COMBUSTIBLE DUST HAZARD RECOGNITION

February 2014

FIPI Fire Inspection & Prevention Initiative

FITF Forest Industry Task Force

GUIDE FOR WORKERS AND FRONT LINE SUPERVISORS

TABLE OF CONTENTS

COMBUSTIBLE DUST HAZARD RECOGNITION

CBC – ANOTHER SAWMILL EXPLOSION

What will happen to industry if another similar explosion occurs?

_____

_____

_____

_____

_____

A] COMBUSTIBLE DUST HAZARD RECOGNITION INTRODUCTORY COURSE

Hazards known for years

Many workplaces don't understand the hazards

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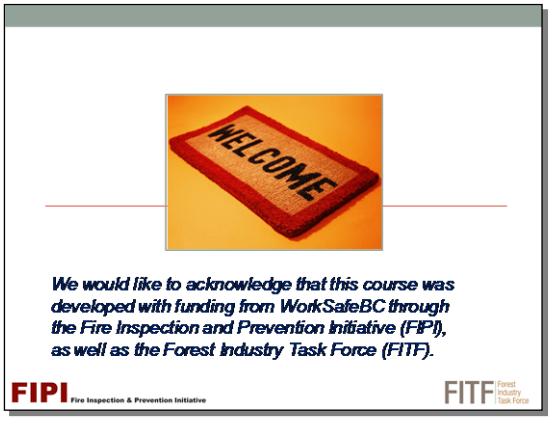

Workers and supervisors are the first line of defense:

- Recognizing unsafe conditions
- Taking preventative action, and/or
- Alerting management

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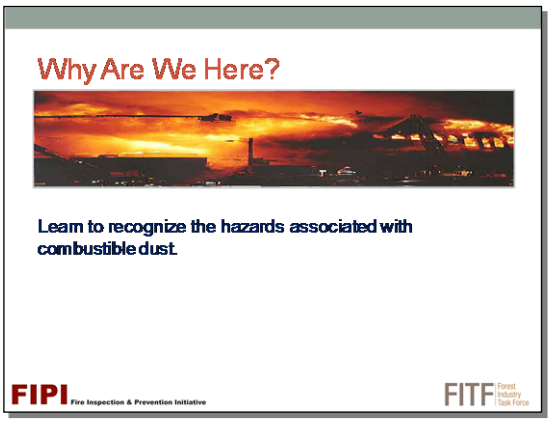


Combustible Dust explosions are very preventable
US Chemical Safety Board 3-year study
Learn from the past and from the expert

US Chemical Safety Board – Investigation Report: Combustible Dust Hazard Study:
http://www.csb.gov/assets/1/19/Dust_Final_Report_Website_11-17-06.pdf
CSB Video Resource: Combustible Dust: An Insidious Hazard:
http://www.csb.gov/videos/combustible-dust-an-insidious-hazard/

This first video clip introduces combustible dust as an insidious hazard.

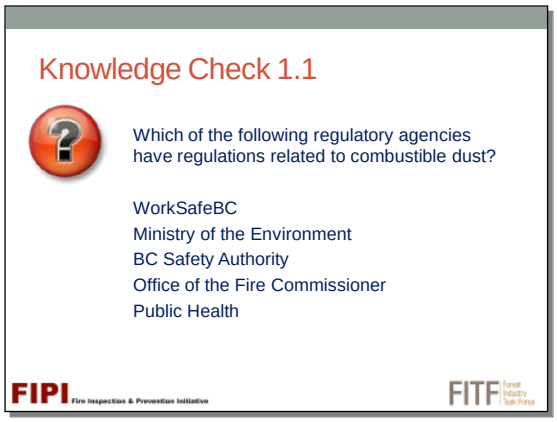
Combustible dust is a “significant industrial safety problem.”

Hazard can develop quickly or take years
Many substances are combustible when in a dry, dust form

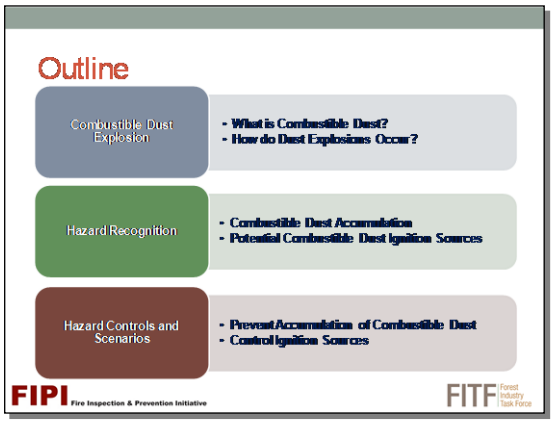
Determine combustibility through testing or assume it is combustible

BC wood product manufacturing operations need to understand what their combustible wood dust hazards are.

B] KNOWLEDGE CHECK #1



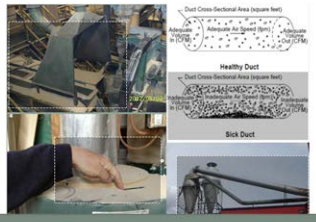
C] MODULE OUTLINE



Combustible dust is a common workplace hazard that can cause fires and explosions if not properly managed.

You will learn to identify combustible dust, when it is a hazard, and especially when it is an explosion hazard. You will also learn about the common dust control mechanisms that are used.

Look Out for …..



There are different places where combustible dust can accumulate.

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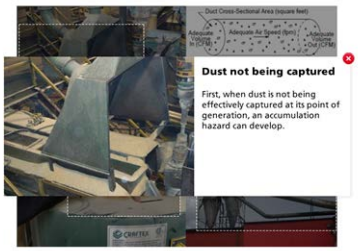
Look Out for …



Dust not being captured

First, when dust is not being effectively captured at its point of generation, an accumulation hazard can develop.

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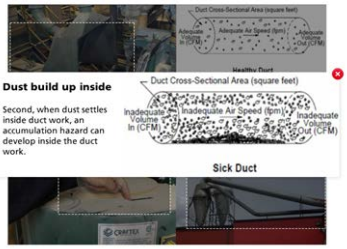
Look Out for …



Dust build up inside

Second, when dust settles inside duct work, an accumulation hazard can develop inside the duct work.

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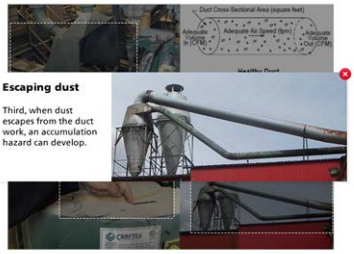
Look Out for …



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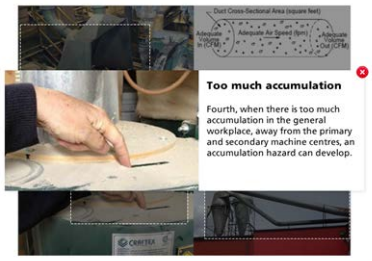
Look Out for …



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Look Out For….

Clean? **… there is still a hazard to be concerned about.**

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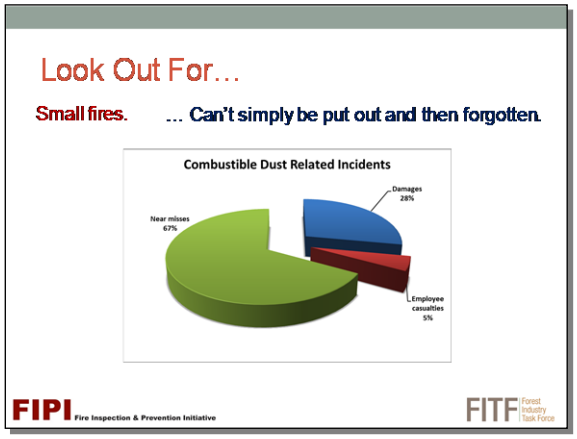
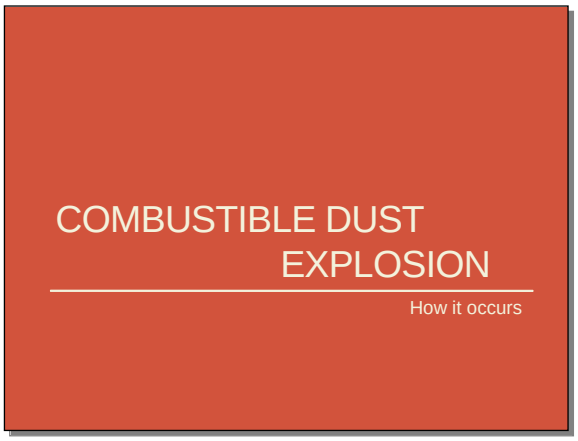


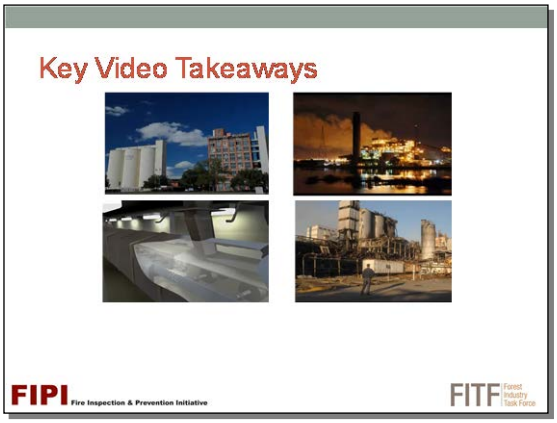
D] COMBUSTIBLE DUST EXPLOSION – HOW IT OCCURS

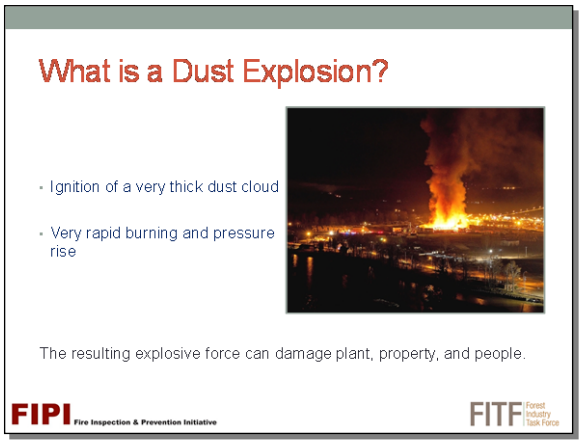


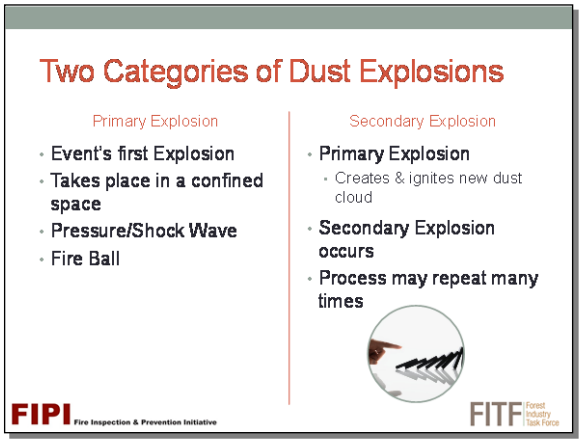
The first step in learning to recognize and address combustible dust hazards is to learn how a combustible dust explosion occurs.

