

COMBUSTIBLE DUST HAZARD MITIGATION

February 2014



FIPI Fire Inspection & Prevention Initiative

FITF Forest
Industry
Task Force

GUIDE FOR FRONT LINE SUPERVISORS AND MANAGEMENT

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COMBUSTIBLE DUST HAZARD MITIGATION

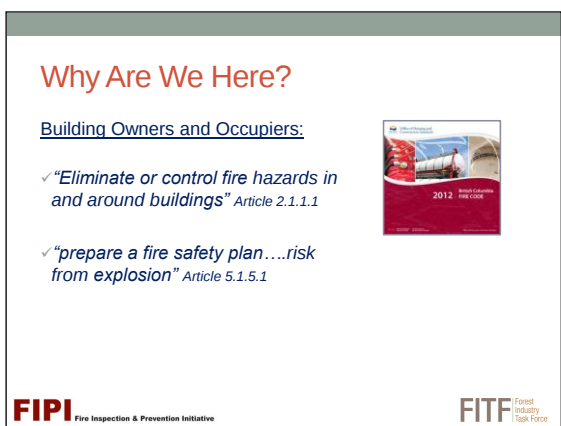
A] COMBUSTIBLE DUST HAZARD MITIGATION



Hazards known for years

NFPA Standards are effective and authoritative

A.1] WHY ARE WE HERE?



Combustible Dust – a fire prevention and control issue and an occupational safety issue

Eliminate or control fire hazards in and around buildings – Article 2.1.1.1.

The Occupational Health and Safety Regulation

The BC Safety Standards General Regulation and related regulations

The BC Fire Code

Eliminate or control fire hazards in and around buildings – Article 2.1.1.1.

Eliminate and control fire hazards using BC Fire Code Acceptable Solutions where required

Prepare a fire safety plan Risk from explosion – Article 5.1.5.1

Fire Safety Plan – Development Guide for Industrial Occupancies

Why Are We Here?



Understand available controls to mitigate combustible dust accumulation and eliminate ignition sources.

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May need use of subject matter experts

A.2] VIDEO – “NOT ENOUGH WAS DONE”

A.2.1] BEFORE VIDEO



US Chemical Safety Board’s investigation findings into the cause of the explosion and recommendations to prevent a similar explosion.



A.2.2] AFTER VIDEO

Did not do enough to mitigate the combustible dust risk.

Lulled management into complacency

Apply NFPA Standards to the design and operation of the rebuilt Port Wentworth facility.

Develop and implement comprehensive combustible dust control, housekeeping and training programs.

Improve emergency evacuation policies and procedures.

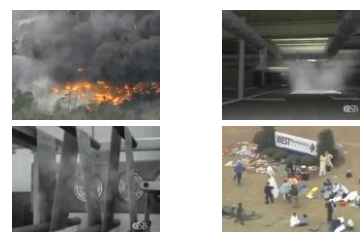
A.3] VIDEO – “FACILITIES DO NOT PROPERLY ASSESS”

A.3.1] BEFORE VIDEO



The next video clip re-creates an explosion that occurred because the facility did not properly assess the risk of a combustible dust fire or explosion.

Key video takeaways



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A.3.2] AFTER VIDEO

If you don't assess the risk properly you cannot properly design the building and equipment.

Key video takeaways



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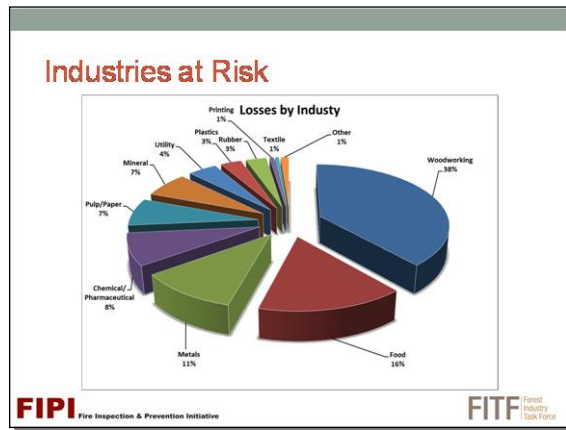
BC wood dust can be explosion hazard in any BC sawmill

