**Dust Collection and Combustible Dust for Secondary Wood Operations: Fundamentals and Safety**

**Handout Document:**

**Seminar WE 29, July 19, 2017**

**Robert Williamson, Nederman LLC**

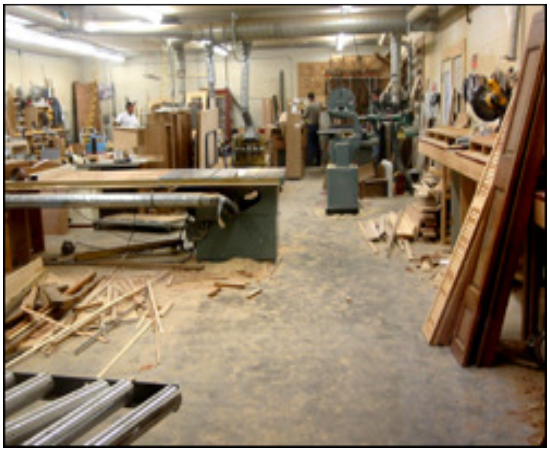
**College of Woodworking Knowledge Education Program**

Objectives:

Upon attending the session, participants will be able to:

1) Understand the health and economic benefits of installing and maintaining a properly designed dust collection system.
2) Survey their dust collection requirements and size the capacity of their dust collection system.
3) Identify the main components of a dust collection system and differentiate between the different types of filtration and source capture technologies.

## Section #1: Benefits of Effective Dust Collection



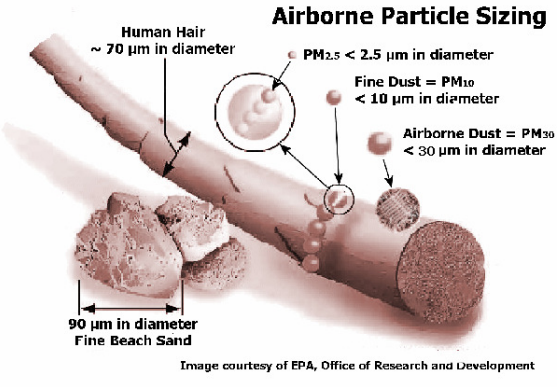
### Defining the Dust Issue:

1. Chips, shavings, coarse and fine dust are generated during the manufacturing process – cutting, routing, sanding, drilling etc.

2. Using compressed air to clean machines, the airborne dust will migrate a further distance from the original point of creation.

3. Processing any type of dried wood product will create fine dusts. Sanding operations and cutting and routing any type of composite materials will create higher volumes of fine dust.

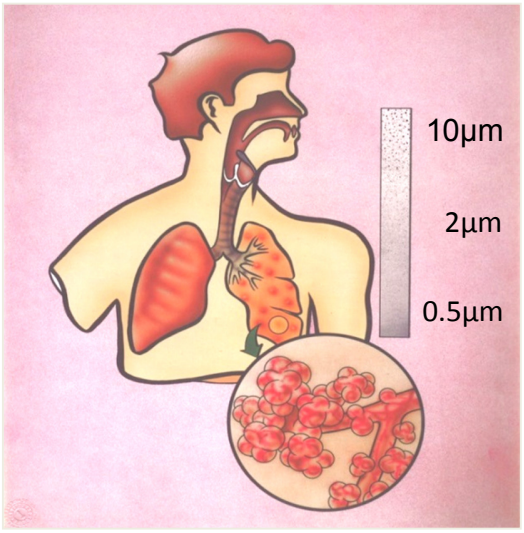
## Enemy #1: Dust




Benefits of Properly Designed System:

**Improve Health**

Chronic exposure to wood dust causes respiratory issues for workers and some wood species are likely to cause cancer.




*Exposure Limits:*

| PEL \ OSHA | TLV \ ACGIH |
|---|---|
| 5 mg / m3 | 1 (& 0.5) mg /m3 |
| Respirable Part | (Western Red Cedar) |
| | Listed Carcinogen |

**Increase Productivity and Product Quality:**
Improve cut quality and product finish by eliminating chip and dust marks on components. Visibility will increase with improvement in air quality.