This next video will demonstrate, using the knowledge gained from a combustible dust explosion investigation, all the conditions that needed to "align themselves" for a catastrophic accident.

Many workplaces don't believe it will happen to them.
At Imperial Sugar, all it took was a change in operation.
Remember the intensity and strength of the multiple secondary explosions.







Test structure 75x stronger than a regular building

Notice the thickness of dust cloud

Notice size of fireball in real time vs slow motion

_____

_____

_____

_____

Fire ball – not much is real time and huge fireball in super slow motion.
Notice the thickness of dust cloud.
Leading pressure waves disturbs debris and dust.
Preventing dust accumulation prevents secondary explosions.

_____

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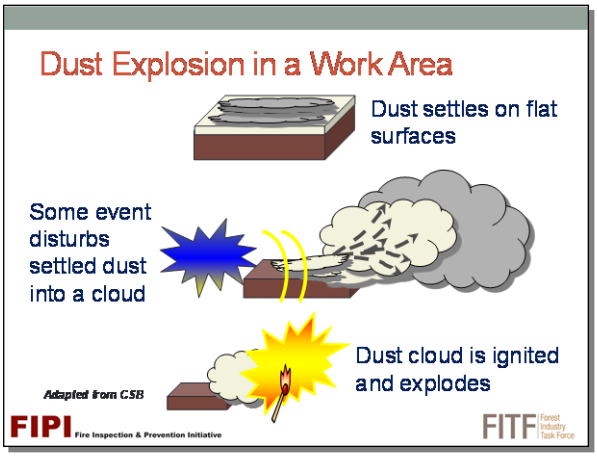

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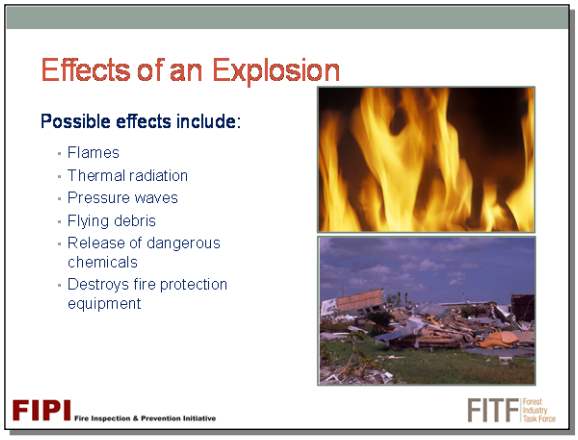
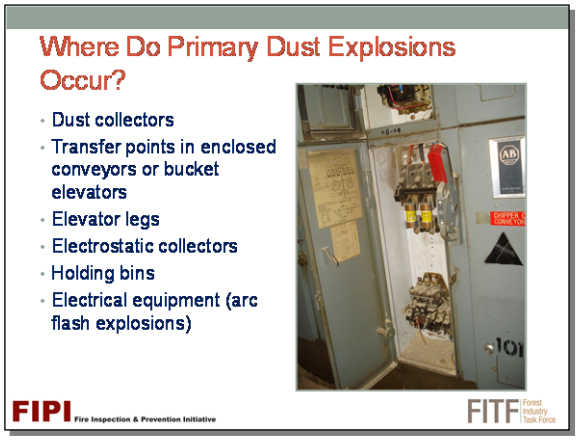
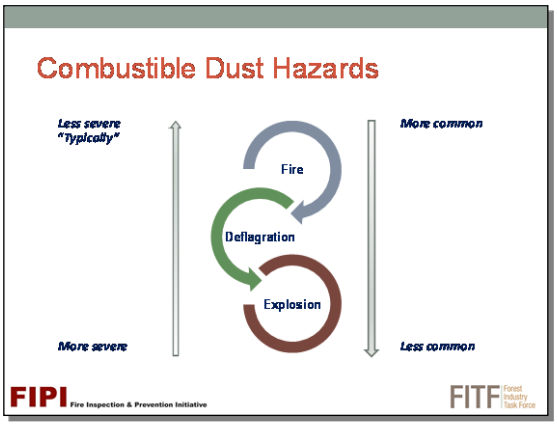


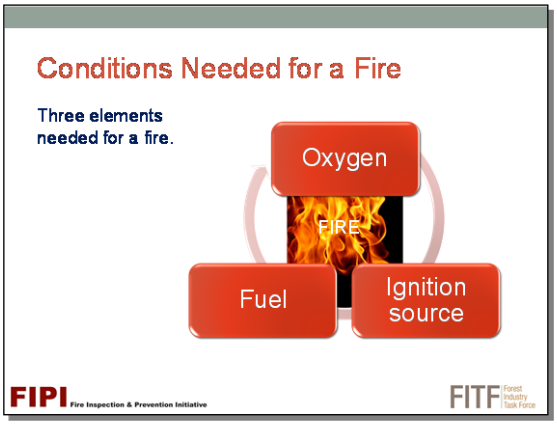


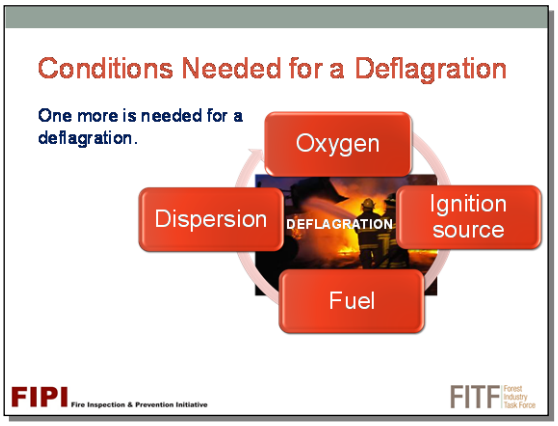
Experts tell us that dust explosions are so preventable. Being able to prevent dust explosions begins with understanding the combustible dust explosion process.

Some key takeaways from the video include:

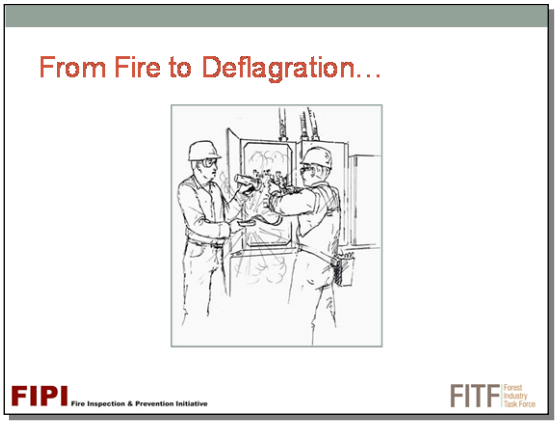
- Many different products, when in a powdered form, are explosible.
- There are 5 elements needed for a dust explosion, which form the explosion pentagon.
- Combustible dust accumulates over time to dangerous levels in the general workplace.
- An initial event, like a primary explosion inside an enclosure, dislodges the accumulated dust and ignites one or more secondary explosions.
- Most fatalities, devastating injuries and property damage are caused by secondary explosions.



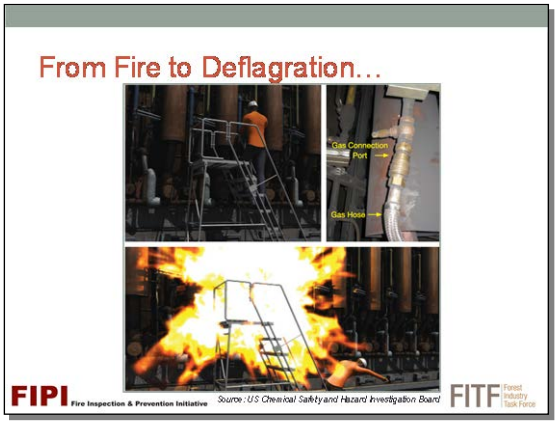




Such a deflagration fireball would severely burn a worker.

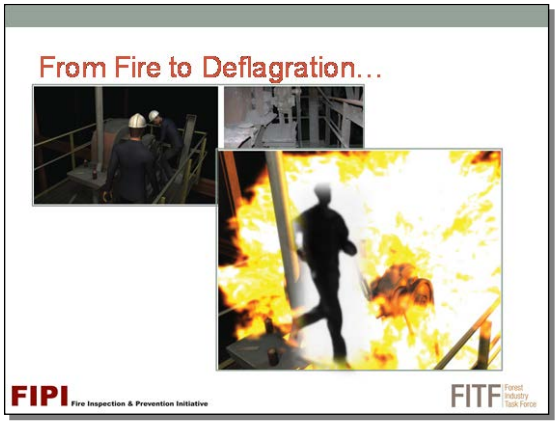


WorkSafeBC investigation - A sudden fireball caused burns to both workers.