Resource: Chemical Safety Board Video – *Combustible Dust: An Insidious Hazard*

Reference: Combustible Dust Testing Sampling

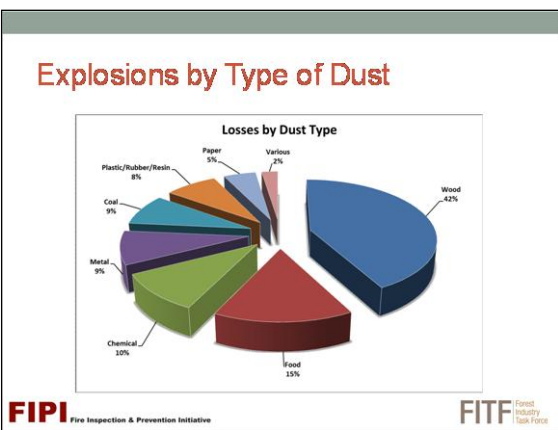
http://www.worksafebc.com/news_room/features/2012/assets/pdf/CombustibleDustTestingSamplingReferencesResources.pdf

A.4] CHART—INDUSTRIES AT RISK



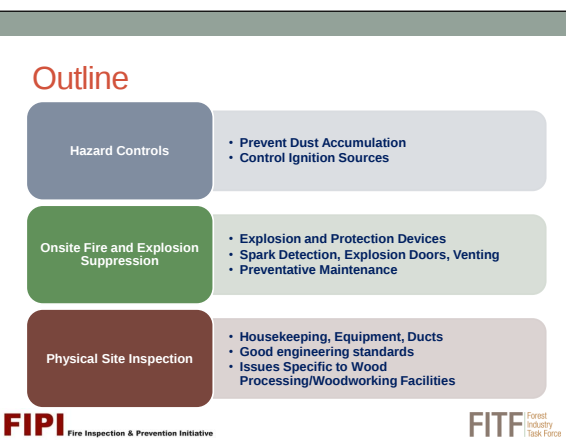
Source: FM Global Property Loss Prevention Data Sheets 7-76 Prevention and Mitigation of Combustible Dust Explosion and Fire.

A.5] CHART—EXPLOSIONS BY TYPE OF DUST



Source: FM Global Property Loss Prevention Data Sheets 7-76 Prevention and Mitigation of Combustible Dust Explosion and Fire.

A.6] WORKSHOP OUTLINE



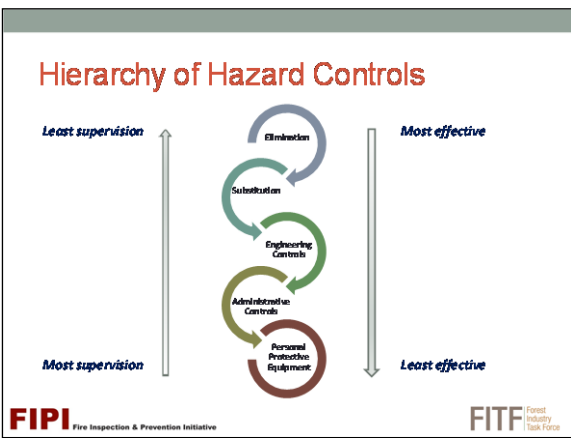
B] HAZARD CONTROLS—PREVENT ACCUMULATION OF COMBUSTIBLE DUST

HAZARD CONTROLS

Prevent accumulation of combustible dust

In this next module, we will discuss different types of controls that can be used to prevent the accumulation of combustible wood dust in the general workplace.

B.1] HIERARCHY OF HAZARD CONTROLS



B.2] IDENTIFY DUST ACCUMULATION AREAS

Where is the Dust?

Processes

Which processes produce combustible dusts.



Accumulations

Where does the dust accumulate?



Fugitive Dust

Proper design for dust-containing systems.



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B.3] ENGINEERING CONTROLS TO PREVENT ACCUMULATION

Engineering Controls





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B.3.1] CONSTRUCTION FEATURES

1) Construction Features

Proper construction can

- Prevent and reduce dust escape from processing equipment
- Reduce dust and debris accumulations
- Simplify and complement good housekeeping practices
- Limit the spread of damage should an event occur



Shaping on edges to minimize dust accumulation



Welded seams and covered glass panels to prevent leaks

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B.3.1.2] EXAMPLES OF GOOD CONSTRUCTION PRACTICES



Sealing of Cableways to prevent dust migration.

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Vertical cable trays to minimize dust accumulation.