**Reduce Safety Risk – Fire \ Explosion and Work Space Injuries:**
The conditions are in place with the addition of a competent igniter to start a fire and or an explosion in the work place. A significant event could lead to injuries to personnel and property loss, as well as the possible claims and litigation associated with this type of incident .

> ***Deadly Combination*** *= Combustible Dust x Ignition Source x Oxygen x Containment x Dispersion*


**Retain Skilled Employees:**
The average cost to train or replace worker is 35% to 45% of an employee's salary.

**Comply with Regulations:**
**OSHA** is implementing a National Emphasis Program on Combustible Dust Safety that includes random inspections of wood processing facilities. Based on published data, six citations per inspection are issued with an average penalty of $1,300.00.

## Excerpt from OSHA Combustible Dust Poster:

**Dust Control Measures**

- The dust-containing systems (ducts and dust collectors) are designed in a manner (i.e., no leaking) that fugitive dusts are not allowed to accumulate in the work area.
- The facility has a housekeeping program with regular cleaning frequencies established for floors and horizontal surfaces, such as ducts, pipes, hoods, ledges, and beams, to minimize dust accumulations within operating areas of the facility.
- The working surfaces are designed in a manner to minimize dust accumulation and facilitate cleaning.

**Ignition Control Measures**

- Electrically-powered cleaning devices such as vacuum cleaners, and electrical equipment are approved for the hazard classification for Class II locations.
- The facility has an ignition control program, such as grounding and bonding and other methods, for dissipating any electrostatic charge that could be generated while transporting the dust through the ductwork.
- The facility has a Hot Work permit program.
- Areas where smoking is prohibited are posted with “No Smoking” signs.
- Duct systems, dust collectors, and dust-producing machinery are bonded and grounded to minimize accumulation of static electrical charge.
- The facility selects and uses industrial trucks that are approved for the combustible dust locations.

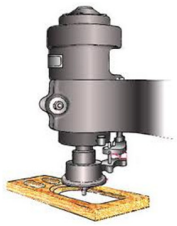
**Prevention Measures**

- The facility has separator devices to remove foreign materials capable of igniting combustible dusts.
- MSDSs for the chemicals which could become combustible dust under normal operations are available to employees.
- Employees are trained on the explosion hazards of combustible dusts.

**Protection Measures**

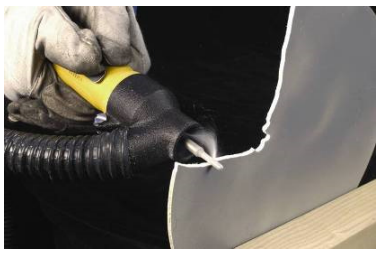
- The facility has an emergency action plan.
- Dust collectors are not located inside of buildings. (Some exceptions)
- Rooms, buildings, or other enclosures (dust collectors) have explosion relief venting distributed over the exterior wall of buildings and enclosures.
- Explosion venting is directed to a safe location away from employees.
- The facility has isolation devices to prevent deflagration propagation between pieces of equipment connected by ductwork.
- The dust collector systems have spark detection and explosion/ deflagration suppression systems.
- Emergency exit routes are maintained properly.

**Lower Cost by Extending Tool \ Blade Life:**
Without correct airflow, tool life is shortened due to heat build up and additional wear from unremoved waste and dust.



**<u>Address the Dust Issue: Source Capture Method</u>**

The best way to minimize dust problems is to avoid spreading the dust in the facility. This is done by capturing the dust as close to the source as possible.