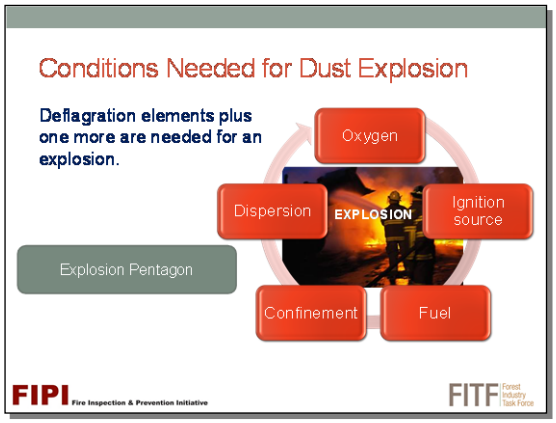
The U.S. Chemical Safety Board has also investigated incidents involving combustible dust deflagration fireballs.

First investigation - one worker died. The hot surface of the furnace was the ignition source.



Second investigation – one worker died. The motor's hot surface was the ignition source.

Remember the images in these last few slides!


Conditions Needed for Dust Explosion
Deflagration elements plus one more are needed for an explosion.
Explosion Pentagon
Oxygen
Dispersion
EXPLOSION
Ignition source
Confinement
Fuel
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From Deflagration to Explosion…
Combustible Dust: An Insidious Hazard
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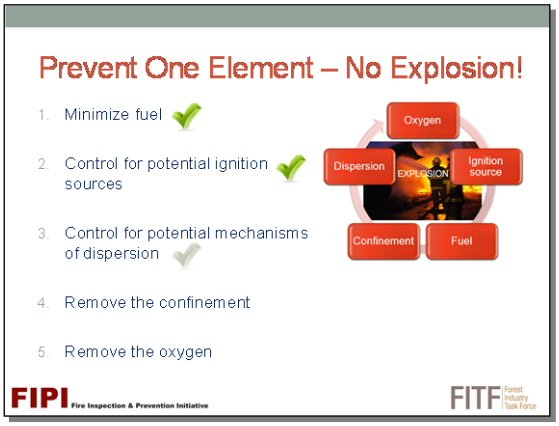
Prevent One Element – No Explosion!
1. Minimize fuel
2. Control for potential ignition sources
3. Control for potential mechanisms of dispersion
4. Remove the confinement
5. Remove the oxygen
Oxygen
Dispersion
EXPLOSION
Ignition source
Confinement
Fuel
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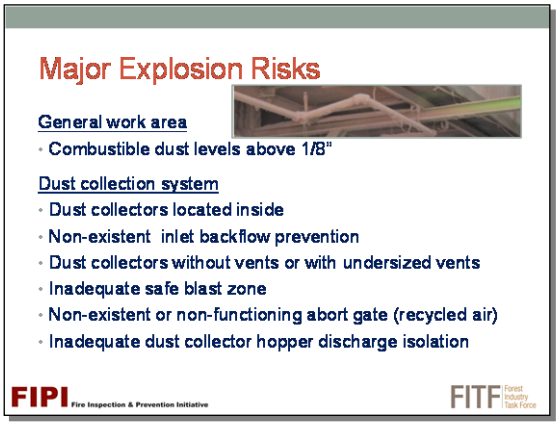
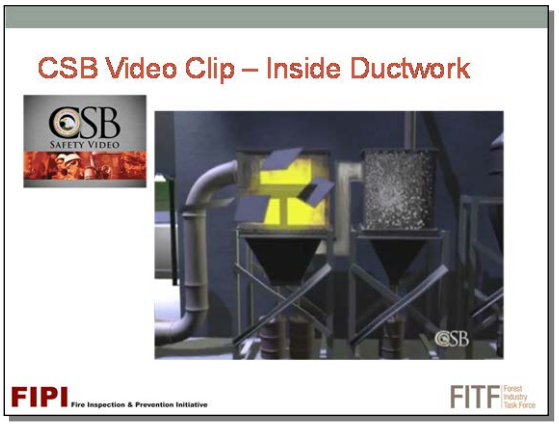




This next video clip shows exactly how a primary explosion originating in the dust collector can result in secondary explosions throughout the facility when combustible dust is allowed to accumulate in the general work area.

- Combustible dust can accumulate in the ductwork if it is not properly designed.
- Leaks in the ductwork can contribute, over time, to the accumulation of combustible dust in the general work area.
- Explosions propagate if no explosion prevention equipment.
- Outcome: devastating secondary explosions in general work area.

_____

How bad would the total event have been if there was no accumulation of combustible dust in the general work area?

_____

_____

How bad the total event would have been if the dust collection system had been operating as designed, that is, no leaks and no accumulation of combustible dust in the ductwork?

_____

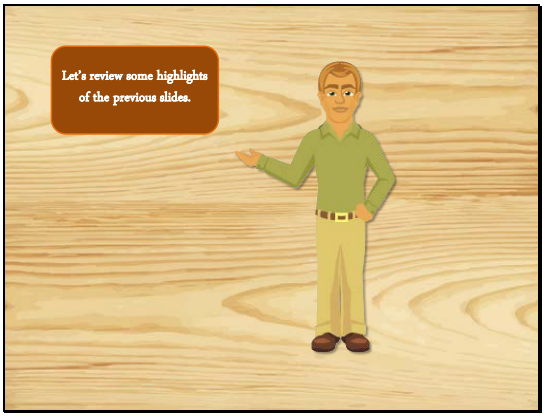
_____

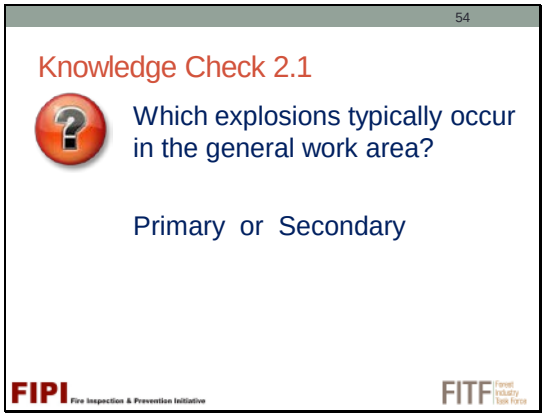
How bad would the total event have been to the dust collector if it had functioning explosion prevention equipment?

_____

_____

E] KNOWLEDGE CHECK #2





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Knowledge Check 2.2

Fill in the blank.

_____ explosions typically occur in a contained space like dust collectors, enclosed conveyance systems, impact equipment, and holding bins.

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Knowledge Check 2.3

Fill in the blanks:

The three fire triangle elements are:
1. **Fuel** 2. **Oxygen** 3. **Heat**

2. Deflagration requires fire triangle elements plus **Dispersion** in air.

3. Explosion requires deflagration elements plus **Containment** .

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Knowledge Check 2.4

Many primary explosion risks are associated with dust collectors.

True or False

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Knowledge Check 2.5

Fill in the blank?

The best strategy to prevent dust explosion and deflagration is to prevent the _____ of dust in the workplace.

Dispersion
or Drying
or Accumulation

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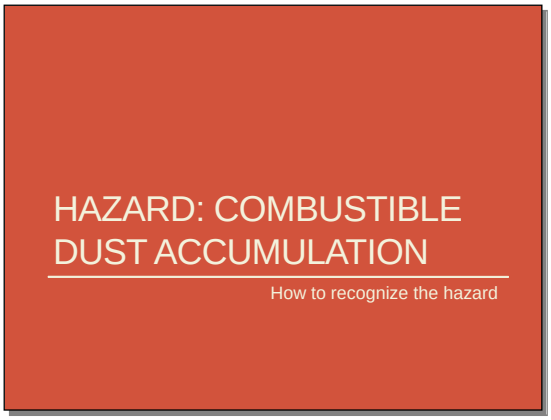
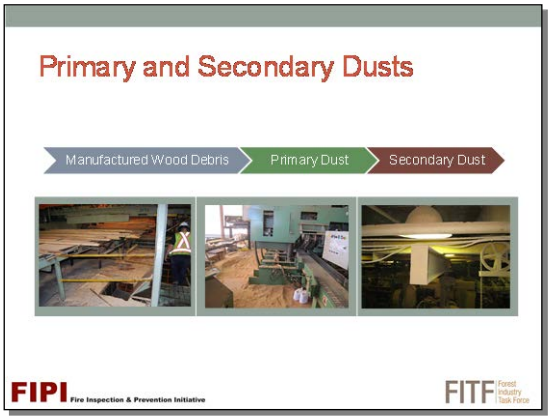
F] HAZARD: COMBUSTIBLE DUST ACCUMULATION HOW TO RECOGNIZE THE HAZARD



The next segment will show how to recognize the hazard associated with the accumulation of combustible dust in the workplace.



About the Dust

- Combustible
  - Moisture content
  - Particle size
  - Particle size distribution
- Concentration of wood dust in the air
- Contained

Adding an ignition source and sufficient oxygen could result in an explosion.

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Average Size of Un-sieved Sample: 700.7µm

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Average Size of Un-sieved Sample: 700.7µm

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Average Size of Un-sieved Sample: 700.7µm

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How Much Dust is a Hazard?

">1/8th inch, 5% area or 1000 ft², whichever is smaller"

Cleaning Rule of Thumb: Obscures the colour of the underlying surface.

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Hazard Alert

WORKSAFE BC

HAZARD ALERT

Combustible dust winter alert — increased risk in winter

The risk of a dust explosion increases when low humidity levels, like those seen in winter months, make dust easy to disperse and ignite. In fact, industrial accident investigations by the U.S. Chemical Safety Board found that seven out of eight fatal combustible dust explosions from 1995 to 2009 occurred during cold winter months when these weather conditions were most prominent.

One of the two tragic sawmill incidents in British Columbia occurred in the middle of winter, the second occurred in early spring.

A number of changes can commonly occur in wood processing facilities as the weather becomes colder.