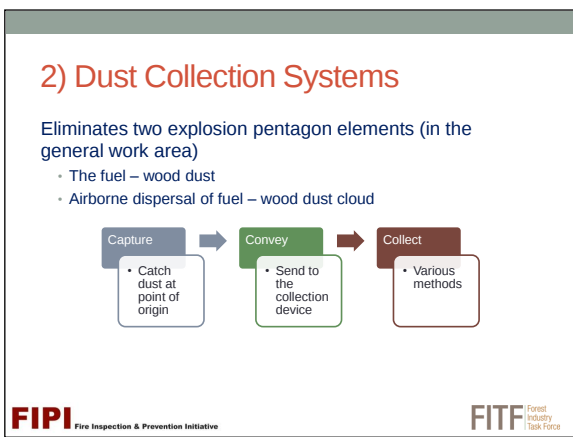
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A word of caution: This passive containment system is effective and safe when properly designed but can increase the risk of an explosion if improperly designed and/or operated. Recall from the Combustible Dust Hazard Recognition workshop that the primary explosion at the Imperial Sugar plant was in a fully enclosed belt conveyor system.

B.3.2] DUST COLLECTION SYSTEMS



B.3.2.2] CAUTION

Only missing element: “Ignition Source”

BC Fire Code – minimum explosion equipment

Going beyond minimum good business sense

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Dust Collection Systems

Caution!

"4 of 5 explosion pentagon elements are present within the dust collection system"

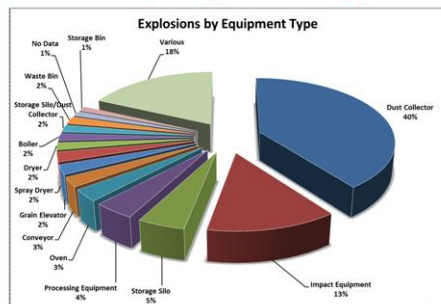
Which one is missing?

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Explosions by Equipment Type



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B.3.3] CHART—EXPLOSIONS BY EQUIPMENT TYPE

Source: FM Global Property Loss Prevention Data Sheets 7-76
Prevention and Mitigation of Combustible Dust Explosion and Fire.

B.3.4] DUST COLLECTION SYSTEM EXAMPLES

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Dust Collection Systems

Baghouses



Cyclones



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Enclosureless Dust Collectors






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B.3.5] SOURCE COLLECTION AND TRANSPORT

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Source Collection and Transport



- Hood capture and transport



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COMMON DESIGN FLAWS AND/OR MAINTENANCE PITFALLS – DUST COLLECTION EQUIPMENT

Common Design Flaws/Maintenance Pitfalls

- Poor / inadequate maintenance programs
- Non-engineered modifications
- Failure to replace / repair collection point / ducting damage






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B.3.6] PASSIVE CONTAINMENT

3) Passive Containment



1. Identify areas that produce fugitive dust.
2. Look for ways to enclose/contain it in that location.

Are passive containment controls in place at:

- Primary Machine Centres
- Conveyance systems

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B.3.7] MISTING

4) Misting

Uses water or chemical to knock down airborne dust.



Cautions:

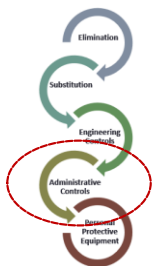
- Use around electrical equipment
- Clogging of filters
- Use in winter weather

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B.4] ADMINISTRATIVE CONTROLS TO PREVENT ACCUMULATION

Administrative Controls



Examples of administrative controls:

- Housekeeping
- Safe work procedures
- Hot work permits
- Preventative maintenance

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B.4.1] HOUSEKEEPING

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1) Housekeeping



"... facilities that are well maintained experience fewer fires, explosions and other accidents ..."