## Section #2: Important Considerations in System Design:

### Machine Air Flow Requirements:

CFM = Cubic Feet Per Minute

**Standard Woodworking Machines:**
Rule of Thumb: Port Velocity = 4,500 FPM

Total Air Volume Requirement = Dust Port Area x Velocity (4,500 FPM)

| *Machine Port Diameter* | *Air Flow CFM @ 4,500 FPM* | *Machine Port Diameter* | *Air Flow CFM @ 4,500 FPM* | *Machine Port Diameter* | *Air Flow CFM @ 4,500 FPM* |
|---|---|---|---|---|---|
| **3”** | **220** | **6”** | **885** | **9”** | **1,990** |
| **4”** | **395** | **7”** | **1,205** | **10”** | **2,455** |
| **5”** | **615** | **8”** | **1,570** | **12”** | **3,535** |

**Multiple Ports: Example**
Machine with 1-4” & 1-6” Total Requirement = 395 + 885 = 1,280 CFM

**Speciality Machines:**

*High Speed Panel Processing:*
Port Velocity: 5,200 FPM

Wide Belt Sander:
1,000 – 1,200 CFM / Head

Moulder:
1,000–1,200 CFM / Head

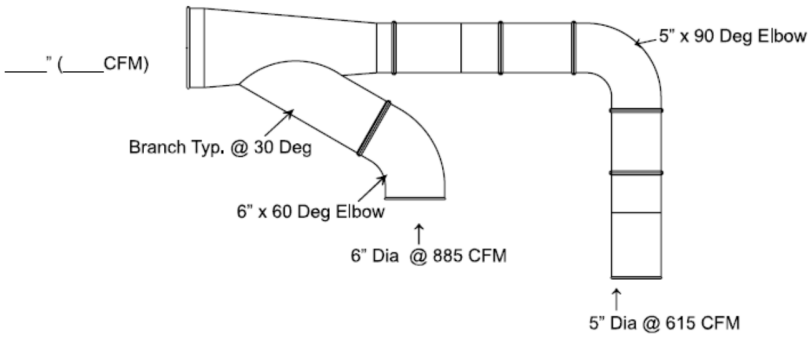
Rule of Thumb – Check with manufacturer to obtain specification on individual makes and models.

## Pipe Sizing and Specification:

### Step by Step Design Process:

1. Determine minimum duct velocity: Dry Wood Dust and Chips = 4,000 FPM
2. Determine pick up diameters/CFM (see Air Volume table from catalogue)
3. Calculate total CFM
4. Layout Main Trunk Line
5. Calculate total system static pressure
6. Select Fan to meet system requirements.

***Size the Pipe Exercise:***




EXAMPLE: Always work from your machines back toward the filter. Suppose that you have a 5" drop that rises and runs back to join with a 6" drop as sketched above. What size branch will you need?

