐
Does the individual wear shoes appropriate for prolonged standing?	☐	☐
Is the work bench height appropriate for the work performed? (Precision Work: 1-2" above elbow height Light Work: 2-4" below elbow height Heavy Work: 8" or more below elbow height)	☐	☐
Does the individual work at a bench cut out? Is there adequate leg room?	☐	☐
Is the individual able to prop a foot up on a stool or ledge?	☐	☐
Do any sharp edges along the bench top have a waterfall or sloped edge OR have padding to reduce the contact pressure?	☐	☐
Are items within easy reach?	☐	☐

CHAIRS	Yes	No
Does the chair support the individual's low back during his/her work?	☐	☐
Are the individual's feet supported by the floor, a footrest, or a foot ring?	☐	☐
Can the chairs in the laboratory be adjusted to accommodate all of the individuals who need to use the chairs?	☐	☐

MICROSCOPES	Yes	No
Is the individual able to avoid a rounded or hunched shoulder posture when using the microscope?	☐	☐
Is the individual able to maintain a relatively neutral neck position (no more than 25° of forward bending)?	☐	☐
Is contact pressure between the individual's forearm and hard surfaces or sharp edges avoided or padded?	☐	☐
Is the microscope position at the near edge of the bench or work surface?	☐	☐
Is there sufficient leg room?	☐	☐
Are the individual's feet supported by the floor, a footrest, or a foot ring?	☐	☐
Has the individual been shown how to properly sit at a microscope work station?	☐	☐
Does the individual take hourly breaks from microscope work?	☐	☐
Are additional supplies within easy reach?	☐	☐

COMPUTERS	Yes	No
Is a seat provided?	☐	☐
Is the seat height adjustable to accommodate all individuals who will use the chair?	☐	☐
Is lumbar support provided?	☐	☐
Are the individual's feet supported by the floor, a footrest, or a foot ring?	☐	☐
Is the adequate leg room?	☐	☐
Is the adequate space for the mouse and keyboard to be at the same height and within easy reach? (They should be positioned so that the employee can rest their arms at their side with forearms parallel to the floor.)	☐	☐
Is there adequate space to place the monitor at arm's length distance from the user?	☐	☐
Is the monitor at the recommended height (the top of the screen should be at or below eye level)?	☐	☐
If documents are frequently used, is there a document holder?	☐	☐

MISCELLANEOUS	Yes	No
When performing any repetitive tasks, are frequent breaks provided?	☐	☐
Are employees encouraged to change tasks every 20-30 minutes?	☐	☐
Are vials easy to cap and thread?	☐	☐
Are heavy items stored on lower shelves (at or below waist height)?	☐	☐
Are chemical and gas valves easy to reach and operate?	☐	☐
When operating a microtome or cryostat, is the employee's wrist in a neutral or straight position?	☐	☐

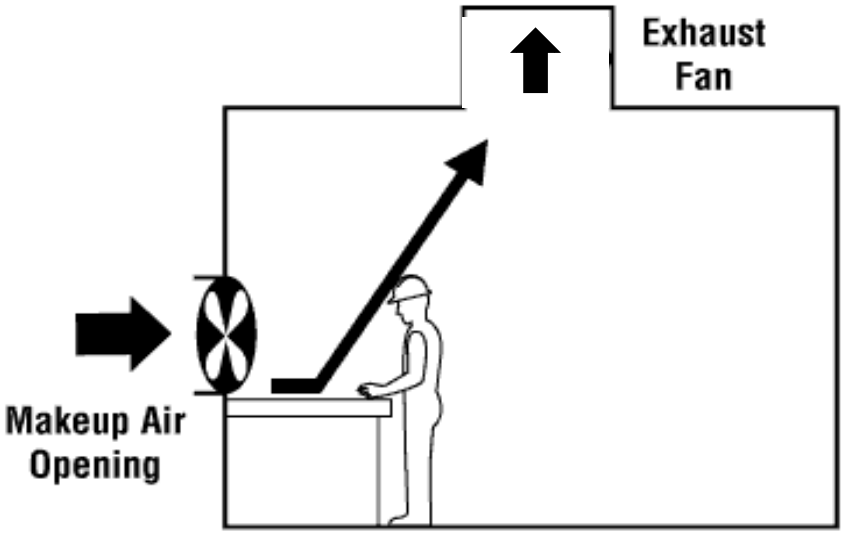
QUESTIONS:

1. WHAT HAZARDS HAVEN'T WE ADDRESSED?
2. WHAT SHOULD BE THE CONSERVATOR'S ROLE IN PROVIDING OVERSIGHT AND COMPLIANCE IN A RENTED SPACE?

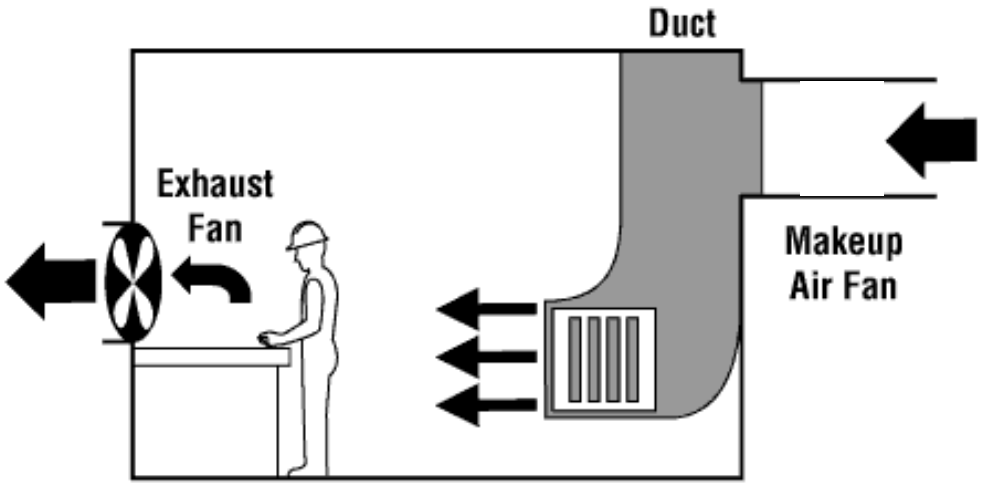
VENTILATION

Directional Airflow

- Air Leakage Into Room
- From Breathing Zone to Contaminant
- More Exhaust Than Supply