- Control measures and clean up practices that rely on the use of water may not be suitable or effective
- Openings such as bay doors and wall dampers may be closed up increasing the degree of enclosure and reducing natural ventilation or make up air
- Ventilation may be reduced or shut down to conserve heat
- Re-circulation of air from exhaust systems may also increase
- Portable heating units potentially introduce additional ignition sources into workspaces

Going into the winter months it is important to maintain attention on controlling the risks associated with combustible dusts. Employers need to assess for any additional risks associated with the impact of the environment on dust accumulations and the methods used to control dust in the winter.

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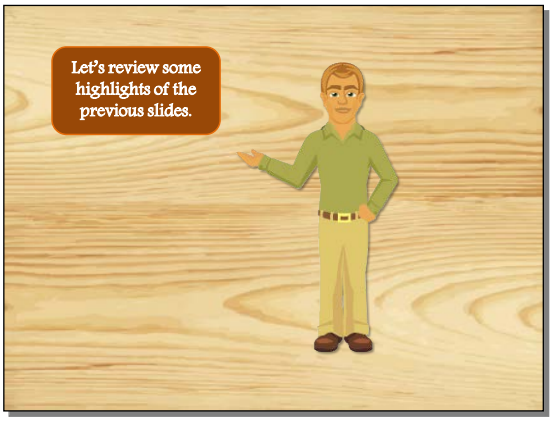
G] KNOWLEDGE CHECK #3



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Knowledge Check 3.1

Fill in the blanks:

What is combustible dust?

A combustible particulate solid that presents a _____ or _____ hazard when suspended in air.

Breathing or Deflagration
or Seeing or Fire or Explosion

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Knowledge Check 3.2

Well, you've heard a lot about dust now. Which of the following do you think is most responsible for the highly combustible nature of dust?

- Shape
- Size
- Dispersion

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Knowledge Check 3.3

Types of wood dust – Choose True or False for each statement

Secondary Dust will burn:	True or False
Manufacturing Wood Debris will explode:	True or False
Primary Dust will explode:	True or False
Secondary Dust will deflagrate:	True or False

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Knowledge Check 3.4

What makes wood dust explosive? (Choose all that apply)

a. It must be combustible
b. Fine enough to be airborne
c. Dry
d. Suspended in the air in an explosive concentration
e. Contained or enclosed in confined area
f. All of the above

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Knowledge Check 3.5

Housekeeping Rule of Thumb:

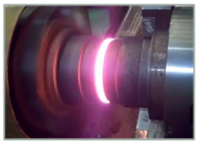
Clean when combustible dust obscures the _____ of the underline surface.

thickness
colour
texture

H] HAZARD: IGNITION SOURCES

The next segment will show how to recognize the hazard associated with potential ignition sources in the workplace.

Ignition Source—Mechanical Sparks and Friction



Sparks

- Grinding metal with an abrasive disk
- Power tools

Friction

- Overheated bearing
- Faulty equipment
- Wood debris on conveyor parts

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Ignition Source—Hot Work

Hot work is any operation that can produce enough heat from flame, spark or other source of ignition, with enough energy to ignite flammable vapours, gases, or dust.

This includes:

- Welding
- Cutting
- Grinding
- Brazing
- Riveting
- Drilling
- Soldering

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Example of Hot Works procedures not being followed

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Example of Hot Works procedures not being followed

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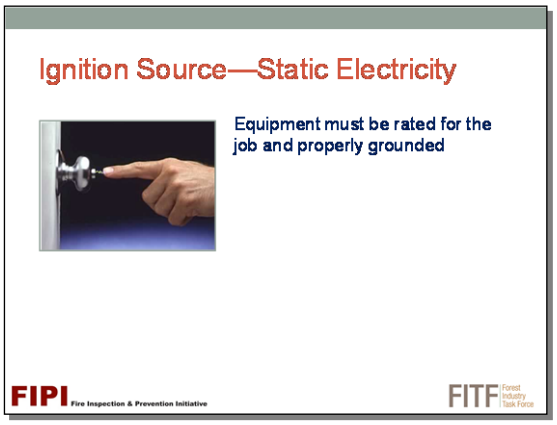
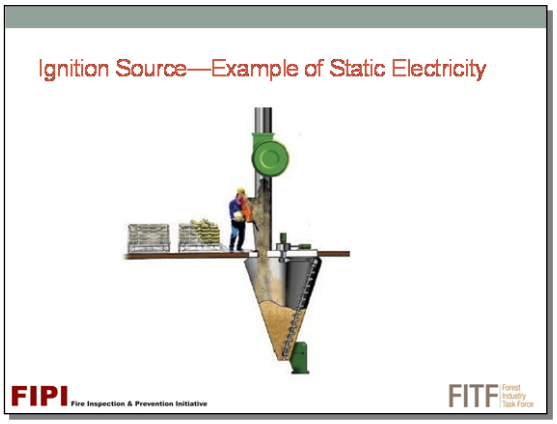
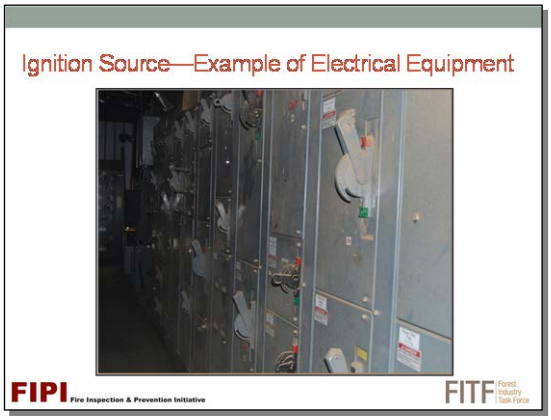


- Flowing movements of combustible wood dust
- Bond & Ground
- Plastic pipes not appropriate for ductwork

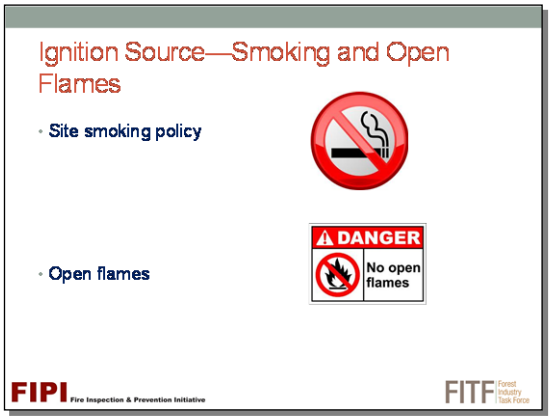


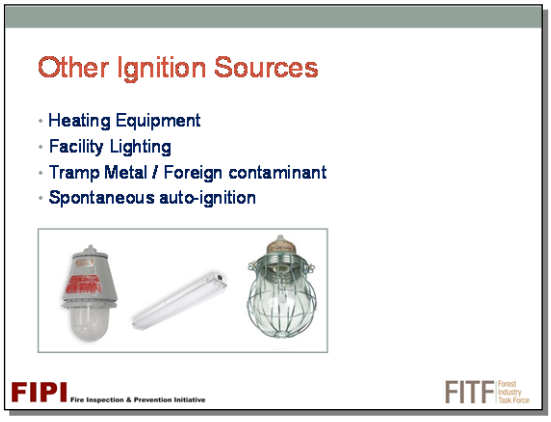
The worker suffered severe burns to his face and upper body.

A word of caution: These statistics refer to a broad range of industries. The BC Safety Authority, after conducting inspections in BC sawmills and other primary wood product manufacturing, is of the opinion that electrical equipment is the ignition source more often than what these statistics demonstrates.

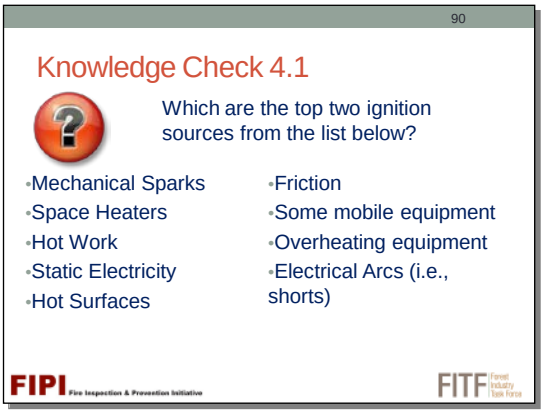


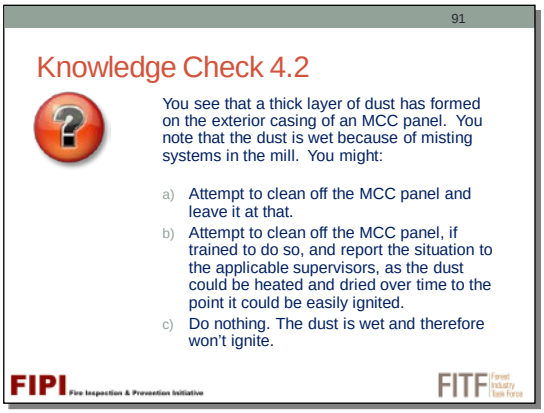
Some common examples of electrical arcs and sparks include:





I] KNOWLEDGE CHECK #4





HAZARD SCENARIOS

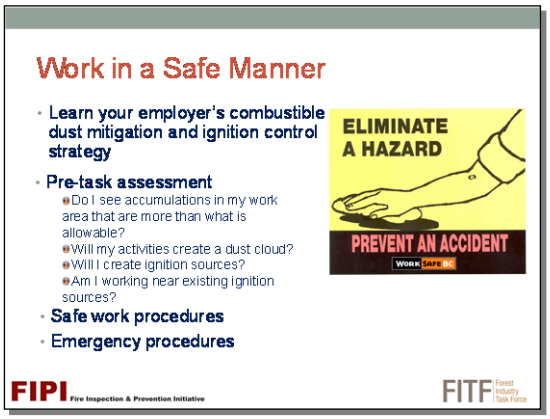
Misaligned blade and jammed wood product
Sparks or embers trigger primary explosion
Sparks or embers trigger primary explosion
Follow safe work procedures

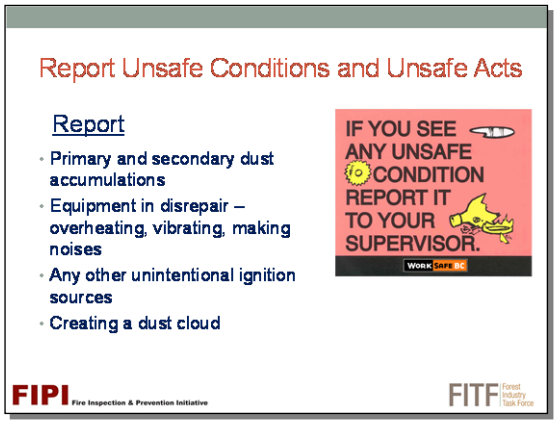
Fighting a combustible dust fire can be dangerous.