1,500 CFM @ 4,500 FPM: Select a 8" Diameter Pipe

| AIR VOLUME IN DUCTS IN CUBIC FEET PER MINUTE (CFM) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| VELOCITY IN FEET PER MINUTE (FPM) | | | | | | | | | | | |
| DUCT Ø | 2000 | 2500 | 3000 | 3500 | 4000 | 4500 | 5000 | 5500 | 6000 | 6500 | 7000 |
| 3 | 100 | 125 | 150 | 170 | 195 | 220 | 245 | 270 | 295 | 320 | 345 |
| 4 | 175 | 220 | 260 | 305 | 350 | 395 | 440 | 485 | 525 | 570 | 615 |
| 5 | 275 | 340 | 410 | 475 | 545 | 615 | 680 | 750 | 820 | 885 | 955 |
| 6 | 395 | 490 | 590 | 685 | 785 | 885 | 980 | 1080 | 1180 | 1275 | 1375 |
| 7 | 535 | 670 | 800 | 935 | 1070 | 1205 | 1335 | 1470 | 1605 | 1735 | 1870 |
| 8 | 700 | 875 | 1050 | 1220 | 1395 | 1570 | 1745 | 1920 | 2095 | 2270 | 2445 |
| 9 | 885 | 1105 | 1325 | 1545 | 1765 | 1990 | 2210 | 2430 | 2650 | 2870 | 3090 |
| 10 | 1090 | 1365 | 1635 | 1910 | 2180 | 2455 | 2725 | 3000 | 3270 | 3545 | 3820 |
| 11 | 1320 | 1650 | 1980 | 2310 | 2640 | 2970 | 3300 | 3630 | 3960 | 4290 | 4620 |
| 12 | 1570 | 1965 | 2355 | 2750 | 3140 | 3535 | 3925 | 4320 | 4710 | 5105 | 5500 |
| 13 | 1850 | 2300 | 2770 | 3225 | 3685 | 4150 | 4610 | 5070 | 5530 | 5990 | 6450 |
| 14 | 2140 | 2675 | 3205 | 3740 | 4275 | 4810 | 5345 | 5880 | 6415 | 6950 | 7485 |
| 15 | 2450 | 3070 | 3680 | 4300 | 4900 | 5520 | 6130 | 6750 | 7360 | 7970 | 8590 |
| 16 | 2790 | 3490 | 4190 | 4885 | 5585 | 6285 | 6980 | 7680 | 8380 | 9075 | 9775 |
| 17 | 3150 | 3940 | 4730 | 5515 | 6300 | 7090 | 7880 | 8670 | 9450 | 10240 | 11030 |
| 18 | 3535 | 4420 | 5300 | 6185 | 7070 | 7950 | 8835 | 9720 | 10600 | 11485 | 12370 |
| 20 | 4365 | 5455 | 6545 | 7635 | 8725 | 9815 | 10910 | 12000 | 13090 | 14180 | 15270 |
| 22 | 5280 | 6600 | 7920 | 9240 | 10560 | 11880 | 13200 | 14520 | 15840 | 17160 | 18480 |
| 24 | 6285 | 7855 | 9425 | 10995 | 12656 | 14135 | 15710 | 17280 | 18850 | 20420 | 21995 |
| 26 | 7370 | 9210 | 11055 | 12900 | 14740 | 16580 | 18420 | 20270 | 22110 | 23950 | 25800 |
| 28 | 8550 | 10685 | 12820 | 14960 | 17100 | 19230 | 21310 | 23500 | 25650 | 27780 | 29920 |
| 30 | 9800 | 12260 | 14700 | 17170 | 19625 | 22080 | 24530 | 26990 | 29440 | 31890 | 34350 |
| 32 | 11160 | 13950 | 16750 | 19541 | 22330 | 25120 | 27910 | 30700 | 33490 | 26280 | 39070 |
| 34 | 12600 | 15755 | 18905 | 22055 | 25210 | 28360 | 31510 | 34660 | 37810 | 40965 | 44115 |
| 36 | 14130 | 17665 | 21195 | 24730 | 28260 | 31800 | 35325 | 38860 | 42390 | 45925 | 49455 |
| 38 | 15745 | 19680 | 23615 | 27550 | 31490 | 35425 | 39360 | 43295 | 47230 | 51170 | 55100 |
| 40 | 17445 | 21800 | 26170 | 30530 | 34890 | 39250 | 43610 | 47975 | 52330 | 56700 | 61055 |

## Dust Collector Technology:

**Dust Collector Selection Criteria:**

**Air-to-Cloth Ratio:** The amount of air or process gas entering the baghouse divided by the sq. ft of cloth in the baghouse.

***Example:***

(bag diameter in inches x pi x bag length in inches)
Bag Diameter (D) = 4.875in. (0.41ft.)
Bag Length (L) = 96in. (8.00ft.)
Area / Bag (A) = (Pi x D x L) = 10.2ft$^2$
# of Bags in Baghouse = 200
Total Filter Area Baghouse = 2,042ft$^2$
Assume the Baghouse is Handling = 10,000 CFM
Air to Cloth Ratio = (ACFM / Total Filter Area) = 4.90ft/min = 4.9:1

**Positive Pressure Baghouse:** A system with a fan located prior to a baghouse on the dirty side, pushing air through the system.

**Negative Pressure Baghouse:** A system where the fan is located after the baghouse on the clean air side, pulling air through the system.

**Dust Collector Selection Criteria:**

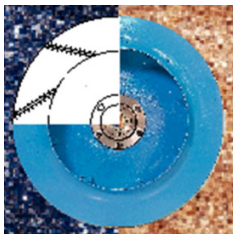
1. More effective filter area = higher filtration efficiency and stable pressure drop.
2. Lower RPM Fan = reduced noise emissions.
3. Meets NFPA standards for enclosureless dust collector.
4. Weight and type of media will affect bag life.

