

Combustible dust in wood products manufacturing

A shop-floor guide for employers and supervisors



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Introduction

A combustible wood dust explosion can occur inside any given work area (see Glossary for definition) that is fully or partially enclosed/contained by walls, equipment, or other objects.

The key to preventing dust explosions is to prevent combustible wood dust from building up to hazardous levels, particularly in hidden areas and on hard to clean, elevated surfaces.

This publication was produced for employers and supervisors as a guide to combustible wood dust-related issues in their daily work environment and to increase their knowledge of combustible wood dust hazard recognition and mitigation. Interested stakeholders may also refer to or use the information contained in this document to assist them in carrying out their occupational health and safety roles and responsibilities.

Workers and supervisors are the first line of defence in preventing and mitigating fires and explosions. If the people closest to the source of the hazard are trained to recognize and prevent hazards associated with combustible wood dust, they can be instrumental in the following:

- Recognizing unsafe conditions
- Taking preventive action
- Alerting management

If company owners and managers understand the hazards associated with combustible wood dust, they are more likely to respond to reports from workers and supervisors about related unsafe conditions and acts.

This document contains information to assist workplaces in assessing the effectiveness of their combustible wood dust management program through regular inspections.



Combustible wood dust accumulations on a light fixture and other elevated surfaces.



This image from an animation shows an explosion in a dust collector. (USCSB image)

Note: This document is not an introduction to the issue of combustible wood dust. It is assumed that readers already have a combustible wood dust management program in place and have received adequate training in combustible wood dust hazard recognition and mitigation controls. For introductory training in combustible wood dust, refer to the training resources on the Fire Inspection and Prevention Initiative website.

Part 1 – Things you must know about combustible wood dust

Respirable dust (see Glossary for definition) hazards are beyond the scope of this document. However, respirable dust may present a serious health hazard that must be mitigated.

Dust explosions are preventable

You can help prevent combustible wood dust explosions (see Glossary for definition) by learning more about dust accumulations, where they can occur, how to assess the risk, and what to do when you find such accumulations.

Combustible wood dust (see Glossary for definition) is made up of very fine particles that can ignite and burn when suspended in air. This dust may also present an explosion hazard under certain conditions.

Some examples of wood products manufacturing facilities that may be at risk for combustible wood dust fires and explosions include:

- Sawmills and planing mills
- Pulp and paper mills
- Shake and shingle mills
- Reconstituted wood product (e.g., pellet, hardboard, particleboard, insulation board) facilities
- Prefabricated wood building and component (e.g., doors, windows) facilities
- Structural wood member facilities
- Millwork facilities
- Wood kitchen cabinet facilities
- Wood household furniture facilities
- Other wood products manufacturing facilities



Wood dust accumulations on a sawmill floor

Part 2 – How combustible wood dust differs from other wood dusts

Not all types of wood dust can create a deflagration (see Glossary for definition) or an explosion. So it is important to understand the differences between these dusts. The BC Fire Code defines combustible wood dust as “dusts and particles that are ignitable and liable to produce an explosion.” U.S. National Fire Protection Association (NFPA) standards 654 and 664 have similar definitions. NFPA 664 also states that combustible wood dust will have a mass median particle size of 500 microns or smaller (see Figure 2).

In wood products manufacturing processes, the type and speed of the process, along with characteristics of the wood, create different dust profiles. These profiles may range from large particulates and debris (e.g., chipping operations) to very fine, powdery dust (e.g., sanding).



Figure 1. Primary dust (BCSA image)

Wood dust that is made up of mostly large particles (see Figure 1) is called primary dust (see Glossary for definition). This dust will only burn, not deflagrate or explode. Wood dust that is made up of mostly fine particles (see Figure 2) is called secondary dust (see Glossary for definition). This dust can burn and may also deflagrate and explode.

Primary dust is the coarser, greener dust more directly associated with production processes. If you took a handful of primary dust and tossed it in the air, most of it would fall to the ground very quickly. Since a dust cloud is not formed, a deflagration or explosion is not possible. For this reason, primary dust piles can only burn.



Figure 2. Secondary dust (BCSA image)

Secondary dust is usually the drier, finer dust that has settled away from areas where it was produced or released. If you took a handful of secondary dust and tossed it in the air, much of it would remain airborne long enough to form a dust cloud that, depending on its profile (i.e., particle size and moisture content) and thickness, could deflagrate or explode. Secondary dust piles can also burn.

Secondary dust is to be considered “deflagrable” unless the employer has conducted appropriate and representative testing to show otherwise. A hazard exists where accumulated deflagrable secondary dust is at a depth of 3 mm (1/8 in.) or more over 5 percent of a given work area. In addition to the floor, the area includes overhead beams, trusses, sills, and other elevated, horizontal surfaces.