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Prevent accumulations from reaching 1/8"

Safe work procedures are required

HOUSEKEEPING—PROPER EQUIPMENT

Housekeeping—Proper Equipment

- Required for safe housekeeping
- Safe if used as described in the safe work procedures
- Preferred — Use approved vacuum for dust collection
- Possible — Regular Shop Vac



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GROUP DISCUSSION – HOUSEKEEPING SCENARIO

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Group Discussion



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B.5] PREVENTATIVE MAINTENANCE

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2) Preventative Maintenance

1. What to maintain?
2. Why?
3. What does an effective Maintenance Program accomplish?

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1. Why? ... to function properly

2. What to maintain? ... explosion prevention equipment

B.6] MANAGEMENT OF CHANGE

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3) Management of Change Process

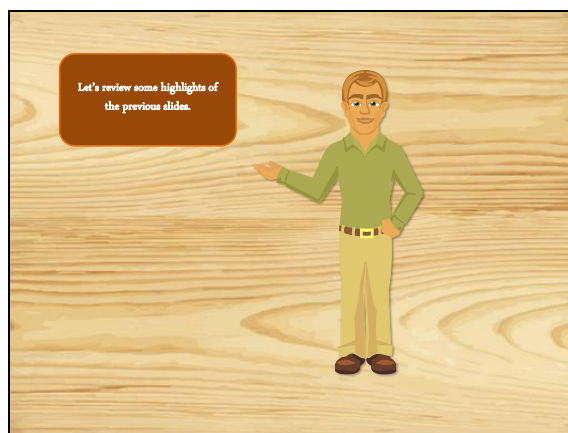


Make sure no changes occur that could increase the severity or consequence of an existing dust hazard or introduce a dust hazard where none previously existed.

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C] KNOWLEDGE CHECK #1



KNOWLEDGE CHECK 1.1

Knowledge Check 1.1

 Put the controls in the correct hierarchy order

PPE	_____
Engineering Controls	_____
Substitution	_____
Administrative Controls	_____
Elimination	_____

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KNOWLEDGE CHECK 1.2

Knowledge Check 1.2

 Are these engineering controls active or passive?

Construction features	_____
Dust Collectors	_____
Passive Containment	_____
Misting	_____

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KNOWLEDGE CHECK 1.3

Knowledge Check 1.3

 Fill in the blanks

3 a) Frequent housekeeping prevents the _____ of dust.

3 b) The only explosion pentagon element missing inside a dust collector is the _____ source.

3 c) Preventive maintenance keep equipment in a good state of _____ so that they continue function effectively.

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D] HAZARD CONTROLS—CONTROL OF IGNITION SOURCES

HAZARD CONTROLS

Control of Ignition Sources

In this next module, we will discuss different types of controls that can be used on potential ignition sources in the general workplace.

D.1] CONTROLLING IGNITION SOURCES

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Controlling Ignition Sources



1. Use intrinsically safe equipment
2. Substitute motors and gear reducers for models that produce less heat.
3. Use Bonding and Grounding to prevent static build-up; shield combustible material from heat source
4. Allow equipment to cool down
5. Wear conductive footwear to bond with grounded floor/wear flame-resistant clothing

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D.1.1] WHAT TYPE OF CONTROL IS IT?

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What Type of Control Is It?

Hot Works	• Policy and procedures
Hot Surfaces	• Remove • Shield/isolate, encapsulate
Temporary Heating Equipment	• Policy and procedures • Prohibit
Friction	• Monitor equipment and clean on regular basis
Machine & Processing Equipment	• Inspect and maintain to prevent overheating and mechanical sparking • Replace with units that produce less heat • Use non-spark producing materials
Electrical Systems	• Isolate • Design for use in dusty environment

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D.1.2] WHAT TYPE OF CONTROL IS IT? (CONT'D)

36

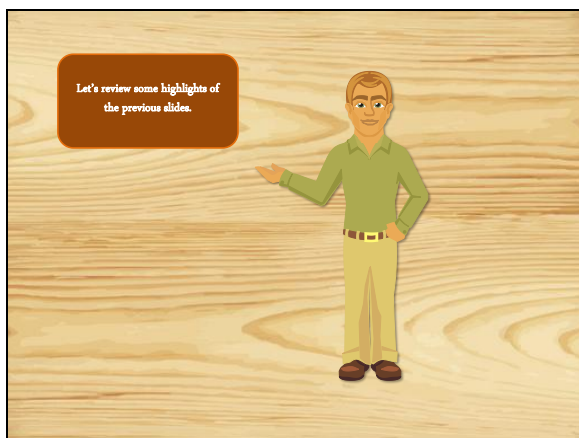
What Type of Control Is It? (cont'd)

Static electricity	• Bond and ground
Tramp Metal/Foreign Contamination	• Use metal detectors, magnetic separation, air density separation
Facility Lighting	• Protect or shield, dust-tight fixtures
Smoking	• Prohibit • Provide safe designated outdoor location

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E] KNOWLEDGE CHECK #2



KNOWLEDGE CHECK 2.1

Knowledge Check 2.1

Put the controls in the correct hierarchy order



Mechanical Friction

Conveyor belts

Exposed electrical
wires

Space Heaters

Open breaker panels

Misaligned fan blades

Welding equipment

**Portable Ignition
Sources**

Electrical

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F] EXPLOSION PROTECTION—DUST COLLECTORS

EXPLOSION PROTECTION

Dust Collectors

In this next module, we will discuss different types of explosion protection equipment that is used in dust collectors.