**Enclosureless Dust Collector Features:**

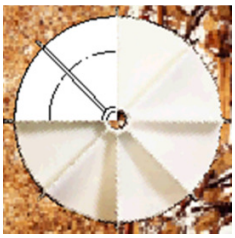
- ✓ Dust on inside of filter media – clean air to surrounding area
- ✓ Filter media is not enclosed
- ✓ No shaker or pressure pulse while fan is on
- ✓ Filter media is under positive pressure
- ✓ Dust <u>not</u> removed continuously or mechanically

**Centrifugal Fan Selection Criteria:**

Curved Backward Inclined
Clean Air Application



Straight Backward Inclined
Dirty Air \ Chip Application



Straight Radial Blade
Dirty Air \ Transport Waste

**Energy Efficiency**

## Compliance with NFPA 664 :

**Purpose of Standard:**
Establish minimum requirements for fire and explosion prevention and protection.
**Scope:**

- Industrial, commercial or institutional facilities.
- Company processes wood or is a manufacturer of wood products: Using wood or other cellulosic fiber as a substitute for or additive to wood fiber.
- Process creates wood chips, particles or dust.

**Limitations:**
Minimum size of facility covered by NFPA 664 Standard:
Woodworking operation area more than 5,000 $ft^{2.}$
Or
Dust collection requirements > 1,500 CFM (8" duct).

**Authority Having Jurisdiction (AHJ):**
An organization, office, or individual responsible for enforcing the requirements of a code or standard, or for approving equipment, materials, an installation, or a procedure.

## Chapter 8: Processes, Operations and Special Systems

### Dust Collector Location: Acceptable Alternatives

1. Outside of building
2. Indoors with no fire or deflagration hazard
3. Indoors with only fire hazard with proper protection
4. Indoors with listed deflagration suppression system
5. Indoors with deflagration relief vents with relief pipe extended to safe area outside building
6. Indoors with deflagration relief vent vented through listed flame-quenching devices
7. Indoors for enclosureless dust collector

### Dust Collector: Indoor Location ( #7)

Meets the Enclosureless DC criteria & the following:

- ✓ Pickup from wood processing machinery no metal or fumes
- ✓ Not used for sanders, molders or abrasive planers having mechanical feeds through machines
- ✓ Maximum 5,000 CFM capacity
- ✓ Fan motor is TEFC
- ✓ Dust is removed daily or more frequently if necessary
- ✓ Located 20 ft. from any means of egress or area routinely occupied by personnel
- ✓ Multiple collectors in same room separated by at least 20 ft.

**Dust Collector: Outdoor Location ( #1) with Return Air**

***Clean air can be returned if:***

- ✓ System efficiency > 99.9 at 10 micron
- ✓ No gasses or hybrid mixtures
- ✓ If a fire hazard:

**Systems < than 5,000 CFM**

Listed spark detection and extinguishing system upstream of dust collector and downstream of last entry point

**Systems > than 5,000 CFM**

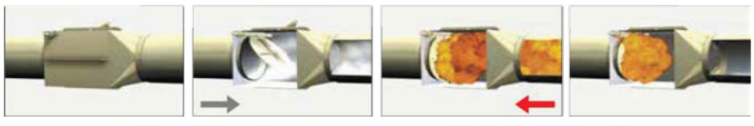
Spark detection system as above
High speed abort gate activated by spark detector and sufficiently fast to divert burning material
Abort gate must be reset at the gate either mechanically or electrically
No remote reset

**Dust Collector: Isolation from Workspace \ Critical Process Equipment**

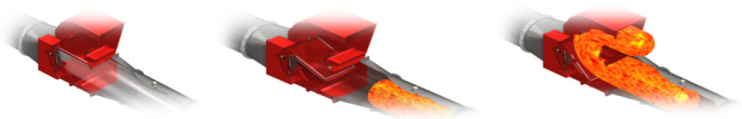
*Prevent propagation of fire and deflagration both upstream and downstream into occupied area or other critical process equipment.*