Secondary dust accumulation in the workplace

A small fraction of most primary dust accumulations will be particles of sizes 500 microns or smaller. Secondary dust accumulations are created by any process or activity that transfers, agitates, or otherwise causes those small dust particles to separate from the primary dust pile and become airborne. Once airborne, these dust particles migrate and settle elsewhere, and may become drier and more combustible in the process.

A fire in a primary dust source can ignite an explosion. For example, the fire could ignite a nearby dust cloud. If the fire is significant enough, it could create a dust cloud by disturbing nearby secondary dust accumulations through heat drafts. The fire could then ignite the dust cloud.

For these reasons, it is important to manage primary dust accumulations as well as secondary dust accumulations.

Part 3 – Dust explosions are preventable

Overview

A combustible wood dust explosion can occur inside any given work area that is fully or partially enclosed/contained by walls, equipment, or other objects. The most common sites of primary explosions (see Glossary for definition) are dust collectors. Enclosed conveyance systems are also common sites of such explosions.

However, the two catastrophic mill explosions in northern B.C. in early 2012 did not originate in these common sites. These events demonstrated that other potential sites for primary explosions also need to be addressed.



A fireball from just a handful of dust can completely engulf a worker.



In this image from an animation, a fireball threatens to engulf workers. (USCSB image)

Dust accumulations in a facility can create conditions (i.e., dust clouds) for deflagrations and secondary explosions (see Glossary for definition). Even a handful of dust can form a dust cloud that can deflagrate and seriously or fatally injure a worker.

Many potential ignition sources exist in wood products manufacturing facilities, ranging from arc flashes in electrical switches to sparks from tramp metal (see Glossary for definition) in ductwork. These ignition sources can ignite combustible wood dust, resulting in potentially deadly fireballs or explosions.

Refer to the Fire Inspection and Prevention Initiative website (www.fipibc.ca) or other training resources to learn more about the fire, deflagration, and explosion hazards of combustible wood dust.

When selecting dust accumulation control strategies, it is important to understand the pros and cons and the best location for use of each control option. This document does not recommend specific control strategies. You will likely require someone with the appropriate subject matter expertise. Otherwise, you may inadvertently create a dangerous condition in which a dust cloud can form inside a fully or partially enclosed/contained area where potential ignition sources exist.

The key to preventing dust explosions is to prevent combustible wood dust from accumulating to hazardous levels, particularly in hidden areas and on hard-to-clean elevated surfaces. Efforts to minimize accumulations and prevent the generation of dust clouds need to be supported by robust control of ignition sources that could ignite a fire or explosion.

Combustible wood dust management programs

After conducting a risk assessment, an employer should implement an effective combustible wood dust management program. The program should include, but not be limited to, the following:

- Effective control of combustible wood dust hazards (i.e., dust accumulations and ignition sources)
- Explosion protection on the dust collection system (see Glossary for definition)
- Scheduled inspections and audits
- The program should include the most appropriate combination of the following dust control options:
 - Engineering controls
 - Dust collection systems
 - Passive containment systems (e.g., enclosures, curtains)
 - Construction features of buildings and structures (e.g., the use of paint, sloping walls, and/or sealing to prevent the buildup or spread of dust)
 - Wet dust suppression
 - Administrative controls (e.g., manual housekeeping, preventive maintenance, management of change)

Education and training of management and workers is required to implement the program effectively. Timely reviews and audits help ensure the program remains effective year after year.

Refer to the FIPI website or other training resources to learn more about the various combustible wood dust control options.



Effectively implemented engineering controls help reduce fire and explosion risks in equipment such as this planer cyclone.

Manual housekeeping: a word of caution

The goals of manual housekeeping are to ensure the following:

- Primary and secondary dusts are actively managed so they do not:
 - Dry out and spread
 - Directly contact equipment that produces heat or is a potential ignition source
- Deflagrable secondary dust does not accumulate to a depth of 3 mm (1/8 in.) or more over 5 percent of a given work area, which includes any elevated horizontal surfaces.

Almost all facilities will require some level of manual housekeeping. Effective housekeeping is an ongoing operation, not a hit-and-miss cleanup done occasionally. Although required, manual housekeeping is meant to supplement, not replace, engineering controls such as an effective dust collection system. And if done incorrectly, manual housekeeping can loft combustible wood dust into the air, increasing the risk of fires or explosions.



This electric motor (a potential ignition source) is covered in wood dust. The drive belts and pulleys within the guard are also potential ignition sources. (BCSA image)

Examples of ignition source controls

The combustible dust management program should include methods to eliminate or control ignition sources in areas where combustible wood dust may accumulate. Examples of ignition source controls include:

- Eliminating the ignition source through removal or prohibition (e.g., prohibiting use of temporary heaters)
- Substituting with something less hazardous (e.g., replacing hot equipment with units that produce less heat, or using non-spark-producing materials)
- Shielding, isolating, or encapsulating the ignition source
- Using intrinsically safe or dust-tight equipment
- Bonding and grounding equipment, tools, and sometimes workers
- Using metal detectors/separators or similar equipment to prevent tramp metal from entering the dust collection system
- Using safe work procedures (e.g., hot work, manual housekeeping)
- Using preventive maintenance to ensure equipment is in a good state of repair

Ensuring your program is effective

An effective combustible wood dust management program includes the following activities on a day-to-day basis:

- **Pre-job planning** ensures that combustible wood dust hazards and ignition sources are considered before beginning tasks.
- **Regular workplace inspections** determine whether or not policies, procedures, and controls remain effective in achieving the program's objectives.
- **Investigations of fires and related combustible wood dust incidents** aim to do the following:
 - Determine the mechanism that allows an ignition source to contact combustible wood dust.
 - Identify measures to prevent recurrence.