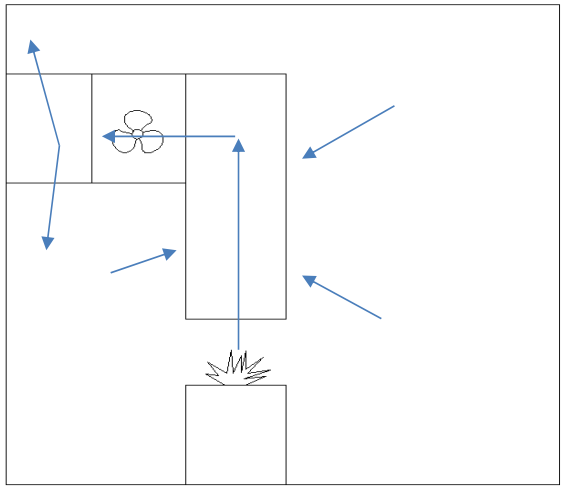


UNACCEPTABLE air inlet and exhaust

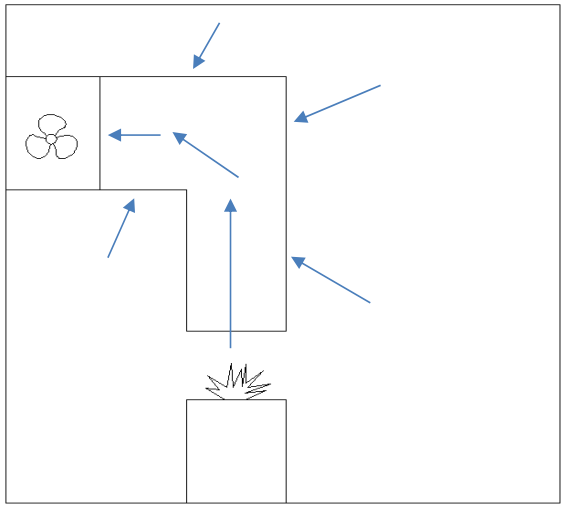


BEST air inlet BEST exhaust

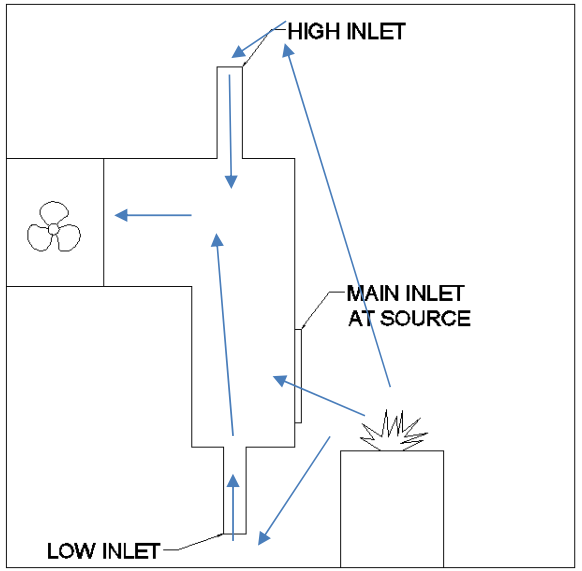
- Locate Fan at end of system
- Provide Low Inlet for Heavy Fumes
- Provide Hi Inlet for Light Fumes
- Largest Inlet at Source