Exception: Enclosureless Dust Collector

**Passive Device:** Explosion Isolation Flap for Dirty Supply Pipe




**Active Device:** High Speed Abort for Clean Return Air – (Activated by Spark Detection)



## Section #3: Real World Scenario

**TOP TEN CONSIDERSATIONS WHEN SPECIFYING A SYSTEM:**

**1 What is the total air volume or do you have your machinery port sizes?**
*What is the CFM requirement of the system?*

**2 What kind of materials are you working with and how much dust do you think you'll produce?**
*Hardwood, MDF, particle board / 100 gallons/hr, 100 yards/week.*

**3 What kind of machines or operation are we extracting from and do you have list of those machines?** *Beam Saw, CNCs, Grinders, etc.*

**4 Where do you want to put the collector?** *Inside, outside, how far will it be from the furthest machine?*

**5 Do you plan to expand your operation?** *Adding CFM in the future?*

**6 How long will the collector be in use every day ?** *Single shift, 24/7, how many breaks?*

**7 What voltage do you have in the facility? 460 V / 3 PH / 60 Hz**

**8 Do you pay to heat or air condition the facility ?** *Are we returning the air?*

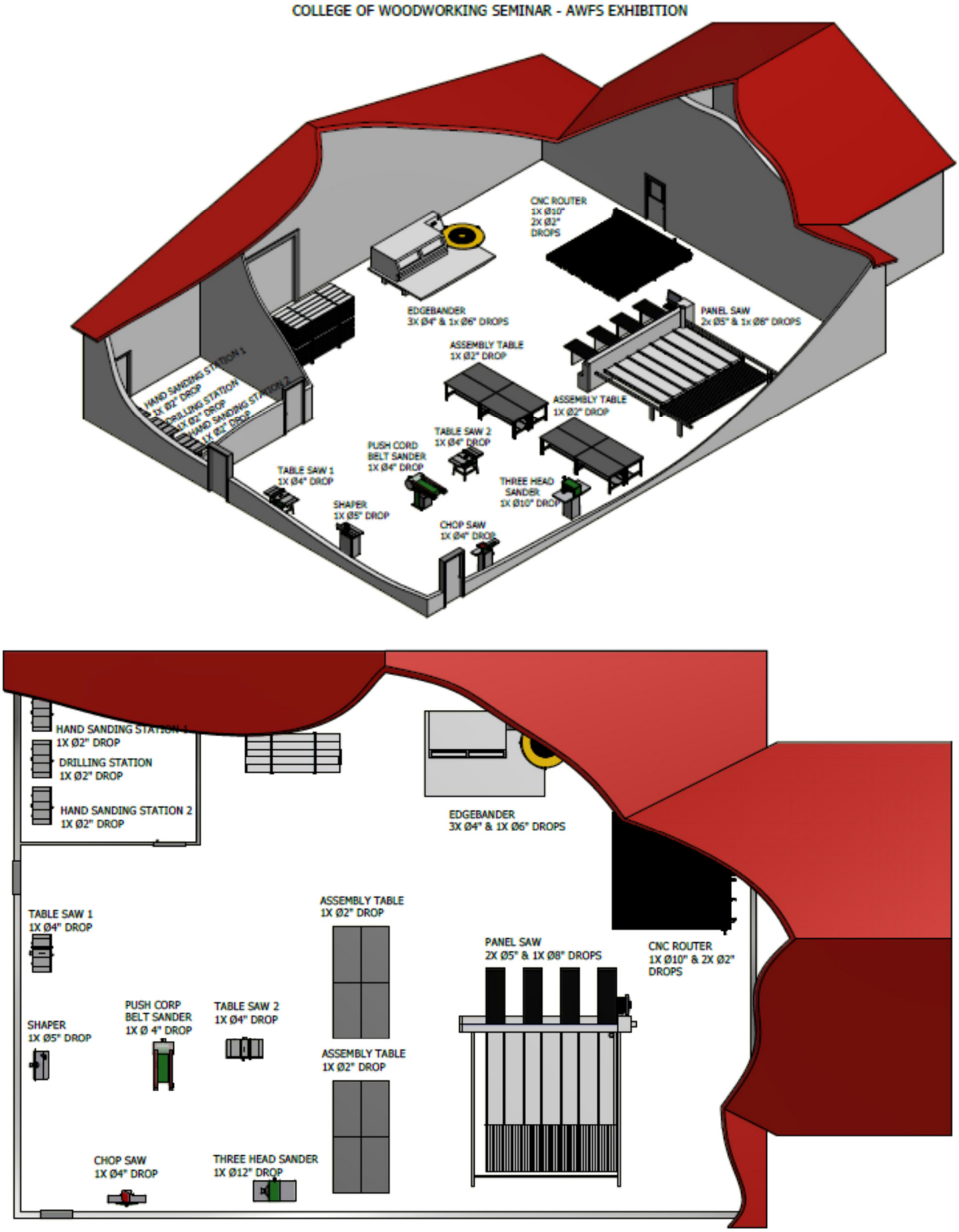
**9 How do you want to collect the dust?** *Plastic bags, barrels, dumpster?*