Regular reviews and at least one audit of the program should be carried out annually.

Part 4 – Know where wood dust builds up in your workplace

Overview

To effectively manage combustible wood dust on a day-to-day basis, you need to know where it builds up in your workplace. Look for the following:

- Processes that:
 - Receive, handle, and/or store raw combustible wood dust materials (e.g., rail car and truck loading/unloading stations, silos, bins)
 - Use raw combustible wood dust materials to produce a product
 - Transfer combustible wood dust materials before or after processing, with or separate from other materials or products (e.g., conveyor transfer points)
 - Produce combustible wood dust by processing raw materials where the combustible wood dust is the finished product, by-product, or waste (e.g., grinders, hammer mills, blenders, bulk bag filling and unloading stations)
 - Store or handle combustible wood dust products or waste prior to shipping or disposal
- Open areas where combustible wood dust may accumulate, such as on or in the following:
 - Floors
 - Structural members (e.g., purlins, girts, beams, and trusses)
 - Conduits
 - Pipe racks
 - Cable trays
 - Equipment
 - Rough, flat, sloped, or vertical building and interior structure surfaces
- Leaks around dust collectors and ductwork
- Hidden areas where “fugitive” combustible wood dusts may accumulate (e.g., behind walls, above false ceilings, and inside guards and enclosures)



Dust accumulation inside an electronic control centre

Management of change

Management of change is a process that considers combustible wood dust hazards when evaluating the impact of change. The goal is to make sure that no changes occur that could increase the severity or consequence of an existing dust hazard or introduce a dust hazard where none previously existed.

Change events would include upset conditions and emergency repairs, equipment or process changes, and new construction. Some temporary events can be managed through pre-job planning, while others may require changes to engineering and administrative controls, as well as policies and safe work procedures. Ensure compliance with applicable codes and regulations.

Part 5 – Pre-job planning to identify job risks

Why pre-job plan?



Improper use of compressed air (for example, in housekeeping or maintenance work) can disperse wood dust into the air, increasing the risk of a fire, deflagration, or explosion.

Even if your facility has a combustible wood dust management program, there will be some regular and ad-hoc tasks that could place workers, contractors, and others at risk of a fire, deflagration, or explosion. For example, the risk increases if the task:

- **Adds or produces dust**, especially fine dust particles
- **Disperses dust** into a thick dust cloud in the general work area, in an enclosed space, or in equipment
- **Contains the dispersed dust**, as a cloud, in an enclosed space or room
- **Introduces one or more ignition sources** in areas where dust accumulations already exist or are being created by the activity (e.g., in the general work area, in designated hazardous locations, and around or within passive containment systems or dust collection system components)
- **Interferes with the proper functioning** of dust accumulation and ignition source controls
- **Interferes with the proper functioning** of equipment and systems for fire suppression, explosion prevention, and monitoring

A few examples of tasks that may increase the risk of fire, deflagration, or explosion include:

- Certain new or newly modified production tasks
- Manual housekeeping
- Preventive maintenance and/or repairs (planned work or upset conditions)
- Construction
- Hot work procedures (e.g., during maintenance, repairs, and construction)
- Operation of processes or equipment that could introduce tramp metal and/or hot embers into the dust collection system

Part 6 – Assessing the job's risks

Overview

Assess the risks of a task before starting work, as well as when a change occurs during a task. Depending on the type of risk posed by the task, it's important to ask some key questions, as noted below. The answers to the questions should suggest appropriate controls.



In this image from an animation, a worker uses a hammer to reconnect a gas line to a furnace. Accumulated combustible dust was lofted into the air and ignited, burning the worker. (USCSB image)

If the task **adds or produces dust**, ask yourself:

- Can the generation of dust be minimized?
- Can the generated dust be captured?

If the task **disperses dust**, ask yourself:

- Can the pre-existing accumulation be removed before starting the task?
- Can the generated dust cloud be prevented or captured?
- Can existing ignition sources be eliminated or otherwise controlled to prevent contact with any dust that is dispersed?
- If the task contains the dispersed dust, ask yourself:
 - Can the dispersion be eliminated or at least minimized?
 - Can the confinement be removed?

If the task **introduces one or more ignition sources**, ask yourself:

- Can the ignition sources be eliminated or otherwise controlled to prevent contact with combustible wood dust?
- Should hot work procedures be used?