K] YOUR ROLE

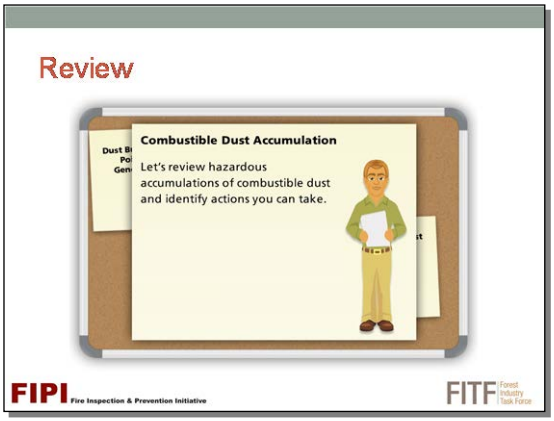
YOUR ROLE

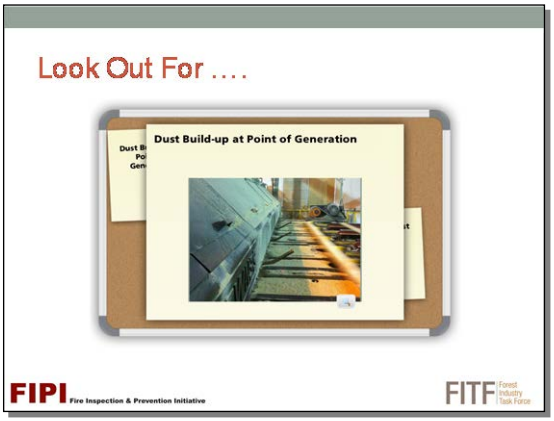
Now that you understand the fire, deflagration and explosion hazard of combustible dust, you must fulfill your role in maintaining a safe and healthy workplace by helping to minimize the accumulation of combustible dust and managing ignition sources.



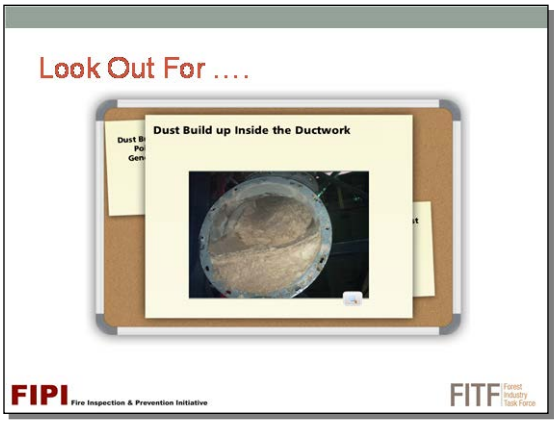


L] REVIEW

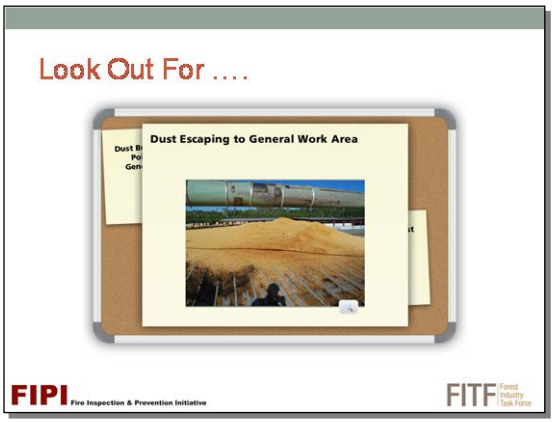




Your role is to report the accumulation to your supervisor or employer who must investigate your report and take any necessary corrective action.



Your role is to report the accumulation to your supervisor or employer who must investigate your report and take any necessary corrective action.



Your role is to report the combustible dust fugitive emission to your supervisor or employer who must investigate your report and take any necessary corrective action.

_____

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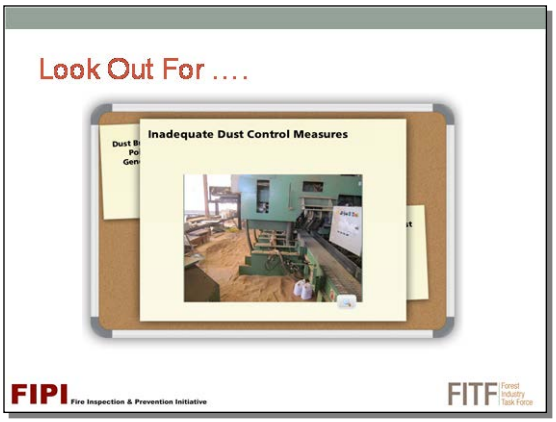

Your role is to report the accumulation to your supervisor or employer who must investigate your report and take any necessary corrective action. If authorized, you can clean-up using safe housekeeping procedures.

_____

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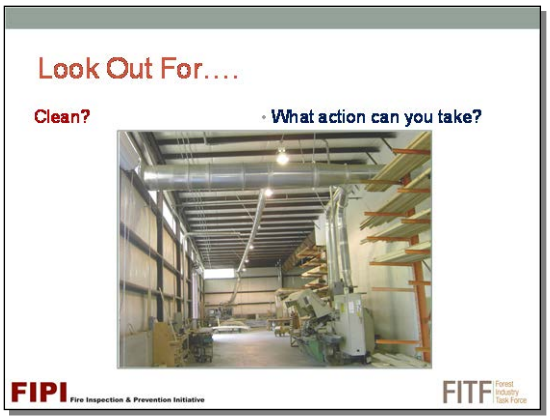


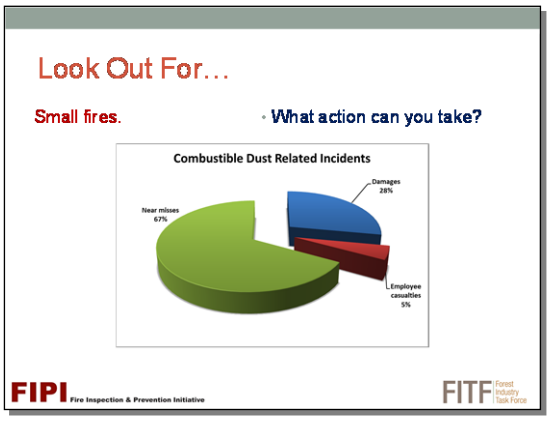
Be vigilant for the presence of tramp metals (e.g., nails, bolts) that could enter the duct work.

Have and follow safe work procedures to quickly shut down the equipment, remove the jammed material, and repair the equipment if necessary.

Monitor the state of repair of the bonding and grounding wires to prevent static electricity sparks.

Be sure to follow hot work procedures when conducting hot work activities on or near any component of the dust collection system.

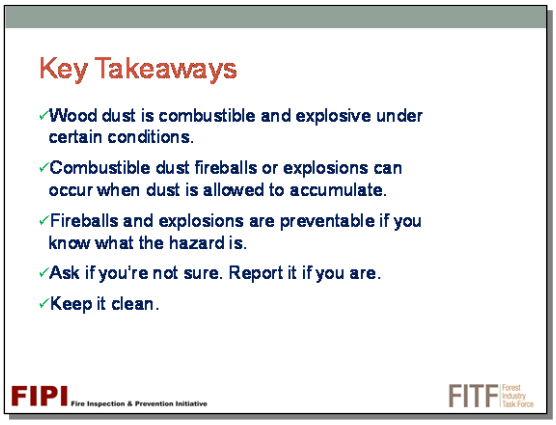
In addition, your role is to report any signs of missing, improperly functioning or disrepair of equipment to your supervisor or employer who must investigate your report and take any necessary corrective action.



Learn and follow the safe procedures for fighting a combustible dust fire.

If you spot a fire, safely put out the fire if capable; pull the fire alarm, otherwise report to your supervisor.

All fires, no matter how small, must be investigated and corrective action taken.

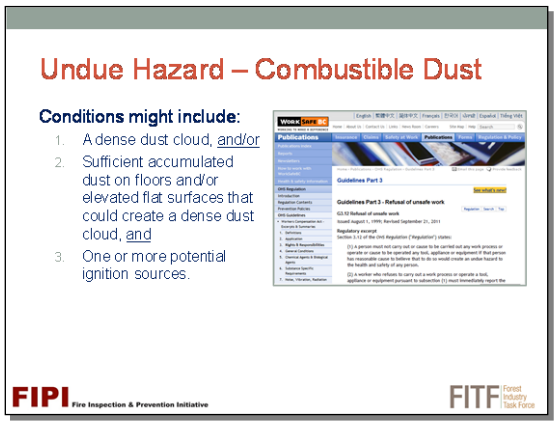


M] LAST WORD – UNDUE HAZARD

LAST WORD

Undue Hazard

Under certain conditions, combustible dust can be an undue hazard. What does that mean?



N] KNOWLEDGE CHECK #5

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Knowledge Check 5.1

Who has a role in preventing fires, deflagrations, and explosions?

- Employees
- Management

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Knowledge Check 5.2

Which are employee roles and responsibilities?

