COMBUSTIBLE DUST HAZARD RECOGNITION

February 2014

GUIDE FOR WORKERS AND FRONT LINE SUPERVISORS
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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

__________________________________________________

__________________________________________________

__________________________________________________

__________________________________________________

__________________________________________________

Workers and supervisors are the first line of defense:

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

__________________________________________________

__________________________________________________
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

Knowledge Check 1.1
Which of the following regulatory agencies have regulations related to combustible dust?

- WorkSafeBC
- Ministry of the Environment
- BC Safety Authority
- Office of the Fire Commissioner
- Public Health

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.

Look Out for...

Dust not being captured
Fires, when dust settles, can effectively spread and can cause explosions. An accumulation of dust can develop.

Look Out for...

Dust build up inside
Sealed, when dust settles, an accumulation of dust can develop. The dust can reach dangerous levels.
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.

What is a Dust Explosion?

- Ignition of a very thick dust cloud
- Very rapid burning and pressure rise

The resulting explosive force can damage plant, property, and people.

Two Categories of Dust Explosions

**Primary Explosion**
- Event’s first Explosion
- Takes place in a confined space
- Pressure/Shock Wave
- Fire Ball

**Secondary Explosion**
- Primary Explosion
- Creates & ignites new dust cloud
- Secondary Explosion occurs
- Process may repeat many times
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.

Dust Explosion in a Work Area

Dust settles on flat surfaces

Some event disturbs settled dust into a cloud

Dust cloud is ignited and explodes
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.

Oxygen
Dispersion
Ignition source
Explosion Pentagon
Confinement
Fuel

From Deflagration to Explosion...

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
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**

**Knowledge Check 2.1**

Which explosions typically occur in the general work area?

Primary or Secondary
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.

Knowledge Check 2.3
Fill in the blanks:
The three fire triangle elements are:
1. __________ 2. __________ 3. __________
2. Deflagration requires fire triangle elements plus __________ in air.
3. Explosion requires deflagration elements plus __________.

Knowledge Check 2.4
Many primary explosion risks are associated with dust collectors.
True or False

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
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.

Average Size of Un-sieved Sample: 700.7 μm

Average Size of Un-sieved Sample: 700.7 μm

Average Size of Un-sieved Sample: 700.7 μm

Average Size of Un-sieved Sample: 700.7 μm
How Much Dust is a Hazard?

">18" inch, 5% area or 1000 ft², whichever is smaller"

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

Hazard Alert

HAZARD ALERT

Combustible dust winter alert — Increased risk in winter

The list of dust hazards has increased in the winter months. This is due to the winter weather where more dust is generated and remains airborne for longer periods of time. Dust hazards can be found in a wide range of industries, including manufacturing, agriculture, healthcare, and construction. The winter weather conditions, such as low humidity and cold temperatures, can increase the risk of dust explosions and fires.

However, there are steps that can be taken to reduce the risk of dust hazards in the winter months.

1. Implement dust control measures such as wetting or vacuuming to reduce the amount of dust in the air.
2. Ensure that ventilation systems are properly maintained and functioning correctly.
3. Keep work areas clean and free of clutter to reduce the risk of accidental contact with dust.
4. Use personal protective equipment such as respirators to protect against exposure to dust hazards.
5. Regularly inspect and maintain machinery to ensure that it is in good working order.

In conclusion, it is important to remain vigilant and take proactive measures to reduce the risk of dust hazards in the winter months.
### 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

### 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

### Knowledge Check 3.3

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

- Secondary Dust will burn: __________
- Manufacturing Wood Debris will explode: __________
- Primary Dust will explode: __________
- Secondary Dust will deflagrate: __________

### Knowledge Check 3.4

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

- It must be combustible
- Fine enough to be airborne
- Dry
- Suspended in the air in an explosive concentration
- Contained or enclosed in confined area
- All of the above

### Knowledge Check 3.5

**Housekeeping Rule of Thumb:**

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

- thickness
- colour
- texture
The next segment will show how to recognize the hazard associated with potential ignition sources in the workplace.
• 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:

- Pipelines
- Motors
- Portable hand tools
- Lighting
- Radiant heaters
- Bearings

Common heat sources include:
- Pipes
- Compressors
- Motors
- Portable hand tools
- Lighting
- Radiant heaters
- Bearings

- Site smoking policy
- Open flames

Other Ignition Sources
- Heating Equipment
- Facility Lighting
- Tramp Metal / Foreign contaminant
- Spontaneous auto-ignition
Let’s review some highlights of the previous slides.