If the task **interferes with the proper functioning** of dust accumulation and ignition source controls, ask yourself:

- If the dust collection system must be shut down to perform the task, then what production process (supported by that dust collection system) needs to be stopped before the task is performed?

If the task **interferes with the proper functioning** of equipment and systems for fire suppression, explosion prevention, and monitoring, ask yourself:

- If such equipment and systems are out of service, then have the dust collection system and the production supported by that system been halted before the task is performed?
- If the fire suppression system is out of service, what temporary measures can be taken to ensure that protection is maintained?

Before starting any of these tasks, also assess for other hazards. These hazards may require precautions such as fall protection, lockout, ergonomic assessments, and PPE.

Put the controls in place BEFORE starting the task, and follow the pre-job plan to safely complete the task.

During inspections, take the time to observe processes and tasks in progress to determine whether or not combustible wood dust is being properly managed.

Part 7 – Preparing for dust inspections

Overview

Conduct regular inspections of premises, machinery, tools, equipment, and work practices to:

- (1) Identify conditions (e.g., wood dust accumulations, potential ignition sources, equipment in a poor state of repair) and acts (e.g., improper housekeeping, poorly planned hot work) that have the potential to cause injury or illness.
- (2) Determine necessary corrective measures.
- (3) Prevent the development of unsafe work conditions.

Types of inspections include the following:

- **General workplace inspections**, typically conducted by area supervisors and workers.
- **Preventive maintenance** of mechanical and electrical equipment, typically conducted by qualified tradespersons. The goal is to prevent equipment from running to failure and becoming an ignition source. A system should be put in place to record and track items requiring repair and items that have been repaired.
- **Specialized equipment inspections** (of fire detection/prevention equipment, for example) that may require qualified third-party technicians specializing in a particular field. The technicians conduct these inspections and any related testing in accordance with codes, reference standards, and manufacturer's instructions.

Schedule inspections based on the risk assessment, the findings from previous inspections, and applicable manufacturer's instructions. Inspections may take place hourly, daily, weekly, or monthly, depending on the workplace and the types of hazards that may develop. Adjust the frequency of inspections as required to ensure timeliness and effectiveness.

Document inspections, recommend corrective action for noted deficiencies, and assign individuals to act on the recommendations.

Dedicate a portion of your regular safety inspections to determining whether or not your facility's policies, procedures, and controls are achieving the three objectives of your combustible wood dust management program. Refer to Part 3, Dust explosions are preventable, for more details.

Identify the frequency of inspections of housekeeping and cleanup activities for each area of the facility based on the findings of the risk assessment. Adjust the inspection frequencies as required to ensure dust accumulations do not exceed limits.

A hazard may exist where accumulated deflagrable secondary dust reaches a depth of 3 mm (1/8 in.) or more over 5 percent of a given work area. For large facilities, a given work area includes overhead beams, sills, and other elevated, horizontal surfaces, as well as the floor.



Inspecting a production area for wood dust accumulations

General inspections

The wood dust component of a general inspection involves the following tasks:

- Assess cleanup and housekeeping activities.
 - Determine if a change in the rate of wood dust accumulation warrants changes to the area's housekeeping practices.
 - Determine if new potential ignition sources have developed.
 - Observe worker activities for adherence to safe cleaning procedures.
- Assess dust-producing processes.
 - Determine if a less-than-normal rate of wood dust capture at the point of generation warrants an inspection of the dust collection system and/or changes to the area's housekeeping practices.
 - Determine if there are any dust leaks from, or damage to, the ductwork.
 - Determine if any equipment is making unusual noises, vibrating, or overheating.
 - Observe workers' activities for adherence to safe work procedures – especially procedures that support the operation of the dust collection system.

- Assess any construction, repairs, or maintenance activities that are in progress.
 - Determine if the work is being done by qualified individuals (whether they are staff or third-party contractors).
 - Determine if an adequate pre-job plan was conducted. (See Assessing a job's risks for details.)
 - Observe worker activities for adherence to the pre-job plan and to safe work procedures (e.g., hot work, equipment testing).
- Monitor for the presence of uncontrolled ignition sources.

Equipment inspections and preventive maintenance

Create a master inspection, testing, and maintenance schedule for the upcoming 12 calendar months. The schedule should be created (1) as part of an annual review, (2) prior to the start of the next calendar year, or (3) at a specific date each year. The schedule should identify who will do the work or who is responsible for engaging a third-party contractor to complete the work.

Some key systems to inspect, test, and maintain include the following:

- The electrical system
 - Inspect and clean electrical room enclosures, electrical equipment, and cabinets. Ensure these parts of the system are intact and properly sealed so that combustible wood dust does not accumulate inside them.
- The mechanical systems
 - Focus on equipment that can act as a potential ignition source (e.g., overheating or generating sparks). Examples include the following:
 - Friction-producing equipment such as gear reducers, bearings, conveyor spools, and belt drives. (See Glossary for a definition of friction.)
 - Machinery and processing equipment.
 - Focus on spaces behind enclosures and guards where wood dust can accumulate.