**10 Do you have specialty equipment –** moulder, CNC router, wood waste grinder.

**Calculation of the Dust Collection Requirements: Scenario #2**

| WS # | Workstation Name | Hood Description | Connection Velocity | SCFM @ Conn Velocity |
|---|---|---|---|---|
| 1 | Table Saw 1 | Machine Connection | 4,500 | 393 |
| 2 | Chop Saw | Back Table Hood | 4,500 | 393 |
| 3 | Table Saw 2 | Machine Connection | 4,500 | 393 |
| 4 | Belt Sander | Machine Connection | 4,500 | 614 |
| 5 | Shaper | Machine Connection | 4,500 | 614 |
| 6 | Three Head Sander | Manifold | 4,500 | 3,534 |
| 7 | Edgebander | Machine Connection | 5,200 | 2,382 |
| 8 | CNC - Point to Point | Machine Connection | 6,500 | 3,545 |
| 9 | Panel Saw | Machine Connection | 5,200 | 3,233 |
| 10 | | | 4,500 | 0 |
| 11 | | | 4,500 | 0 |
| | | **TOTALS** | **4,809** | **15,100** |
| | | **Add Future Capacity** | **0** | **0** |
| | | **100% CAPACITY TOTAL** | **4,809** | **15,100** |

## Example Facility:



**Estimate Fan Energy Consumption:**

| | Annual Energy Cost of Fan Operation ( 16 Hrs Per Day x 5 Days Per Week x 50 Weeks Per Year) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | $ Per KWH | 0.06 | 0.08 | 0.10 | 0.12 | 0.14 | 0.16 | 0.18 | 0.20 |
| Fan HP | 25 | $4,474 | $5,965 | $7,456 | $8,947 | $10,438 | $11,930 | $13,421 | $14,912 |
| | 50 | $8,947 | $11,930 | $14,912 | $17,894 | $20,877 | $23,859 | $26,842 | $29,824 |
| | 100 | $17,894 | $23,859 | $29,824 | $35,789 | $41,754 | $47,718 | $53,683 | $59,648 |
| | 200 | $35,789 | $47,718 | $59,648 | $71,578 | $83,507 | $95,437 | $107,366 | $119,296 |
| | 300 | $53,683 | $71,578 | $89,472 | $107,366 | $125,261 | $143,155 | $161,050 | $178,944 |
| | 500 | $89,472 | $119,296 | $149,120 | $178,944 | $208,768 | $238,592 | $268,416 | $298,240 |
| | 1000 | $178,944 | $238,592 | $298,240 | $357,888 | $417,536 | $477,184 | $536,832 | $596,480 |
| | | Calculated at 100% Load | | | | | | | |