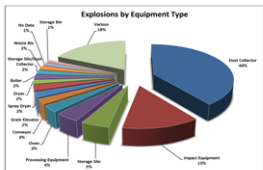
F.1] WHY?

39

Explosion Protection – Dust Collection Systems

Why?

- 40% of primary explosions originate somewhere in the dust collection system



Equipment Type	Percentage
Dust Collector	40%
Process Equipment	25%
Storage Silos	15%
Transfer Systems	10%
Other	10%

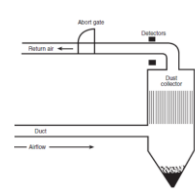
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F.2] EXPLOSION PROTECTION METHODS

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Explosion Protection Methods

- Containment
- Inerting
- Deflagration Venting
- Deflagration Suppression
- Deflagration Isolation



Passive or Active?

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F.2.1] CONTAINMENT

41

Explosion Protection Methods

- Containment
- Build it strong!



Passive or Active?

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F.2.2] INERTING

42

Explosion Protection Methods

- Inerting
- Get rid of the air!



Passive or Active?

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F.2.3] DEFLAGRATION VENTING

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Explosion Protection Methods

- Deflagration venting
- Vent to a safe location!



Passive or Active?

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F.2.4] DEFLAGRATION SUPPRESSION

44

Explosion Protection Methods

- Deflagration Suppression
- Prevent the explosion!

Passive or Active?

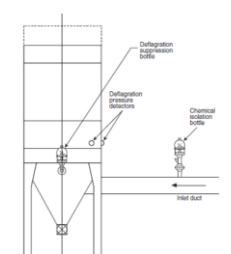


FIGURE B.5.2 Dust Collector Suppression System.

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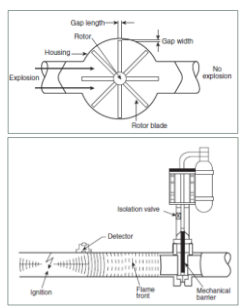
F.2.5] DEFLAGRATION ISOLATION

45

Explosion Protection Methods

- Deflagration Isolation
 - Mechanical
 - Chemical
- Prevent the spread!
- Use – process equipment interconnected by pipes or ducts

Passive or Active?



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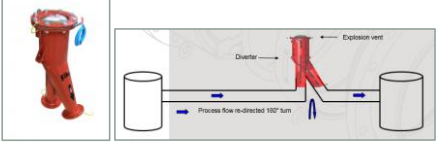
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F.2.6] FLAME FRONT DIVERTERS

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Explosion Protection Methods

- Flame Front Diverters have limitations



Passive or Active?

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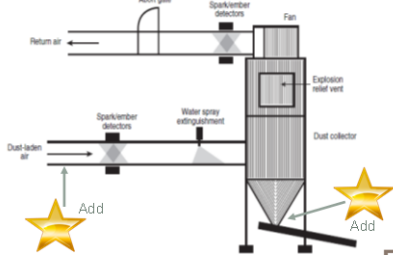
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F.2.7] EXPLOSION PROTECTION SYSTEMS

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Explosion Protection Methods