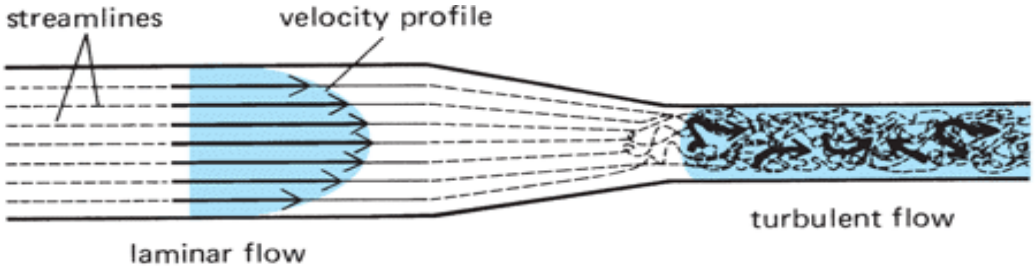
UNACCEPTABLE

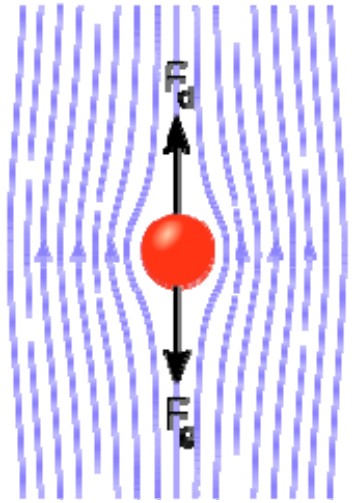


GOOD

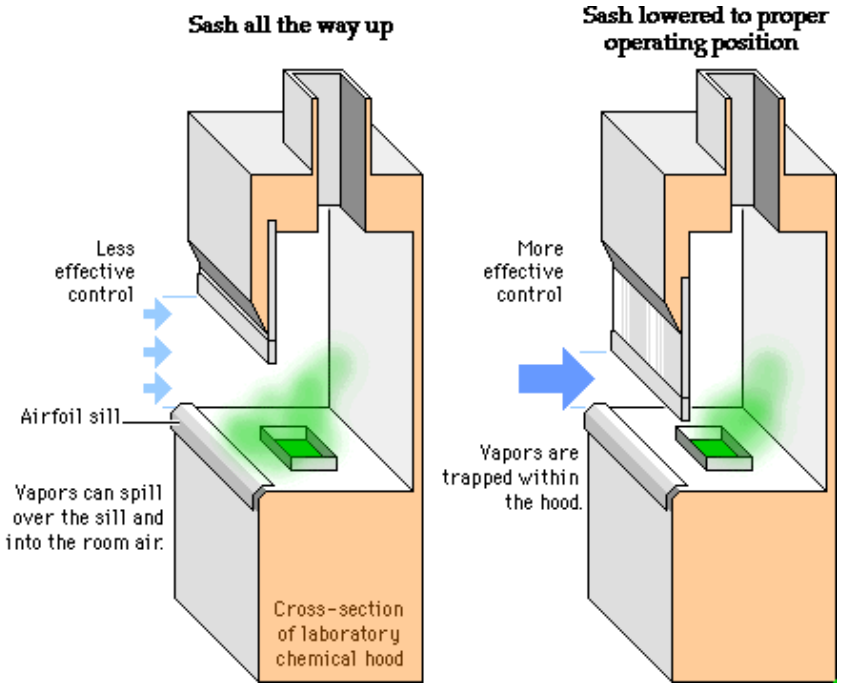


BEST





- Optimize Velocity
- Minimize Disturbance



EQUATIONS

TOTAL AIR FLOW (CFM) = FPM x INLET AREA (FT^3)

CAPTURE VELOCITY (FPM) = $\frac{\text{CFM } (FT^3/MIN)}{\text{INLET AREA } (FT^2)}$

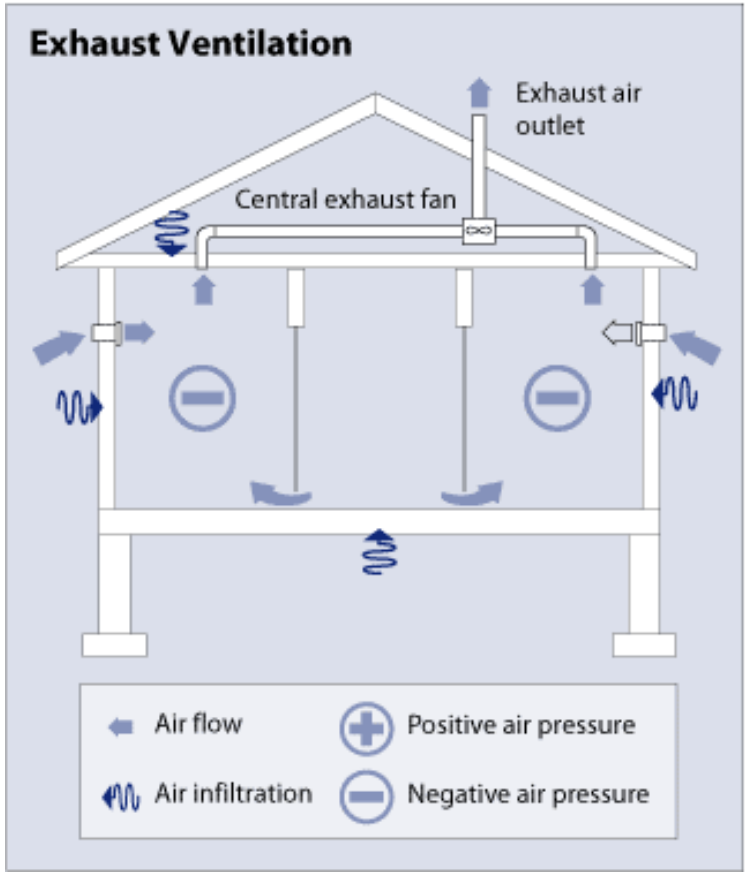
Capture Velocities*

Fumes/Vapors/Mists

Dispersion	Examples	Capture Velocity Range (FPM or Ft/Min)
No Velocity In Still Air	Evaporation	50-100
Low Velocity In Still Air	Welding	100-200
Active Generation In Rapid Air	Spray Painting	200-500
High Velocity In Very Rapid Air	Grinding	500-2000

*For Dusts/Particles, Capture Velocity should be within Duct Velocity Range

Recommended Air Changes Per Hour	
Building / Room	**Air Change Rate (AC / Hr)**
All Spaces in General	min 4
General Exhaust (Odor)	>10
Factory Buildings, Ordinary	2 to 4
Factory Buildings, Fumes and Moisture	10 to 15
Spray Paint Booth	15-20



EQUATIONS

$$\text{TOTAL AIR FLOW (CFM)} = \frac{\text{AC}}{\text{hr}} \times \frac{1\text{ hr}}{60\text{ min}} \times \text{Room Volume (ft}^3\text{)}$$

$$\text{AIR CHANGE PER HOUR (AC/hr)} = \frac{\text{CFM (ft}^3\text{/min)}}{\text{Room Vol. (ft}^3\text{)}} \times \frac{60\text{ min}}{\text{hr}}$$

ROOM VOLUME (ft^3) = H (ft) x L (ft) x W (ft)

CFM = Ft^3/Min

Duct Design Velocity

Containment	Examples	Duct Velocity Range (FPM or Ft/Min)
Vapors, Gases, Smoke	All Vapors Gases, Smoke	1000-2000
Fumes	Welding	2000-2500
Fine Dust	Cotton, Lint, Wood, Flour	2500-3000
Dry Dust & Powder	Rubber Dust, Leather Shavings	3000-4000
Industrial Dust	Grinding Dust, Gravity Dust	3500-4000
Heavy Dusts	Saw Dust, Metal Turnings	4000-4500
Heavy or Moist Dusts	Lead Dust	>4500

- Static Pressure Drop (PD) Measure in Inches Water
- Use Gradual Duct Transitions
- Fan P.D. usually determines by dirty filter P.D.

Simplified PD Estimations

- Design for </= 1200 FPM
- Duct Systems </= 100' Long
- Duct Systems </= 6 Elbows
- Duct System PD approx. = 0.25" – 0.75"

Purpose		Recommended	Filtration Media	Spent Media Measurement	Remarks
Gases	Hazardous	Yes/No	Specialty	None	Use Only With Exhaust System
	Odors	Yes	Gas-Phase	None	
	Flammable	No	No	None	Use Only With Exhaust System
Contaminants	Biological	Yes/No	HEPA	Filter P.D.	Use Only With Exhaust System
	Lead	Yes/No	HEPA	Filter P.D.	
	Asbetos	Yes/No	HEPA	Filter P.D.	
Particles	All Low Risk	Yes	High Efficiency (90-99.99%)	Filter P.D.	