Select & design dust mitigation strategies:	True or False
Learn and follow safe work procedures:	True or False
Report unsafe conditions and acts:	True or False
Investigate reports of unsafe conditions and acts:	True or False

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Knowledge Check 5.3

When is combustible dust an "Undue Hazard"? (3 possible conditions)

A dense airborne cloud exist:	Yes or No
A thick accumulation of primary dust exist:	Yes or No
A thick accumulation of secondary dust exist:	Yes or No
One or more ignition sources exist:	Yes or No
Combustible dust is inside a dust collection system:	Yes or No

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Additional Handouts

- Combustible Dust Awareness Quick Guide

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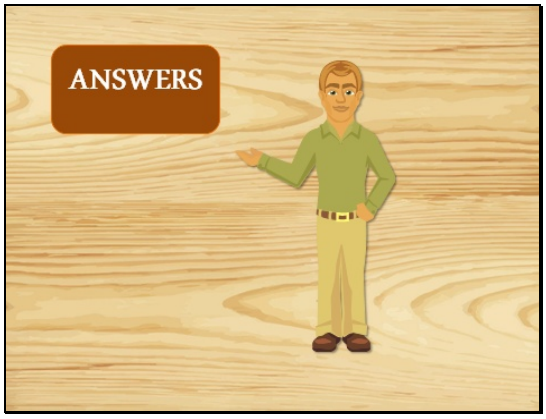
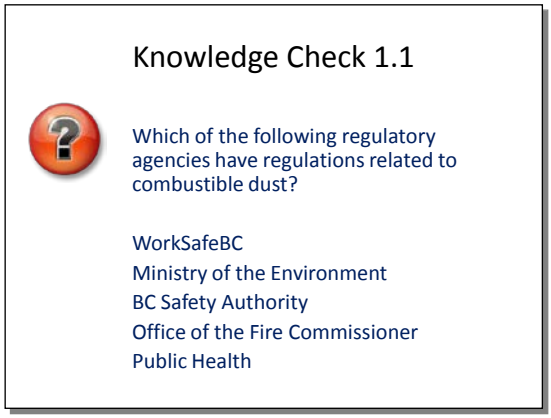
O] KNOWLEDGE CHECK ANSWERS



O.1] KNOWLEDGE CHECK #1



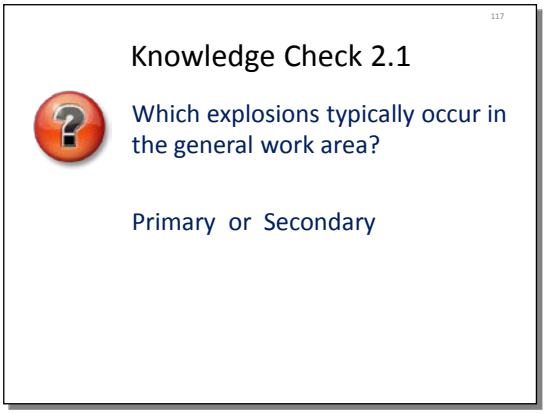
The three applicable statutes, their regulations, the responsible inspectorates and their combustible dust related focuses are:

- The *Fire Services Act* and the *BC Fire Code* – When performing site inspections, Local Assistants to the Fire Commissioner, appointed by the **Office of the Fire Commissioner (OFC)**, will focus on current and effectively implemented Fire Safety Plans as required by the *BC Fire Code*, including controlling combustible dust fire/explosion hazards.

- The BC Safety Standards Act and the Safety Standards General Regulation – When performing site inspections, safety officers from the **BC Safety Authority** will focus on the installation and operation of gas and electrical equipment located in areas where combustible dust could accumulate and would therefore be considered a hazardous location, and will also focus on the licensing and certification of workers who perform work on this equipment.

- The Workers' Compensation Act and the Occupational Health and Safety Regulation – When performing site inspections, prevention officers from **WorkSafeBC** will focus on evaluating employers' management of dust dispersion and accumulation at their workplaces, including administrative and engineering controls.

O.2] KNOWLEDGE CHECK #2

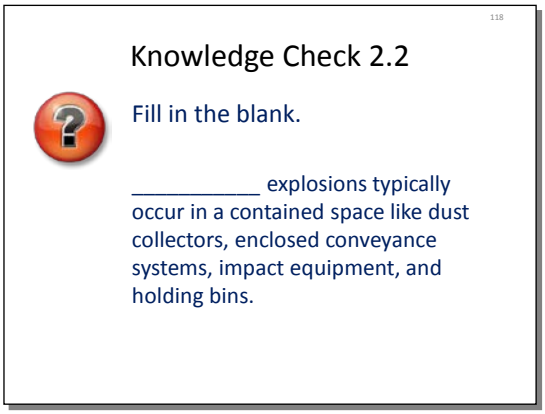


Answer 2.1

Secondary explosions typically occur in the general work area.

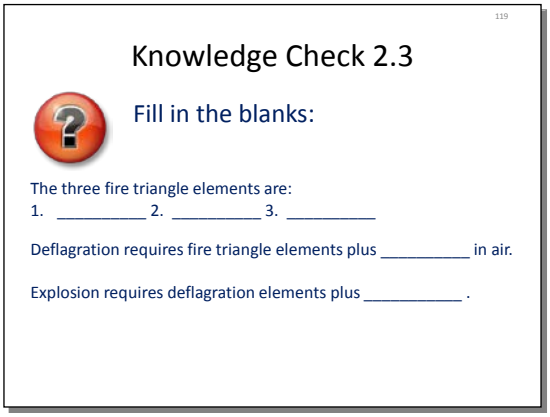
The event that will typically disturb dust that has accumulated in the general workplace is a primary explosion that originated elsewhere, often within the dust collection system. Sometimes, it is work activities around the accumulate dust that causes the disturbance of secondary dust in the general work area.

An earthquake is another example of an event that could disturb secondary dust accumulations in the general workplace.



Answer 2.2

- **Primary** explosions typically occur in a contained space like dust collectors, enclosed conveyance systems, impact equipment, and holding bins.
- The reason is that 4 of the 5 pentagon explosion elements are present – fuel, oxygen, dispersion, and containment. The only element missing is an ignition source.



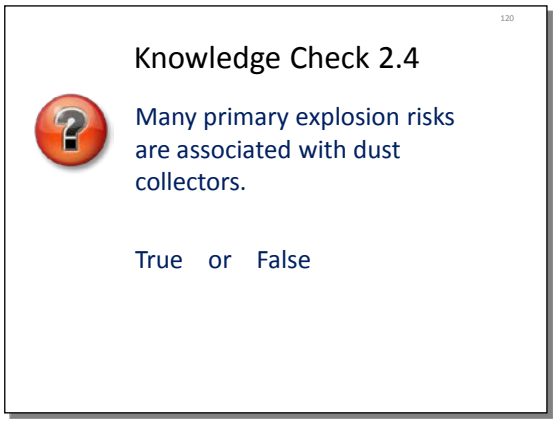
Answer 2.3

Fire Triangle:

- **Fuel**
- **Heat**
- **Oxygen**

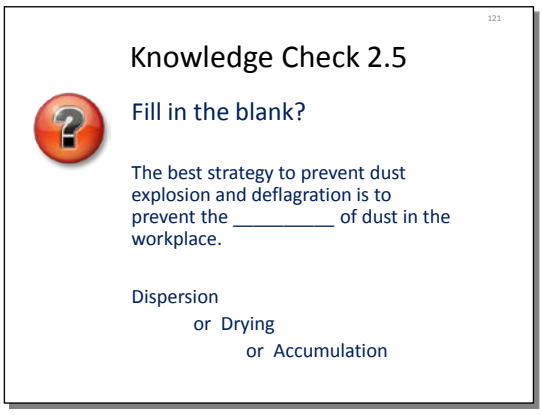
For deflagration , add '**Dispersion**'

And, for explosion, add '**Containment**'



Answer 2.4

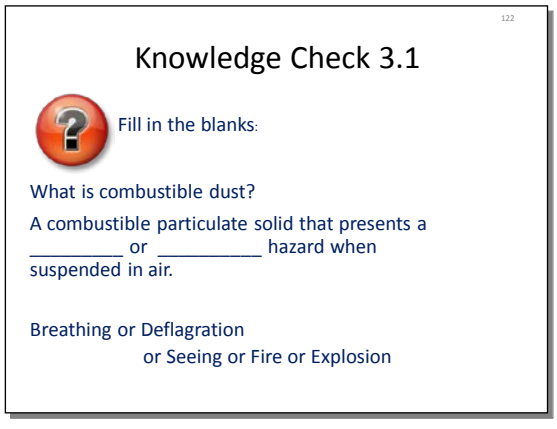
True, because dust collectors have 4 of 5 explosion pentagon elements present – fuel, oxygen, dispersion, and containment. The only element missing is an ignition source.



Answer 2.5

The best strategy to prevent dust explosion and deflagration is to prevent the **accumulation** of dust in the workplace.

O.3] KNOWLEDGE CHECK #3



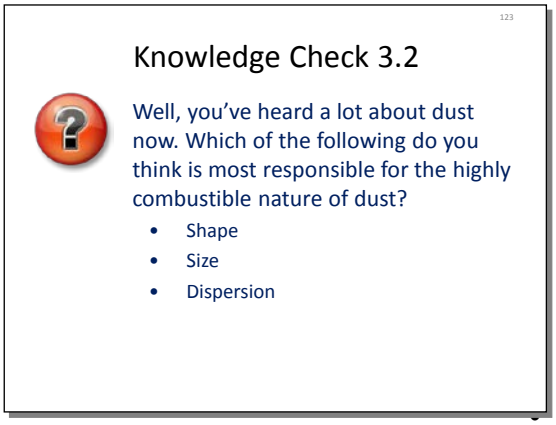
Answer 3.1

A combustible particulate solid that presents a **deflagration** or **explosion** hazard when suspended in air.

Combustible Dust:

A finely divided combustible particulate solid that presents a flash fire (deflagration) hazard or explosion hazard when suspended in air or the process-specific oxidising medium over a range of concentrations.