- The dust collection system
 - Focus on explosion venting and other explosion-prevention features, including the following:
 - The dust collection system's bonding and grounding.
 - Electrical interlocks between dust-producing equipment and the dust collection system.
 - Explosion vents and the safe blast zone (see Glossary for definition).
 - Explosion-prevention equipment, if used (e.g., spark- or explosion-suppression systems, abort gates, and backflow preventers).

A method should be in place to record and track items requiring repair and items that have been repaired.



Combustible wood dust accumulations on and inside machinery

Part 8 – Reviewing documentation before inspection

Overview

Before carrying out an inspection, it's important to review documentation related to your facility's combustible wood dust control efforts.

Inspection reports

- Review one or more previous inspection reports to learn what was observed, what hazards were identified, and what corrective actions were recommended.
- Contact the person(s) responsible for responding to the recommendations to learn the response.
- During the inspection, determine whether or not each issue still exists and if any corrective actions taken have been effective and sustainable.



Evidence of a dust collection system leak

Incident reports

Review all combustible wood dust-related incident reports written since the last inspection. Pay special attention to the following:

- Reports of small fires and/or deflagration fireballs (e.g., in the general work area and inside the dust collection system)
- Worker reports of excessive dust accumulations, dust collection system leaks, and refusal of unsafe work
- Contact the person(s) responsible for responding to the incident reports' recommendations to learn the response.

- During the inspection, determine whether or not each issue still exists and if any corrective actions taken have been effective and sustainable.

Preventive maintenance reports

- Review all preventive maintenance reports written since the last inspection. Pay special attention to maintenance activities involving production equipment, the dust collection system, fire suppression and firefighting equipment, and related monitoring equipment.
- Determine the following:
 - If any equipment (e.g., fire suppression, monitoring, emergency) inspections and/or tests have been postponed or cancelled, and why
 - If any of the scheduled preventive maintenance activities have been postponed or cancelled, and why



Poorly designed conveyance ducting in a poor state of repair

Housekeeping reports

Review all housekeeping reports written since the last inspection. Determine if any of the scheduled housekeeping activities have been postponed or cancelled, and why.

Fire investigation reports

Review all fire investigation reports written since the last inspection to learn how the combustible wood dust came in contact with the ignition source and what corrective actions were recommended.

During the inspection, determine whether or not the issue still exists or if the corrective actions taken have been effective and sustainable.



In this image from an animation, a worker uses compressed air to dislodge a dust buildup in ductwork. (USCSB image)

Management-of-change reports

Review all management-of-change reports written since the last inspection. Find out if there have been any changes to structures, processes, raw materials, production, or the dust collection system. During the inspection, confirm that the findings from the management-of-change process have been addressed and incorporated into the operation.



A motor sparks a deadly combustible dust fire in this image from an animation. (USCSB image)

Part 9 – Conducting a site inspection

Overview

To ensure a thorough inspection, follow a systematic process based on the floor plans that show combustible wood dust generation points and known ignition sources.

- Inspect locations where primary dust is being produced. Ensure that these accumulations are actively managed and separated from potential ignition sources.
- Inspect all other areas for secondary wood dust accumulations. Ensure that these accumulations are maintained below the hazard threshold (i.e., based on [1] the risk assessment, or [2] if the dust is deflagrable, a layer as little as 3 mm (1/8 in.) deep over 5 percent of the given work area).
- Inspect locations of interest from your review of previous inspection reports, preventive maintenance reports, and fire and other incident/investigation reports.
- Review management-of-change findings that have been implemented since the last inspection.
- Observe any manual housekeeping, hot work, maintenance tasks, contractor work, and any other task that might generate or disturb combustible wood dust. Ensure that these tasks are carried out in accordance with safe work procedures (e.g., to avoid creating dust clouds and/or contacting ignition sources).
- Discuss with the cleanup crew(s) whether the manual housekeeping frequency for each area is appropriate for the combustible wood dust accumulation rate (e.g., hourly, daily, weekly, monthly, quarterly, and other intervals).
 - Did the crews find any unexpected heavier accumulations in any location?
 - Were these heavier accumulations due to production increases, upset conditions, cancelled housekeeping, or other reasons?
 - What was considered to prevent a recurrence?
- Interview workers to gauge the following:
 - Their combustible wood dust knowledge
 - Their understanding that they must report excessive dust accumulations and conditions that could create ignition sources (e.g., excessive noise, vibration, jammed product)
 - Their understanding of immediately dangerous conditions and their right to refuse unsafe work



Using powered hand tools in a dust-covered area could disturb and ignite combustible dust.