- Applications
  - Odor Counter
  - Dust & Other Particles
  - Source Control
  - Good for Supplementing Exhaust Systems

- Benefits
  - Ductless
- Risks
  - No Dilution
  - Gas Phase Filtration Effectiveness

EQUIPMENT

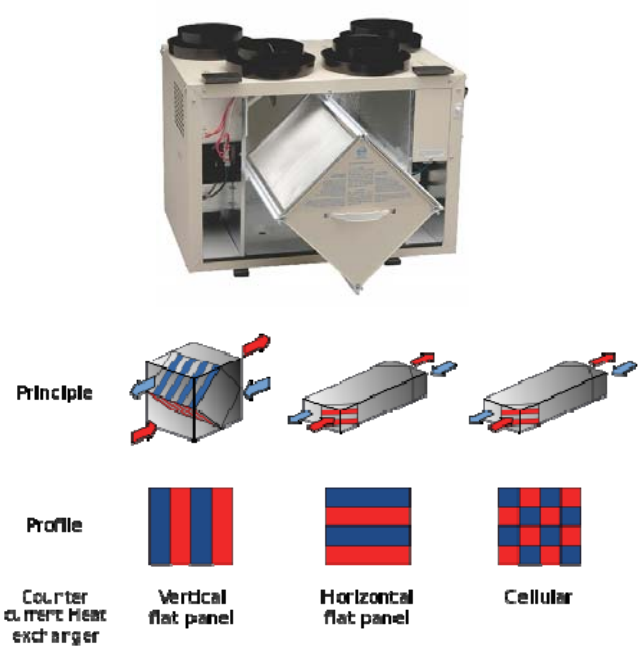
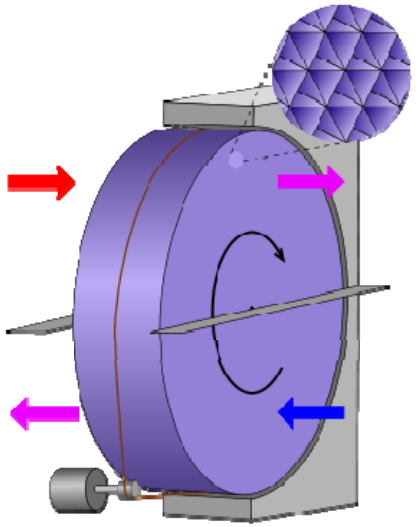


Plate Heat Exchanger
Less Efficient (50-60% Effectiveness)
Heat Recovery
No Cross-Contamination
Less Moving Parts
($4000 for 500 CFM@.75"esp)

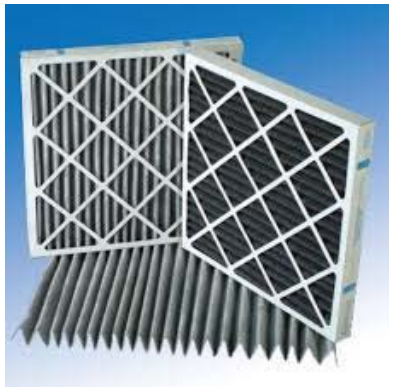


Rotary Air-To-Air Enthalpy Wheel
Most Efficient (70-80% Effectiveness)
Heat & Moisture Recovery
Possible Cross-Contamination
($5000 for 500 CFM@.75"esp)

- What Goes Out, Must Come In
- Filter Makeup Air to Control Contaminants
- Assume 100 Cfm per Door for Air Leakage
- Size Non-powered Makeup Air Filters for 100-200 FPM
- Consider Energy Recovery Ventilators for High Usage Applications
- Code requires >10' Separation from Exhaust

Energy Recovery Ventilators

Particulate Filter Rating	
Efficiency	**MERV**
30-35%	8
60-65%	11
90-95%	14
HEPA (99.97%)	17
HEPA (99.999%)	20



Gaseous Phase Filtration		
Purafil Model	**Media (Pellets)**	**Application**
CHEMOISORBANT	ROMED OF ALUMINA IMPREGRENATED WITH POTASSIUM PERMANGANATE	CONTAINMENT GASES
PURKAKOL	ACTIVATED CARBOLI	CHEMICAL CONTAMINANTS (OZONE IN OUTDOOR AIR, VOC'S, HUMAN BIO-EFFLUENTS)
SGM	CARBOLI FREE ACTIAVTED ALUMINA	ACID GASES (SEMICONDUCTOR AND MICROELECTRONIC MFG)
TRIPLE-BLEND	FORMED FROM A COMBINATION OF ACTIVATED ARBON, ALUMINA AND OTHER BINDERS	CHEMICAL CONTAMINANTS (JET FEUL FUMES, DIESEL EXHAUST AND AUTOMOBILE EMISSIONS)

Filter Selection / Replacement

- Types of Filters
  - Gaseous
  - Particulate
- Change filters based on:
  - Usage
  - Calendar Schedule
  - Use labels
- Dispose of properly

Utilitech 8-in 3-Speed Window Fan
- 0 CFM @ 0” ESP
- $44.98
- Controllable Speed

Inline Explosion Proof Fan
- 1390 CFM
- $615

- Air Volume – CFM (ft^3/min)
- Fan Static – Inches W.G. (“)
- Explosion Proof/Spark Proof

Explosion Proof Prop Fan
- 620 CFM @ 0” ESP
- $579
- 10” Blade

Small Inline Fan
- 500 CFM @ 8” ESP
- $38

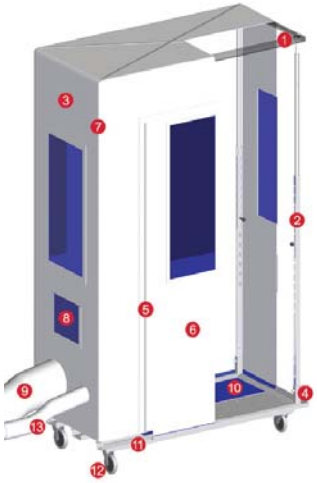
Fitting Testing Kit
- $130

- Smoke Test
  - Confirm Draw
  - Confirm Capture
  - Discover Infiltration
  - Check for Leaks