**Payback of Returning Clean Air to Building:**

## Make Up Air Costs for Heating Air:

| Facility Location: | Air Volume: | Heating Degree Days | 1 Shift \ Hours | 2 Shifts \ Hours | 3 Shifts \ Hours | Return Air |
|---|---|---|---|---|---|---|
| | | | 2,000 | 4,000 | 6,000 | Investment |
| | SCFM | | *Make Up Air Costs: Annual Cost USD* | | | |
| St Louis, MO | 10,000 | 6023 | $7,838 | $15,677 | $23,515 | $20,000 |
| Pittsburgh, PA | 10,000 | 5968 | $7,767 | $15,534 | $23,300 | $20,000 |
| Seattle, WA | 10,000 | 4611 | $6,001 | $12,002 | $18,002 | $20,000 |
| Omaha, NE | 10,000 | 6413 | $8,346 | $16,692 | $25,038 | $20,000 |
| Los Angeles, CA | 10,000 | 1458 | $1,897 | $3,795 | $5,692 | $20,000 |

| | | |
|---|---|---|
| *Discharge Air Temperature:* | *65* | *Fahrenheit Degrees* |
| *Available Heat Per Unit Fuel:* | *106500* | *BTU Per Unit* |
| *Energy Cost Per Unit:* | *2.25* | *USD Per Gallon* |
| *Return Air Cost:* | *2* | *USD Per CFM* |

## Simple Payback for Return Air Investment:

| Facility Location: | Air Volume: | Heating Degree Days | 1 Shift \ Hours | 2 Shifts \ Hours | 3 Shifts \ Hours | Return Air |
|---|---|---|---|---|---|---|
| | | | 2,000 | 4,000 | 6,000 | Investment |
| | SCFM | | *Simple Payback - Years* | | | |
| St Louis, MO | 10,000 | 6023 | 2.55 | 1.28 | 0.85 | $20,000 |

**Pipe Sizing and Layout:**

## FIVE TAKE AWAYS FROM TODAY'S PRESENTATION:

1. *New Paradigm : Dust Collection is essential to a high performing and profitable woodworking facility.*

2. *Best way to address the Dust Issue is at the source.*

3. *When looking at different options, make sure you are comparing apples to apples. The lowest price up front may have a significantly higher cost of ownership over the lifespan of the system.*

4. *Get to know your AHJs – they will be critical in the design process and ongoing compliance with regulations.*

5. *Knowledge is power. Take this information and put it to use in your plant.*

### Resource References:

1.) **National Fire Protection Association** is a non-profit organization that develops, publishes, and disseminates consensus codes and standards intended to minimize the possibility and effects of fire and other risks.

**2.) NFPA 664: Standard for the Prevention of Fires and Explosions in Wood Processing and Woodworking Facilities, 2017 Edition.**

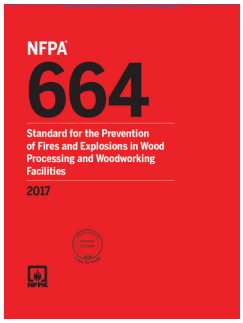
3.) **OSHA** is implementing a National Emphasis Program on Combustible Dust Safety that includes random inspections of wood processing facilities.

### Book and Documents:

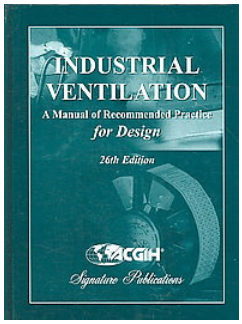
a. **NFPA 664: Standard for the Prevention of Fires and Explosions in Wood Processing and Woodworking Facilities, 2017 Edition.**

b. **A Guide for Protecting Worker from Woodworking Hazards, Small Business Management Series, US Department of Labor, OSHA 3157 – 1999**

c. **Industrial Ventilation: A Manual of Recommended Practice, 27th Edition**







**Speaker Bio:**

**Robert Williamson** is the North American Sales Director of Nederman LLC. Having worked in the air pollution control industry for over 20 years, Rob is well versed in the successful planning and execution of industrial filtration projects. In addition to his BSME and PMP certification, Rob holds an MBA from Wake Forest University. His projects and expertise include; fabric filters, centrifugal separators, pipe systems, energy management controls and explosion and fire safety systems. His current work involves assisting clients in meeting regulations on combustible dusts and lowering the costs of ownership of air pollution control systems.

Nederman

Nederman is a world leader in the design, manufacture, installation and service of industrial air pollution control equipment. Nederman currently has locations in the U.S., Brazil, China, Denmark, Finland, France, Germany, Poland, Russia, Sweden, Thailand, Ukraine and the United Kingdom.

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