Source of definition: NFPA® 654 Standard for the Prevention of Fire and Dust Explosions from the Manufacturing, Processing, and Handling of Combustible Particulate Solids 2013 Edition



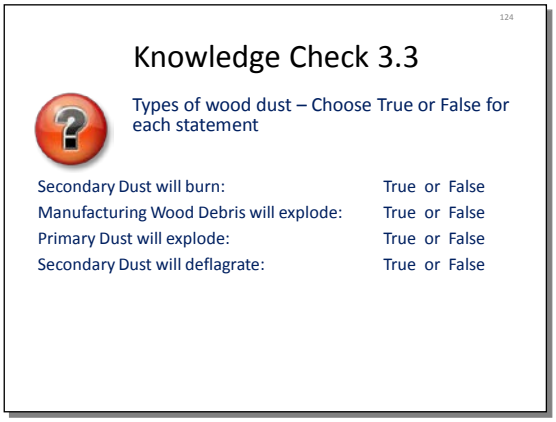
Answer 3.2

The **size** of the dust particle determines its combustibility:

- The dust particle size must be fine enough to become airborne.
- If too many of the particles are too large, that is, over 500 micrometers (or microns), it will not explode.
- As you increase the amount of finer particles in the mixture, the risk that the dust is explosible increases. When the portion of finer particles increases to a certain level, the mixture becomes explosible.

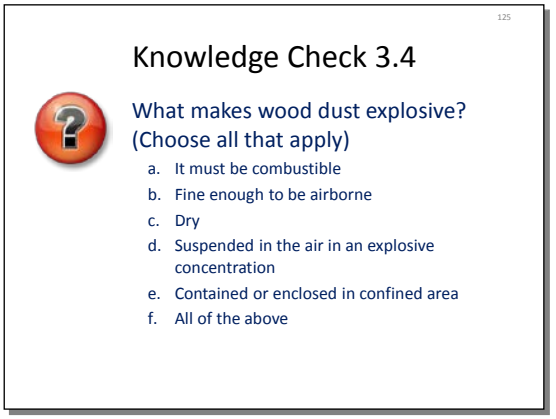
The finer the dust, the faster it burns, and the greater the severity of the explosion.

Also, keep in mind that explosions are possible because dust can be suspended or dispersed. Dust can be dispersed if it exists above floor level or at floor level and can be put in suspension by some activity or hazard.



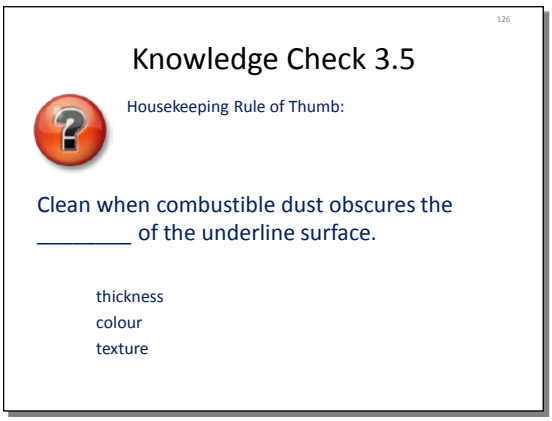
Answer 3.3

- Secondary Dust will burn – **True** (It's wood!)
- Manufacturing Wood Debris will explode – **False** (Particle sizes way too big!)
- Primary Dust will explode – **False** (Typically not enough small particles that can remain airborne in sufficient concentration to explode)
- Secondary Wood Dust will deflagrate – **True** (Small dust particles remain airborne when dispersed.)



Answer 3.4

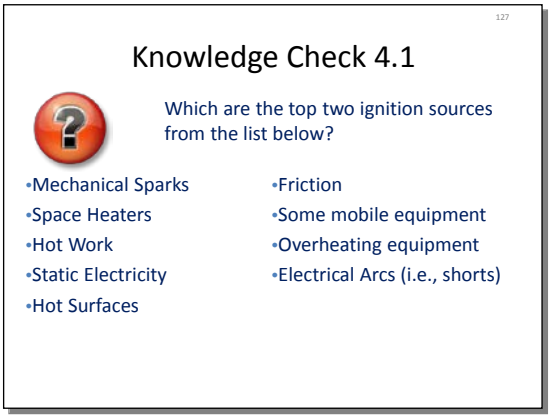
•Selection (**f**) – Refer to the "About the Dust" slide for details.



Answer 3.5

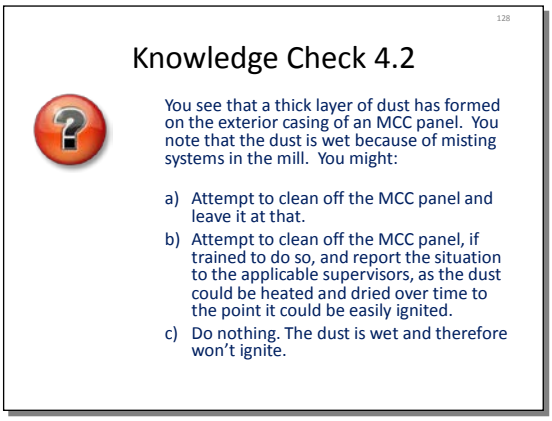
- Once the colour of the underlying surface is obscured, the thickness of the accumulated dust is approaching hazardous levels. If that accumulated dust covers a large amount of the flat surfaces in the area, an event could disperse the dust into a dust cloud, which could then be ignited by an ignition source and cause an explosion.
- Even if there is insufficient amount to cause an explosion a localized deflagration (flash fire) could still occur, which could severely injure or kill a worker.

O.4] KNOWLEDGE CHECK #4



Answer 4.1

Friction at 30% and **Mechanical Sparks** at 23% ,based on FM Global Statistics.



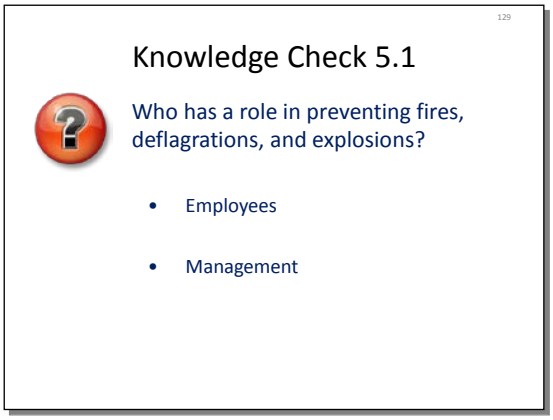
Answer 4.2

Selection (**b**)

"Train to do so" because there are safe work procedures to be followed when cleaning secondary combustible dust accumulations.

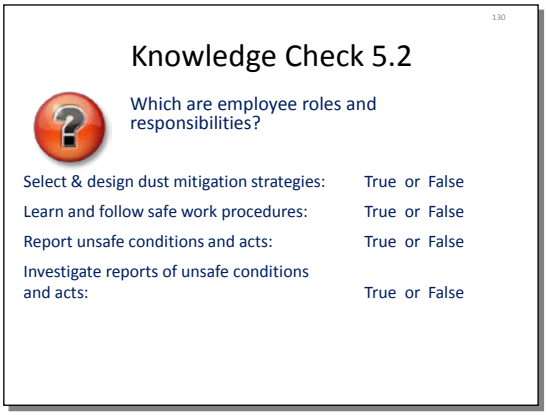
This is especially important in this situation given all the electrical equipment in the area. Remember the WorkSafeBC investigation into a deflagration incident at a main service panel? Two workers were burned.

O.5] KNOWLEDGE CHECK #5



Answer 5.1

Both employees and management have roles in preventing fires, deflagrations and explosions. Management will design and implement the control and mitigation program. Workers will learn and follow the program, and report unsafe acts and conditions.



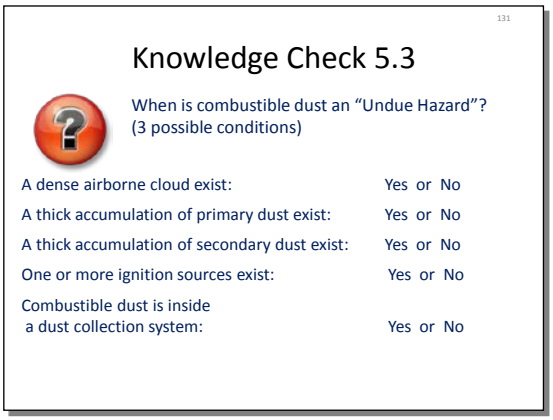
Answer 5.2

False: Select and design 'dust mitigation strategies' is a management responsibility. The workers safety representatives and knowledgeable workers should be invited to participate in the design process.

True: 'Learn and follow safe work procedures' is a worker responsibility.

True: Report unsafe conditions and acts is a worker responsibility.

False: 'Investigate reports of unsafe conditions and acts' is a management responsibility. The workers safety representatives and knowledgeable workers should be invited to participate in the investigations.



Answer 5.3

To have a combustible dust undue hazard , you need to have:

A dense airborne cloud and/or

A **thick accumulation of secondary dust**, and

One or more ignition sources present.

Note 1: Primary dust cannot explode.
Note 2: A dust collector system is designed to capture, transport, and collect combustible dust. A properly functioning system is not an undue hazard.

ADDITIONAL INFORMATION

US CHEMICAL SAFETY BOARD'S MISSION

(Excerpt from their website's home page http://www.csb.gov/)

The Chemical Safety Board (CSB) is an independent federal agency charged with investigating industrial chemical accidents. Headquartered in Washington, DC, the agency's board members are appointed by the President and confirmed by the Senate.

The CSB conducts root cause investigations of chemical accidents at fixed industrial facilities. Root causes are usually deficiencies in safety management systems, but can be any factor that would have prevented the accident if that factor had not occurred. Other accident causes often involve equipment failures, human errors, unforeseen chemical reactions or other hazards. The agency does not issue fines or citations, but does make recommendations to plants, regulatory agencies such as the Occupational Safety and Health Administration (OSHA) and the Environmental Protection Agency (EPA), industry organizations, and labor groups. Congress designed the CSB to be non-regulatory and independent of other agencies so that its investigations might, where appropriate, review the effectiveness of regulations and regulatory enforcement.