Smoke Emitter
- Clean, nontoxic smoke
- Pkg. of 10 for $18.33
- 45 second burn

Fit Testing Kit, Irritant Smoke
- $467

HEPA Vacuum
- Superior Suction
- Low Noise Level
- HEPA Filter
- Good for construction/ remodeling
- $700



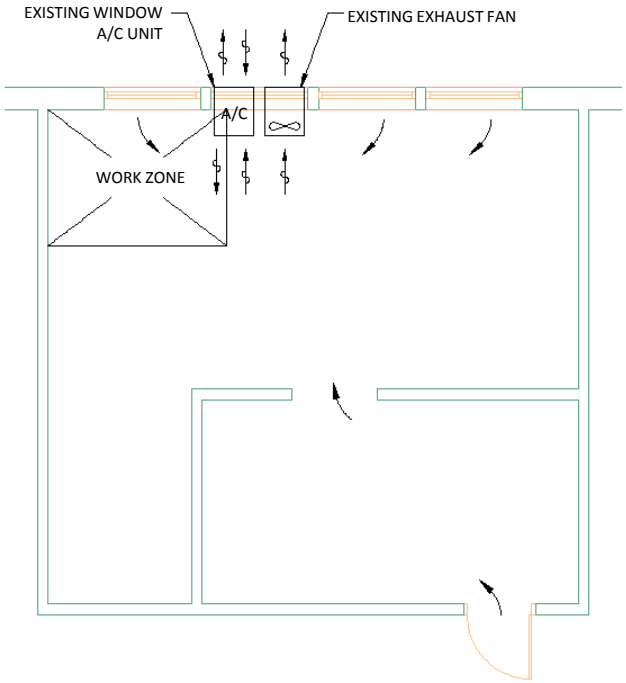
Mobile Containment Cube
- Lightweight
- Negative Pressure Containment
- HEPA Vacuum Ports
- Extremely Portable
- $3200

Portable Air Scrubber
- Lightweight and Compact
- Powerful (200-600 CFM)
- HEPA Filter
- $1000

EXAMPLES

- Paint Conservator
- Light Duty
- Solvents

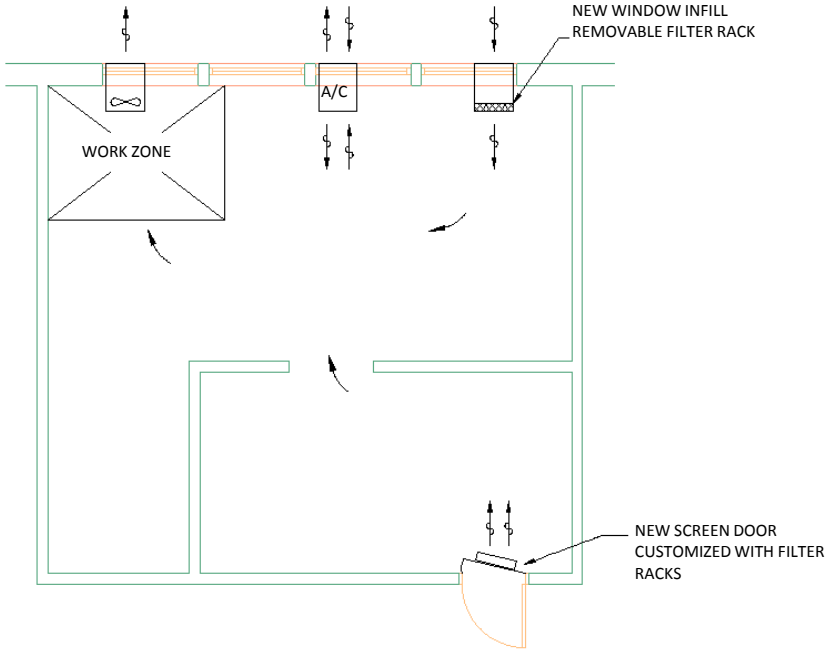
Floor Plan- Existing



Existing Configuration Issues

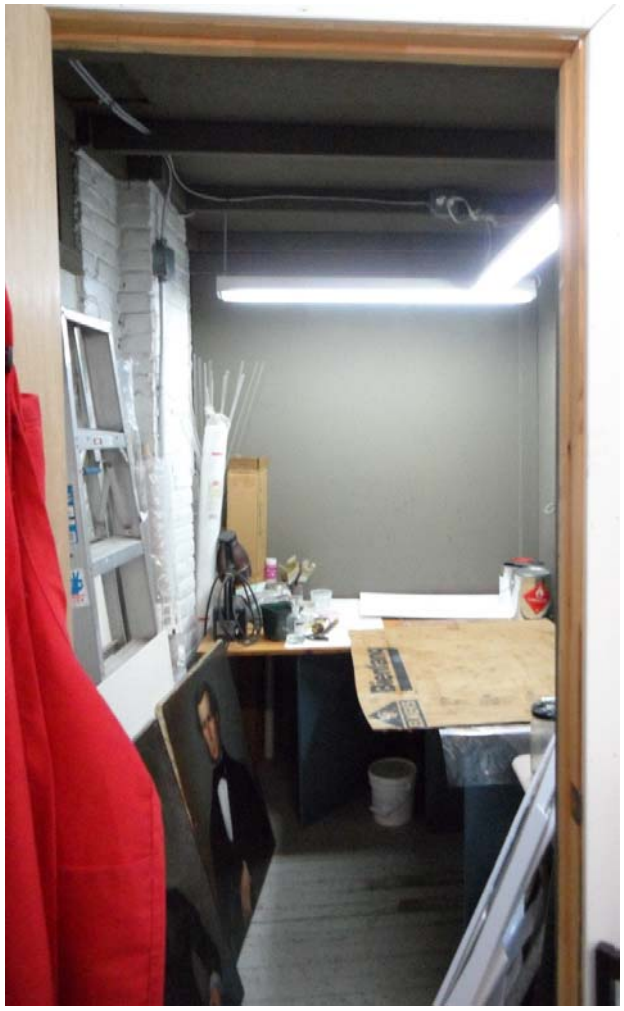
- A/C Disrupts Exhaust Airflow
- Uncontrollable Make-Up
- Possible Short Circuit