Assess dust accumulations, controls, and ignition sources

For each location, consider the following:

- The wood dust accumulation level:
 - Is it at or below the hazard threshold?
 - Is it mostly primary dust or secondary dust? If secondary, is it also deflagrable?
 - What is the source of the dust?
 - Dust not captured at the point of generation?
 - Leaks from the dust collection system or passive containment systems?
 - Other sources (e.g., construction or repair activities)?
 - Is the manual housekeeping frequency sufficient to support the dust collection system in keeping secondary dust accumulations below the hazard threshold?
- Is dust accumulating in concealed spaces such as attics, false ceilings, crawlspaces, behind equipment enclosures and guards, inside ductwork, etc.?
- Are building construction features still in a good state of repair to hinder accumulations and ease housekeeping?

- Have there been any changes to equipment, materials, the building structure, etc., in the area since the last inspection that could combine to increase the level of containment (full or partial) and the risk of a primary explosion?
- Can the dust accumulation rate be reduced through additional engineering controls or repairs/modifications to existing controls?
- Is accumulated dust interfering with the equipment's ability to dissipate heat, thus creating an ignition source?
- If the equipment is provided with a cooling system, is the interlock between the equipment and the cooling system functioning?
- Is any machine or processing equipment making unusual noises, vibrating, or overheating?
- Are other ignition sources or potential ignition sources adequately controlled? Examples include hot surfaces, heating equipment, friction, static electricity, and facility lighting. (Refer to Dust explosions are preventable for details on ignition source controls.)
- Is there a potential for upset conditions to release additional combustible wood dust or create ignition sources (e.g., mechanical sparks, friction heat, hot embers)? Are procedures in place to respond appropriately and safely?



Dust accumulations near a conveyor

Assess work activities

- Was pre-job planning required and carried out? (See Pre-job planning for details.)
- Do work activities currently in progress comply with safe work procedures (e.g., procedures to minimize dust generation, capture dust, and prevent the formation of dust clouds and ignition sources)? Pay special attention to the following:
 - Production activities (routine, modified, or new) that generate wood dust
 - Preventive maintenance or repairs that could generate or disturb wood dust and/or create ignition sources
 - Manual housekeeping activities, including the use of compressed air, and their potential to disperse wood dust into the air
 - Construction work (in-house or contractor) that could generate wood dust and/or ignition sources
 - Any hot work activity associated with construction, maintenance, or repair

Assess the dust collection system

Inspect the dust collection system for fire and explosion hazards.

- If there is ductwork in the area, check the following:
 - Is it in a good state of repair with no leaks?
 - Do workers take measures to ensure tramp metal or hot embers (e.g., from fractioning equipment and floor sweeps), as well as flammable gases or vapours, are not drawn into the dust collection system?
 - Is combustible wood dust accumulating inside the ductwork? (Use inspection access points on ductwork to look inside.)
- If there is passive containment in the area, check the following:
 - Are dust and debris being contained adequately?
 - If a dust cloud is being created, is it sufficiently thick to be of concern?
 - Are the collected dust and debris being removed regularly?
- If there is wet dust suppression in the area, check the following:
 - Is the suppression system operating as designed to control and contain the dust?
 - Are other areas and equipment being caked or fouled with wet dust?

- If there is an air-material separator (e.g., cyclone, baghouse, or enclosureless dust collector), check the following:
 - Is it in a good state of repair with no leaks?
 - Is the collected combustible dust being handled in a manner that does not produce dust clouds or spills?



Storage bins with heavy dust accumulations

Assess explosion prevention/suppression equipment

Assess explosion prevention/suppression equipment on the dust collection system.

- Is the safe-blast-zone fencing outside the explosion vents in a good state of repair to prevent unauthorized entry?
- Are the explosion vents in a good state of repair? Are there any signs of damage, corrosion, etc.?
- Are the explosion vents' warning labels still affixed and readable?
- If abort gates are present, are they in a good state of repair?

Assess emergency preparedness

Assess the following aspects of your emergency preparedness program.

Escape from fire

- Are evacuation routes and emergency procedures posted?
- Are exit doors free of obstructions that could hinder or prevent escape?
- Are exit signs and emergency lighting functioning?
- Do workers know how to sound the alarm, how to evacuate, and where to muster?

Fire control and extinguishment

- Are workers aware of the dangers of fighting a combustible wood dust fire? (See Part 10 – What to do in an emergency for more information.)
- Are fire extinguisher inspections up to date (i.e., less than one year since the last inspection)?
- Are sprinkler systems and other fire extinguishing equipment in a good state of repair?

Post-inspection activities

Write a report that identifies all hazards, risks, and recommended corrective actions, and that answers the following questions:

- (1) Should the housekeeping frequency be increased?
 - Is any equipment in need of repair?
 - Does the preventive maintenance program appear to be effective?
 - Did workers demonstrate sufficient knowledge to perform their duties safely?
- (2) Assign responsibility to address recommendations and take corrective actions.
- (3) Confirm with the persons who have been assigned responsibilities that they accept the responsibilities.
- (4) Assign target dates for completion or implementation.
- (5) Follow up at a later date to verify that the tasks have been completed and the desired results have been achieved.
- (6) Distribute and post the report according to company policies.