Explosion Protection Systems

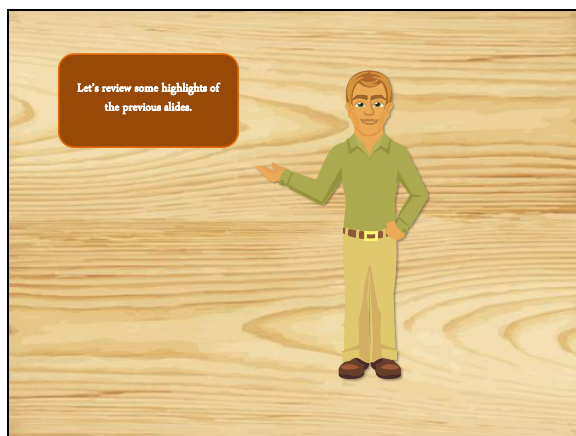


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G] KNOWLEDGE CHECK #3



KNOWLEDGE CHECK 3.1

Knowledge Check 3.1



Match Passive and Active

**Reacts to and
controls the
explosion**

**Detects and reacts
prior to or during an
explosion**

**Passive Explosion
Protection**

**Active Explosion
Protection**

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KNOWLEDGE CHECK 3.2

Knowledge Check 3.2



Match phrases

Containment

Inerting

Deflagration Venting

Deflagration

Suppression

Deflagration Isolation

**Prevent the
explosion**

**Vent to safe
location**

Prevent the spread

Build it strong

Get rid of the air

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H] PHYSICAL SITE INSPECTION—COMBUSTIBLE DUST HAZARD

PHYSICAL SITE
INSPECTION

Combustible Dust Hazard

In this next module, we will discuss the visual combustible dust accumulation that might be observed in the workplace.

H.1] MAJOR EXPLOSION RISKS

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Major Explosion Risks

General work area

- Combustible (secondary) dust levels above 1/8"

Dust collection system

- Dust collectors located inside
- Non-existent inlet backflow prevention
- Dust collectors without vents or with undersized vents
- Inadequate safe blast zone
- Non-existent or non-functioning abort gate (recycled air)
- Inadequate dust collector hopper discharge isolation

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Let's re-cap a bit.

H.2] WHAT TO LOOK FOR

H.2.1] DUST COLLECTING AROUND THE DUST CAPTURE POINT

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Look Out For....

Dust not being captured.

What action can you take?



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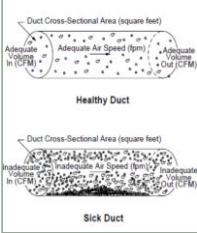
Improper hood and/or duct work design
 Insufficient capacity or capture velocity
 Blockage
 Inadequate maintenance

Clean up accumulation
 Take action to improve efficacy of dust capture

H.2.2] DUST BUILDUP INSIDE DUST TRANSPORT DUCTWORK

Look Out For....

Dust build-up inside. • What action can you take?




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Improper duct work design
Transport velocity too low

Clean out duct work
Take action to improve efficacy of dust transport

H.2.3] DUST ESCAPING THE DUST TRANSPORT DUCTWORK OR COLLECTION VESSEL

Look Out For....

Escaping dust. • What action can you take?




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Duct in state of disrepair

Clean up accumulation
Identify and correct reason for fugitive emissions

H.2.4] DUST IN THE GENERAL AREA

Look Out For....

Too much dust accumulation. • What action can you take?




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(Escaping from production processes and/or dust collection system and accumulating in general work area)

Inadequate or non-existent dust control measures
Inadequate housekeeping

Clean up accumulation
Investigate and correct reason for accumulation

H.2.5] CLEAN WORKPLACE –COULD THERE STILL BE A PROBLEM?

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Look Out For....

Clean? • What action can you take?



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Tramp metal / Foreign contamination

Add engineering controls to capture tramp metal / foreign contamination

Develop safe work procedures for clearing product jams

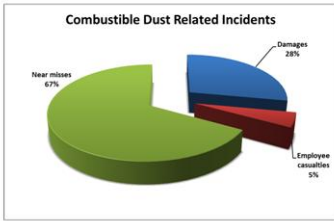
Ensure effective preventive maintenance of dust collection system

H.2.6] SMALL FIRES

Look Out For...

Small fires. • What action can you take?

Combustible Dust Related Incidents



Category	Percentage
Near misses	67%
Damages	28%
Employee casualties	5%

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A near miss and source of valuable information to prevent recurrence

Investigate all fires, no matter how small

Act on fire investigation recommendations

H.3] KEY TAKEAWAYS

Key Takeaways

- A Combustible Dust Mitigation and Control program is needed to ensure this hazard is properly managed.
- Subject Matter Experts likely required to design engineering controls and to inspect and maintain some monitoring and suppression equipment.
- Dust collection systems should include explosion prevention equipment.
- Encourage employees to have good housekeeping habits.
- If it's not working, understand why then correct.