Floor Plan- Reconfigured



Improvements

- Relocate Exhaust to Draw Across Work Zone
- Relocate A/C Out of Work Zone
- Add Remote Air Inlets
- Filter Make-Up Air

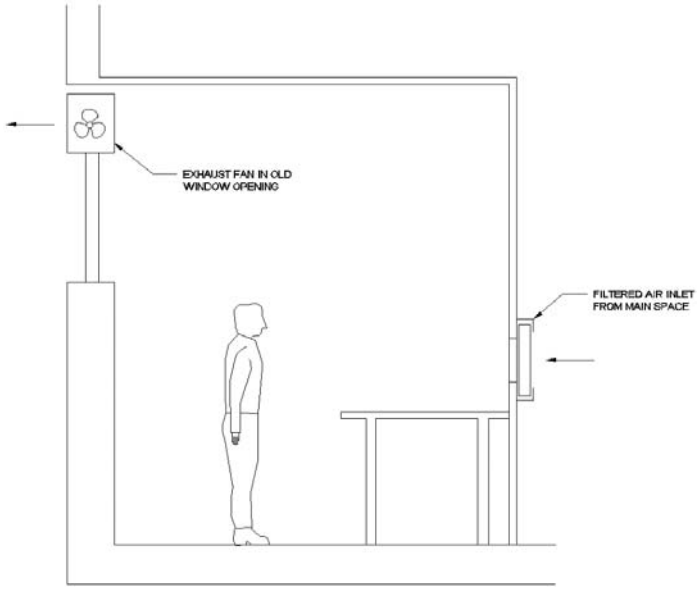


- Art Conservator
- Light Duty
- Spray Varnish

AIC

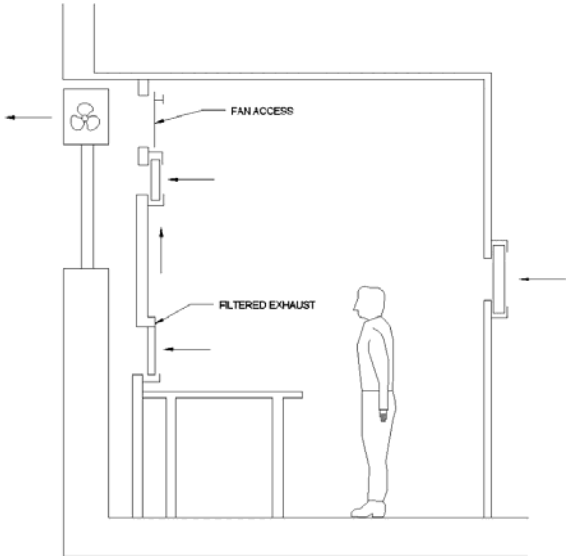
EXAMPLES

VARNISH ROOM



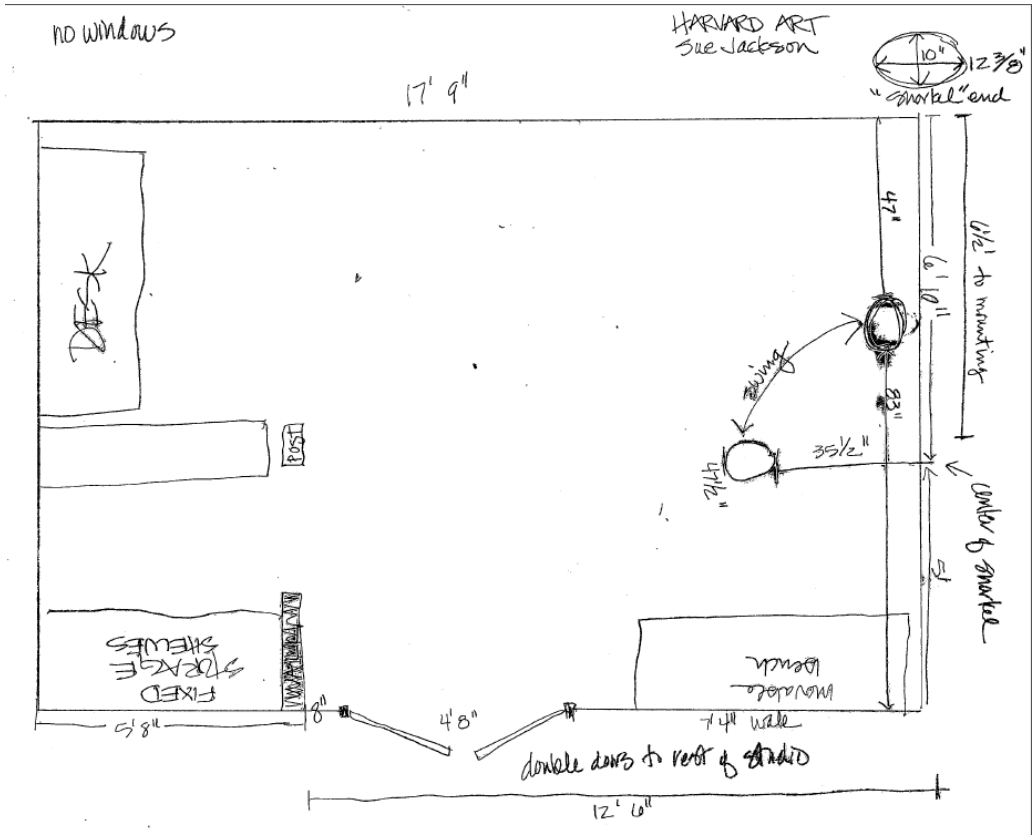
Good

- Fan at end of exhaust system
- Cross Flow
- Filters Inlet Air
- Containment



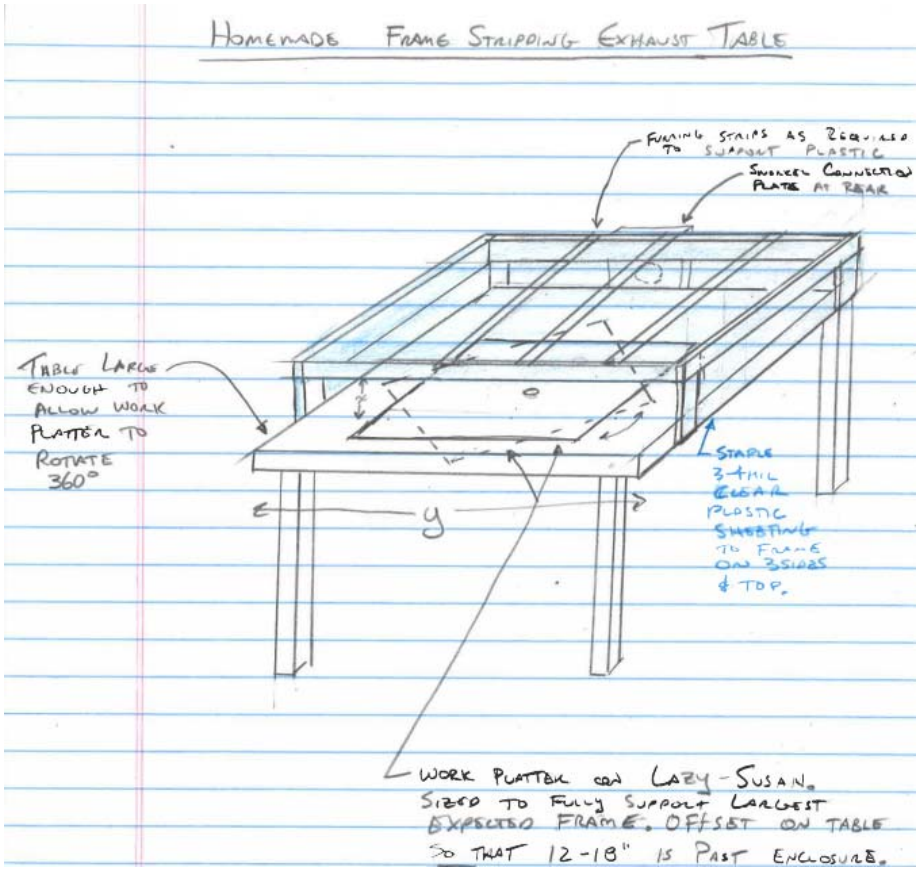
Better

- Fan at end of exhaust system
- Cross Flow
- Filters Inlet Air