Part 10 – What to do in an emergency

Overview

Each facility should have a fire safety plan that meets the requirements of the BC Fire Code. The fire safety plan must include emergency procedures and related information.

- Workers are responsible for knowing and following the fire safety plan for firefighting, alerting others, and evacuating.
- Supervisors and employers are responsible for following the fire safety plan for firefighting, alerting others, and evacuating. They are also responsible for investigating the causes of all fires, regardless of size.



(FPOABC image)

Hazards of fighting a combustible wood dust fire

All fires are hazardous. Combustible wood dust fires present additional hazards. First, if there is airborne combustible wood dust nearby, the fire could ignite a primary explosion. Second, improperly attacking the fire could also disturb the accumulated combustible wood dust and trigger a primary explosion or a deflagration fireball.

Unless you have been properly trained, do not fight a combustible wood dust fire. Sound the alarm, alert designated responders, and follow evacuation procedures.

The OSHA publication *Firefighting Precautions at Facilities with Combustible Dust* can assist with the development of safe firefighting procedures for personnel responding to a fire or explosion.

Glossary

Combustible wood dust

Combustible wood dust is made up of very fine particles that can ignite and burn when suspended in air. Under some conditions, this may result in an explosion.

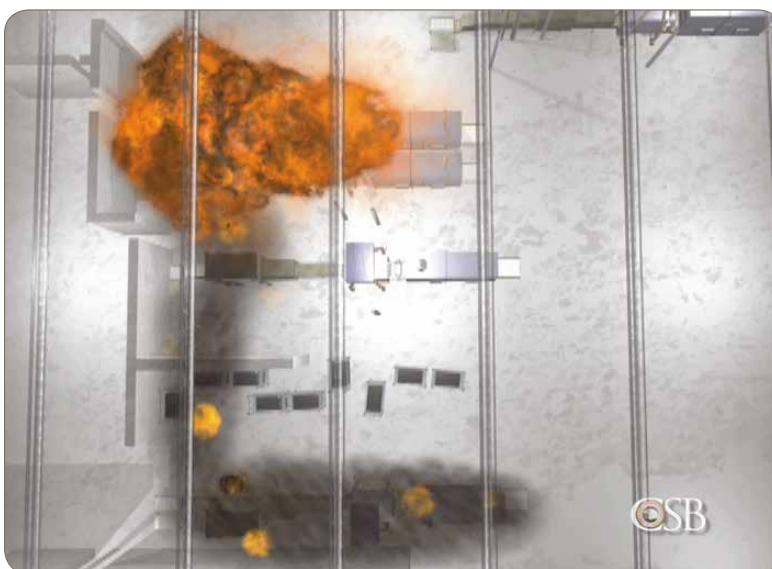
Combustible wood dust makes up a very large portion of secondary dust. Combustible wood dust can be found in varying amounts in primary dust (depending on the equipment producing the dust). Combustible wood dust makes up only a very small fraction of manufactured wood debris

Combustible wood dust explosion

A combustible wood dust explosion is the very rapid combustion of a wood dust cloud or suspension of wood dust in air where heat and pressure are generated very quickly. A combustible wood dust explosion can occur when five conditions are present: oxygen, fuel (combustible wood dust), an ignition source, dispersion of fuel in the air, and containment.

Deflagration

Deflagration is the very fast propagation, or spreading, of a fire. Although fast, the expanding pressure rise is not as strong as that of an explosion. For example, you might hear a “whoosh” sound when you turn on the gas in your barbecue and are a little slow at lighting the gas. This is a deflagration. Larger deflagration fireballs in a wood products manufacturing setting can cause serious or life-threatening burns.



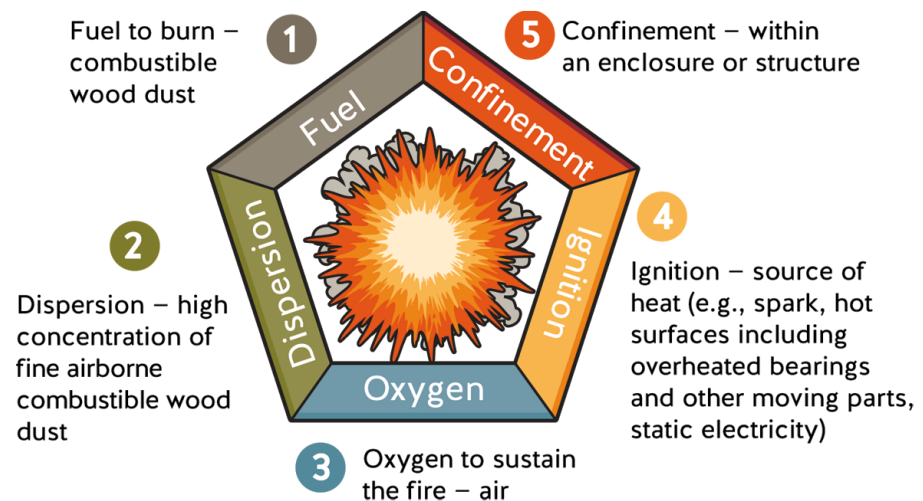
Overhead view of a deflagration fireball moving from one production line to another in a manufacturing plant, resulting in multiple explosions.