In 2003, the CSB launched investigations of three major industrial explosions involving combustible powders. These explosions - in North Carolina, Kentucky, and Indiana - cost 14 lives and caused numerous injuries and substantial property losses. The Board responded by launching a nationwide study to determine the scope of the problem and recommend new safety measures for facilities that handle combustible powders. The CSB issued its final report at a public meeting in Washington, DC, on November 9, 2006, calling for a new OSHA regulatory standard designed to prevent combustible dust fires and explosions.

While some recommendations may be adopted immediately, others require extensive effort and advocacy to achieve implementation. Board members and staff work to promote safety actions based on CSB recommendations. In many cases, the lessons from CSB investigations are applicable to many organizations beyond the company investigated. Many CSB recommendations have been implemented in industry, leading to safer plants, workers, and communities.

COMBUSTIBLE DUST AWARENESS QUICK GUIDE

A copy of the Guide is reproduced on next page. Get full size PDF copies at www.fipibc.ca

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Combustible Dust Awareness Quick Guide

What is a Dust Explosion?

The ignition and very rapid burning of a dust cloud in an enclosure or container causing a pressure rise (i.e., shock wave) that bursts or ruptures the enclosure or container. The event's first explosion is called the primary explosion, which can start a chain reaction of secondary explosions.

In order to explode, the dust cloud needs certain characteristics:

- The dust must be relatively dry — less of a factor at smaller particle sizes and more of a factor at large particle sizes.
- The dust particle size must be fine enough to be airborne — typically secondary dust — see definition below.
- The airborne concentration must be at its Minimum Explosive Concentration (MEC). The dust cloud is "in the range" when you can't see a 25 watt light bulb six feet away.

Combustible wood dust can be categorized as:

- **Primary dust:** Created by production or other work processes. Found on floors and surfaces near or below the dust producing or waste handling equipment, they are the source for secondary dusts. While primary dusts may consist primarily of greener, moister and coarser particulate, unmanaged primary dusts will over time release the finer, drier secondary dusts if they are not promptly abated and are disturbed.
- **Secondary dust:** The finer, drier dusts that are broadly dispersed and that settle away from the production area [usually rafters, ceilings, and beam, ductwork, walls, joints, top of machinery]. Secondary dusts are often the fuel source for serious fires and explosions: where "secondary" dusts are present at 1/8" over 5% of the work area they present a significant fire/explosion hazard.

How an Explosion Occurs

A dust explosion can occur when the five basic conditions of the 'Dust Explosion Pentagon' come together in a "perfect storm" scenario.

Figure 1: Dust Explosion Pentagon

1. *Fuel*, e.g., combustible dust
2. *Ignition source*, e.g., spark, friction, hot surfaces, open flame
3. *Oxidant*, e.g., oxygen in air
4. *Dispersion*, e.g., a dust cloud of dry wood dust at or above its Minimum Explosive Concentration (MEC)
5. *Confinement*, e.g., closed room, inside equipment or dust collector

Combustible dust is a finely divided particulate solid (e.g., typically the size of granulated sugar or smaller) that presents a flash fire hazard or explosion hazard when suspended in air.

Primary Explosion: The event's first explosion typically occurs in a dust collection system or processing equipment where dust clouds can easily form, or a small area where accumulated fugitive dust is disturbed to form a dust cloud.

Secondary Explosion: The primary explosion's shock wave will disturb accumulated (secondary) dust in the surrounding area creating another dust cloud. The shock wave is followed by burning dust thrown by the primary explosion, igniting the newly formed dust cloud and causing a secondary explosion. In similar fashion to the primary explosion, secondary explosions can trigger more secondary explosions. All large scale dust explosions result from chain reactions of this type.

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Combustible Dust Awareness Quick Guide

How to Prevent an Explosion

Prevent **one** explosion pentagon element from existing and an explosion is not possible.

"The most effective mitigation strategy is to minimize dust accumulation."

- → Dust collection systems that capture the dust at the source and transport the dust to a collection point for disposal are the "first best solution where practicable."
- → Passive containment systems prevent the primary dust from spreading and allow for manual removal.
- → Good housekeeping practices prevent fugitive secondary dusts from accumulating to unsafe levels in the general work area.

Good housekeeping practices means: regularly scheduled, in areas known for primary and secondary dust accumulation, using appropriate methods that prevent or minimize the generation of dust clouds.

- → Sometimes, for a variety of reasons, secondary dust may accumulate and some event will disperse that accumulation into a dust cloud.
- → Some methods of preventing the accumulation of combustible dust actually create an environment where the ignition source is the only missing element (e.g., a dust collector). For these reasons, there also needs to be a program to manage potential ignition sources, including:

• → *Hot works*	• → *Mechanical sparks*	• → *Open flames/heating equip.*
• → *Hot equipment*	• → *Overheating (e.g., friction)*	• → *Facility lighting*
• → *Hot Surfaces*	• → *Electrical equipment*	• → *Tramp Metal*

Combustible Dust Accumulation Vigilance — What to Look For

1. → ***General Housekeeping***—if there is too much dust accumulation (i.e., secondary dust levels approaching 1/8" over 5% of the area, or 1000 ft^2, whichever is smaller), determine why and correct.
2. → **Dust Collection Systems**
   a. → If dust is not being captured at the source, determine why and correct.
   b. → If dust is building up inside the duct work, determine why and correct.
   c. → If dust is escaping the duct work or collector, determine why and correct.
   d. → If tramp metal or other contaminants (i.e., potential ignition sources) are getting into the dust collection system, determine why and correct.
3. → If there is a history of fires in the facility, investigate their causes and correct. Why? If conditions had been a little different, it may have been an explosion instead of a fire.

Learn from these near misses!!

Major Explosion Hazard
*** Excessive secondary dust levels (See item #1 above)**
*** Presence of significant dust cloud(s)**

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CONTRACTOR INFORMATION RE COMBUSTIBLE DUST

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CONTRACTOR·INFORMATION¶

This·workplace·has·a·Combustible·Wood·Dust¶ Mitigation·and·Control·Program¶

¶

The·purpose:¶

- → To·control·combustible·wood·dust·accumulation·and·potential·ignition·sources¶
- → To·prevent·a·combustible·wood·dust·fire,·deflagration,·or·explosion.·¶

All·employees·and·contractors·are·expected·to·work·in·accordance·with·that·program.¶

Any·contractor·activity·that·introduces·a·new·combustible·dust·hazard·is·an·at-risk·activity·and·must·be·pre-planned·to·mitigate·the·risk.·The·new·hazard·would·include·one·or·more·of·the·following:¶

1. → **Added·Fuel**:·Activity·produces·wood·dust,·especially·fine·particle·size·dust.¶
2. → **Dispersion·of·Fuel**:·Activity·disperses·wood·dust·(pre-existing·accumulation·or·newly·created)·into·a·thick·cloud.¶
3. → **Containment·of·Dispersed·Fuel**:·Activity·disperses·fuel,·as·a·cloud,·in·an·enclosed·space·or·room.¶
4. → **Introduction·of·Ignition·Sources**:·Activity·introduces·one·or·more·ignition·sources·(e.g.,·heaters,·hot·work,·hot·equipment,·spark·generating·tools)·in·areas·where·wood·dust·accumulation·already·exist·or·are·being·created·by·the·activity,·in·the·general·work·area,·in·designated·hazardous·locations,·and·around·or·within·a·passive·containment·system,·or·dust·collection·system·components·such·as·duct·work·and·dust·collector·(baghouses,·cyclones,·etc.).¶
5. → **Any·activity**·that·might·interfere·with·the·proper·functioning·of·the·workplace's·existing·dust·accumulation·and·ignition·source·controls.¶
6. → **Any·activity**·that·might·interfere·with·the·proper·functioning·of·the·workplace's·existing·equipment·and·systems·for·fire·suppression·and·explosion·prevention.¶

¶

Why?¶

When·finely·divided·(i.e.,·powdered)·wood·dust·is·allowed·to·accumulate·in·the·workplace,·it·becomes·a·significant·fire·and·explosion·hazard.·All·that·is·required·is·for·some·activity·or·event·to·disperse·the·wood·dust·into·an·airborne·cloud·and·contact·an·ignition·source.·¶

¶

¶

For·small·amounts·of·dust,·the·result·will·be·a·large·fireball,·which·is·capable·of·severely·burning·workers;·if·the·activity·or·event·occurs·in·an·enclosure·or·room·with·larger·amounts·of·wood·dust,·a·powerful·explosion·will·result,·which·is·capable·of·severely·injuring·or·killing·workers·and·causing·significant·property·damage.¶

¶

Refer·to·the·*Combustible·Dust·Awareness·Quick·Guide*·for·more·information.¤

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Pre-Planning

Pre-planning to eliminate or minimize the risk and the proper execution of the plan are important.

For those hazard and risks that cannot be eliminated, the contractor will work with the workplace's management to develop appropriate controls and safe work procedures for the planned activities. These safe work procedures include hot work permits and housekeeping (i.e., wood dust and tramp metal/foreign contamination) before, during and after activity.

The dust explosion incident summarized below is based on an actual incident, although not wood dust. The outcome would have been the same had the combustible dust been wood dust.

Example: Working in the presence of existing combustible dust accumulation

As part of an ongoing furnace improvement project, a company engineer and an outside contractor were replacing igniters on a band furnace.

The pair experienced difficulty in reconnecting a particular natural gas line after replacing an igniter. The vibration, caused by using a hammer to force the gas port to reconnect, inadvertently lofted large amounts of combustible iron dust from flat surfaces on the side of the band furnace, spanning 20 feet above them.

Source: Chemical Safety Board
http://www.csb.gov/hoeganaes-corporation-fatal-flash-fires/

As soon as the dust dispersed, the engineer recalled being engulfed in flames. One worker died. The ignition source was the hot surface of the furnace.

The contractor activity disturbed an existing accumulation of combustible dust near an existing ignition source, i.e., the hot furnace surface.

Pre-job planning would have required the removal of the combustible dust accumulation. If possible, the furnace could have been shut down and allowed to cool before the work began thus removing a potential ignition source.

End of Combustible Dust Hazard Recognition Participant Handbook