- Containment
- **Exhaust at Source**
- **Inlet near breathing zone**
- **HI/LO Exhaust**
- **Filtered Exhaust**



Existing Floor Plan

- Large Frame Conservation
- Paint Stripper, Alcohol
- Inexpensive
- Existing Exhaust Snorkel Ducts to outside (1 HP/500 CFM)



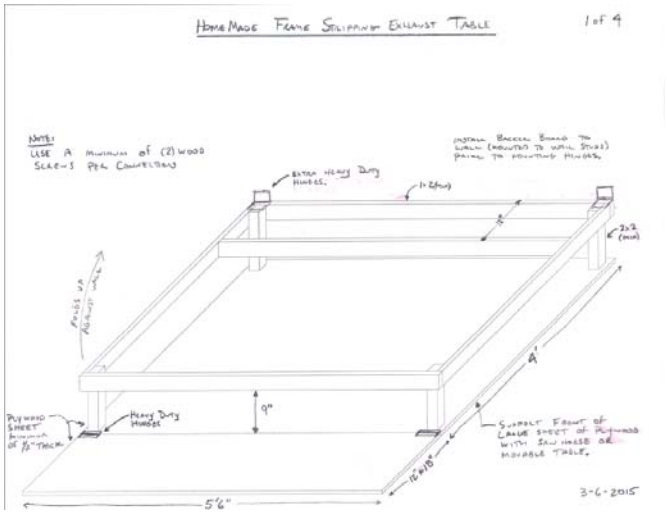
EXAMPLE FOR SIZING THE OPENING

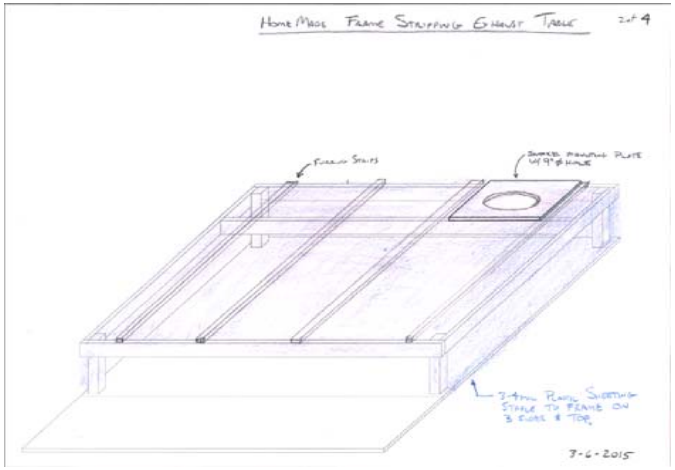
A 4'x5' FRAME WOULD REQUIRE

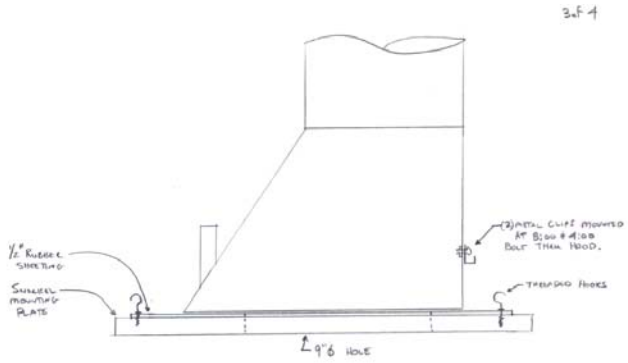
$\sqrt{4^2+5^2} = 6.4 \approx 7'$ OPENING WIDTH. TO MAINTAIN A 100 FT/MIN CAPTURE VELOCITY: $\frac{500\ CFM}{100\ FPM} = 5\ FT^2$