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I] LAST WORD—INDUSTRY’S WOOD DUST MITIGATION AND CONTROL AUDIT

LAST WORD

Industry’s Wood Dust Mitigation and Control Audit

I.1] MILL SAFETY: FOREST INDUSTRY TASK FORCE AUDIT



Reference: Forest Industry Task Force, *Wood Dust Mitigation and Control Audit June 21, 2013*

Reference: This page contains information that will help sawmills manage dust and keep informed about the Task Force activities and findings. <http://www.cofi.org/bc-forest-industry/mill-safety-forest-industry-task-force/>

J] ADDITIONAL RESOURCES

- NFPA 664: *Standard for the Prevention of Fires and Explosions in Wood Processing and Woodworking Facilities*
- NFPA 654: *Standard for the Prevention of Fire and Dust Explosions from the Manufacturing, Processing, and Handling of Combustible Particulate Solids*
- NFPA 68: *Standard on Explosion Protection by Deflagration Venting*
- NFPA 69: *Standard on Explosion Prevention Systems*
- NFPA 91: *Standard for Exhaust Systems for Air Conveying of Vapors, Gases, Mists, and Noncombustible Particulate Solids*
- NFPA 77: *Recommended Practice on Static Electricity*
 - NFPA 499 – *Classification of Combustible Dusts and Hazardous Locations*
 - OSHA-Occupational Safety & Health Administration
 - US Chemical Safety Board
 - FM Global Insurance Company Loss Prevention Data Sheet 7-76, *Prevention and Mitigation of Combustible Dust Explosions and Fires*

THIS ENDS THE
PRESENTATION



K] KNOWLEDGE CHECK ANSWERS



K.1] KNOWLEDGE CHECK #1

K.1.1] ANSWER 1.1

Knowledge Check 1.1

 Put the controls in the correct hierarchy order

PPE	_____
Engineering Controls	_____
Substitution	_____
Administrative Controls	_____
Elimination	_____

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- Elimination
- Substitution
- Engineering Controls
- Administrative Controls
- Personal Protective Equipment (PPE)

K.1.2] ANSWER 1.2

Knowledge Check 1.2

 Are these engineering controls active or passive?

Construction features	_____
Dust Collectors	_____
Passive Containment	_____
Misting	_____

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- Construction Features – Passive
- Dust Collectors – Active
- Passive Containment – Passive
- Misting - Active

K.1.3] ANSWER 1.3

Knowledge Check 1.3



Fill in the blanks

- 3 a) Frequent housekeeping prevents the _____ of dust.
- 3 b) The only explosion pentagon element missing inside a dust collector is the _____ source.
- 3 c) Preventive maintenance keeps equipment in a good state of _____ so that they continue function effectively.

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3a) Frequent housekeeping prevents the accumulation of dust.

3b) The only explosion pentagon element missing inside a dust collector is the ignition source.

3c) Preventive maintenance keeps equipment in a good state of repair so that they continue to function effectively.

K.2] KNOWLEDGE CHECK #2

K.2.1] ANSWER 2.1

Knowledge Check 2.1



Put the controls in the correct hierarchy order

Mechanical Friction

Conveyor belts
Exposed electrical wires
Space Heaters
Open breaker panels
Misaligned fan blades
Welding equipment

Portable Ignition Sources**Electrical**
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Mechanical Friction:

- Conveyor Belts
- Misaligned Fan Blades

Portable Ignition Sources

- Space Heaters
- Welding Equipment

Electrical

- Exposed Electrical Wires
- Open Breaker Panels

K.3] KNOWLEDGE CHECK #3

K.3.1] ANSWER 3.1

Knowledge Check 3.1



Match Passive and Active

Passive Explosion Protection

Reacts to and controls the explosion

Detects and reacts prior to or during an explosion

Active Explosion Protection
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Passive Explosion Protection – reacts to and controls the explosion

Active Explosion Protection – Detects and reacts prior to or during an explosion.

K.3.2] ANSWER 3.2

Knowledge Check 3.2



Match phrases

Prevent the explosion
Vent to safe location
Prevent the spread
Build it strong
Get rid of the air

Containment
Inerting
Deflagration Venting
Deflagration Suppression
Deflagration Isolation

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Containment – Build it strong!

Inerting –Get rid of the air!

Deflagration Venting – Vent to a safe location!

Deflagration Suppression – Prevent the explosion!

Deflagration Isolation – Prevent the spread!