Knowledge Check 4.1

Which are the top two ignition sources from the list below?

- Mechanical Sparks
- Space Heaters
- Hot Work
- Static Electricity
- Hot Surfaces
- Friction
- Some mobile equipment
- Overheating equipment
- Electrical Arcs (i.e., shorts)

Knowledge Check 4.2

You see that a thick layer of dust has formed on the exterior casing of an MCC panel. You note that the dust is wet because of misting systems in the mill. You might:

a) Attempt to clean off the MCC panel and leave it at that.
b) Attempt to clean off the MCC panel, if trained to do so, and report the situation to the applicable supervisors, as the dust could be heated and dried over time to the point it could be easily ignited.
c) Do nothing. The dust is wet and therefore won’t ignite.
Misaligned blade and jammed wood product
Sparks or embers trigger primary explosion
Follow safe work procedures

Fighting a combustible dust fire can be dangerous.
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.

**Work in a Safe Manner**
- Learn your employer’s combustible dust mitigation and ignition control strategy
- Pre-task assessment
  - Do I see accumulations in my work area that are more than what is allowable?
  - Will my activities create a dust cloud?
  - Will I create ignition sources?
  - Am I working near existing ignition sources?
- Safe work procedures
- Emergency procedures

**Report Unsafe Conditions and Unsafe Acts**
- **Report**
  - Primary and secondary dust accumulations
  - Equipment in disrepair – overheating, vibrating, making noises
  - Any other unintentional ignition sources
  - Creating a dust cloud
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.

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.

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

Undue Hazard – Combustible Dust

Conditions might include:
1. A dense dust cloud, and/or
2. Sufficient accumulated dust on floors and/or elevated flat surfaces that could create a dense dust cloud, and
3. One or more potential ignition sources.
### Knowledge Check #5

**Knowledge Check 5.1**

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

- Employees
- Management

**Knowledge Check 5.2**

**Which are employee roles and responsibilities?**

1. Select & design dust mitigation strategies: **True** or **False**
2. Learn and follow safe work procedures: **True** or **False**
3. Report unsafe conditions and acts: **True** or **False**
4. Investigate reports of unsafe conditions and acts: **True** or **False**

**Knowledge Check 5.3**

**When is combustible dust an “Undue Hazard”?**

(3 possible conditions)

1. A dense airborne cloud exist: **Yes** or **No**
2. A thick accumulation of primary dust exist: **Yes** or **No**
3. A thick accumulation of secondary dust exist: **Yes** or **No**
4. One or more ignition sources exist: **Yes** or **No**
5. Combustible dust is inside a dust collection system: **Yes** or **No**

### Additional Handouts

- Combustible Dust Awareness Quick Guide

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**THIS ENDS THE PRESENTATION**
Knowledge Check 1.1

Which of the following regulatory agencies have regulations related to combustible dust?

- WorkSafeBC
- Ministry of the Environment
- BC Safety Authority
- Office of the Fire Commissioner
- Public Health

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.
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.

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.

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.

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

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

Knowledge Check 3.4

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

- It must be combustible
- Fine enough to be airborne
- Dry
- Suspended in the air in an explosive concentration
- Contained or enclosed in confined area
- All of the above

Answer 3.2

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.
Knowledge Check 3.5
Housekeeping Rule of Thumb:
Clean when combustible dust obscures the _______ of the underline surface.
- thickness
- colour
- texture

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

Knowledge Check 4.1
Which are the top two ignition sources from the list below?
- Mechanical Sparks
- Space Heaters
- Hot Work
- Static Electricity
- Hot Surfaces
- Friction
- Some mobile equipment
- Overheating equipment
- Electrical Arcs (i.e., shorts)

Answer 4.1

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

Knowledge Check 4.2
You see that a thick layer of dust has formed on the exterior casing of an MCC panel. You note that the dust is wet because of misting systems in the mill. You might:

a) Attempt to clean off the MCC panel and leave it at that.
b) Attempt to clean off the MCC panel, if trained to do so, and report the situation to the applicable supervisors, as the dust could be heated and dried over time to the point it could be easily ignited.
c) Do nothing. The dust is wet and therefore won’t ignite.

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

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.

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.

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.
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 mean: 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
  - Hot equipment
  - Hot Surfaces
  - Mechanical sparks
  - Overheating (e.g., friction)
  - Electrical equipment
  - Facility lighting
  - 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 ft², 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)**
CONTRACTOR INFORMATION RE COMBUSTIBLE DUST

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

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