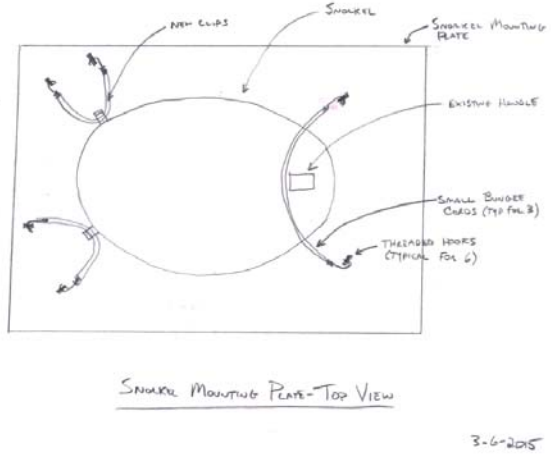
$\frac{5\ FT^2}{7\ FT} = .71\ Ft$ OR 9" HEIGHT.

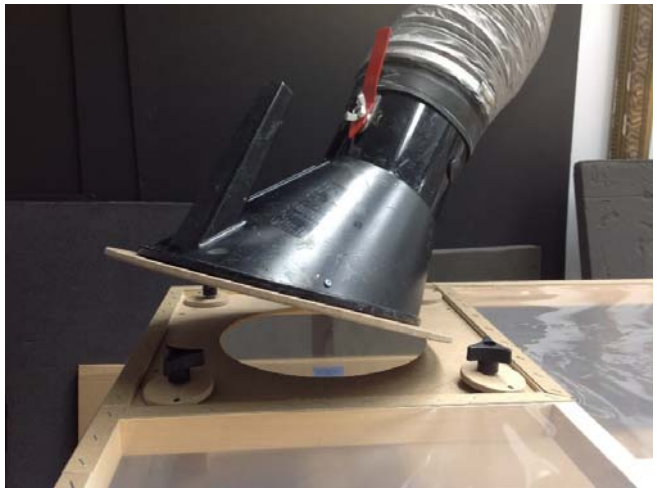
SO $x = 9"$ & $y = 7'$


HOME MADE FRAME STIFFENED EXHAUST TABLE
1 of 4
NOTE:
USE A MINIMUM OF (2) WOOD SCREWS PER CONNECTION
EXTRA HEAVY DUTY HINGES.
2x2 (min)
9"
HEAVY DUTY HINGES
5'6"
3-6-2015


HOME MADE FRAME STIFFENED EXHAUST TABLE
2 of 4
3-6-2015


3 of 4
1/2" RUBBER SHEETING
SNORKEL MOUNTING PLATE
9"ø HOLE
THREADED HOOKS
SNORKEL MOUNTING PLATE - SIDE VIEW
4 of 4


NEW CLIPS
SNORKEL
SNORKEL MOUNTING PLATE
EXISTING HINGLE
THREADED HOOKS (TYPICAL FOR 6)
SNORKEL MOUNTING PLATE-TOP VIEW
3-6-2015



EXAMPLES

EXHAUST TABLES (FUMES)

- Materials: $50
- Fabrication Time: 8 Hours
- Approximate Wholesale Cost: $500

Capture Velocities

- Equations
  http://www.engineeringtoolbox.com/exhaust-outlet-d_1008.html
- Range of Velocities
  http://www.cat-vacuum-collectors.com/dust-collectors/Hood%20Design%20Data%20-%20Range%20of%20Capture%20Velocities.pdf
- Air Change
  - Equations
    http://www.engineeringtoolbox.com/air-change-rate-d_882.html
  - Tables
    http://www.engineeringtoolbox.com/air-change-rate-room-d_867.html
- Face Velocity
  - Equations
    http://www.engineeringtoolbox.com/ductwork-equations-d_883.html
  - Tables
    http://www.engineeringtoolbox.com/duct-velocity-d_928.html

Pressure Drop Calculations

- On-line Ductulator
  http://efficientcomfort.net/asp/ResDuct_Web/ResDuct_Web.asp
- On-line Fitting Coefficients
  http://www.engineeringtoolbox.com/minor-loss-air-ducts-fittings-d_208.html
- Equipment
  - Energy Recovery Units
    http://www.grainger.com/category/ecatalog/N-1z0dkku?searchSortKey=priceAsc
  - Gaseous Phase Filter Media
    - Http://purafil.com
    - http://www.labconco.com/services/chemical-guide-for-filtered-enclosures
    - http://www.labconco.com/services/request-chemical-assessment

Chemical Assessment

- SIRI MSDS index
  http://hazard.com/msds/index.php
- CDC NIOSH Pocket Guide to Chemical Hazards
  http://www.cdc.gov/niosh/npg/default.html

Additional Resources

- Health & Safety Committee Conservation Wiki
  http://www.conservation-wiki.com/wiki/Health_%26_Safety

QUESTIONS:

1. PLEASE SHARE ANY HOME SOLUTIONS YOU'VE DEVELOPED THAT WE HAVEN'T ADDRESSED.
2. WHAT ARE YOUR IDEAS FOR THE DESIGN OF THE EXHAUST TABLE FOR THE PAPER CONSERVATOR?

- Large Paper Conservation
- Treatment with Ethanol
- Health & Safety Dept. Requires Fume Hood

SUMMARY

THANK YOU

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Principal, Director Of Cultural Practice

Daniel Klein, RA, LEED AP
Project Architect

Roger Rudy, PE
Fire Protection / Life Safety Engineer

William Jarema, PE
Mechanical Engineer

AIC

- Large Paper Conservation
- Treatment with Ethanol
- Health & Safety Dept. Requires Fume Hood

1.WHAT ARE YOUR IDEAS FOR THE DESIGN OF THE EXHAUST TABLE FOR THE PAPER CONSERVATOR?

THOUGHTS?