Dust collection system

An engineering control designed, using good engineering practice (e.g., NFPA 664, ACGIH Industrial Ventilation Manual), to capture dust and pneumatically convey it to a central collection device for removal from the airstream. A dust collection system may consist of the following:

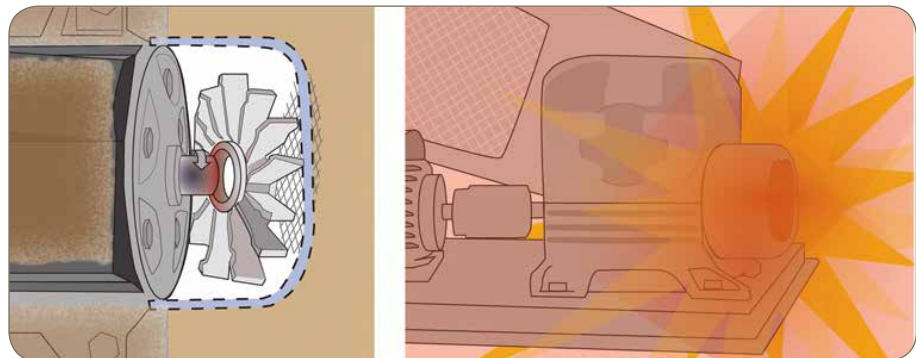
- Fans, collection hoods, and interconnecting ductwork
- One or more air-material separators (e.g., baghouses, cyclones, electrostatic precipitators, wet collectors)
- Dust containment prior to shipping or disposal (e.g., bags, metal barrels, bins)
- Appropriate controls and safety systems (e.g., spark detection/suppression, explosion prevention)

Dust explosion pentagon



Friction

Friction can cause overheating. Examples of overheating from friction include moving parts such as belts, conveyor spools, nip points, gears, drive shafts, and bearings. Friction can be an ignition source.



Friction from damaged moving parts can be an ignition source.

Given work area

A given work area is considered to be an area of the workplace, whose boundaries are defined by the various physical structures around it, which may enclose, contain, or compartmentalize the area. These structures may include walls, floors, ceilings, process equipment, or any combination of these, which have the effect of either fully or partially enclosing, containing, or compartmentalizing that work area within the facility. The greater the extent of confinement, enclosure, or containment in an area where dust has accumulated, the greater the risk that an explosion may occur.

Management of change

Management of change is a process that considers combustible wood dust hazards when evaluating the impact of change. The goal is to make sure that no changes occur that could increase the severity or consequence of an existing dust hazard or introduce a dust hazard where none previously existed.

Manufactured wood debris

Manufactured wood debris is defined as a waste by-product of a manufacturing process. In a sawmill, manufactured wood debris consists of bark, wood chunks, some chips, and possibly some sawdust. If allowed to accumulate, this debris can become a fire hazard. Over time, manufactured wood debris can release finer, drier secondary dust, which can become a fire and explosion hazard.



The larger pieces of wood are considered manufactured wood debris.

Primary dust

Primary dust is created by primary machine centres and other work processes. It is the wood dust found on floors and surfaces near or below dust-producing (e.g., primary breakdown) or waste-handling equipment. Primary dust is the source for secondary dust, which is often the fuel source for serious fires and explosions.

Primary explosion

A primary explosion is an initial event (caused by a work activity or an ignition source) that disturbs and ignites nearby settled wood dust. Under the right conditions, a primary explosion can spark one or more secondary explosions.



Primary dust accumulations

Respirable dust

Respirable dusts are particles so small that they can be inhaled and held deep in the lungs. When a fog or mist-like haze is present as a result of cutting, shaping, grinding, or transporting materials, respirable dust is likely in the air. Respirable dusts remain airborne for a very long time. Combustible wood dust particles, although very small, are many thousands of times larger than respirable dusts.

Respirable dust exposure hazards depend on the type and amount of the specific contaminant (e.g., wood dust) present and the exposure time. Inhaled respirable dusts may cause occupational illness and disease. Short and long-term effects can include irritation of the eyes, mucous membranes, and upper respiratory system; allergic reactions; chronic cough; asthma; pneumonitis; difficulty breathing, and a variety of cancers.

Safe blast zone

A safe blast zone is an area in front of the dust collector's explosion vents. This area is free of machinery and is inaccessible to workers (e.g., due to fencing). When an explosion is vented, a fireball (i.e., burning gases and other burning material) and shock waves are ejected at extremely high speeds and travel a significant distance. These blasts can cause serious damage to property and personnel caught in the fireball's path.

Secondary dust

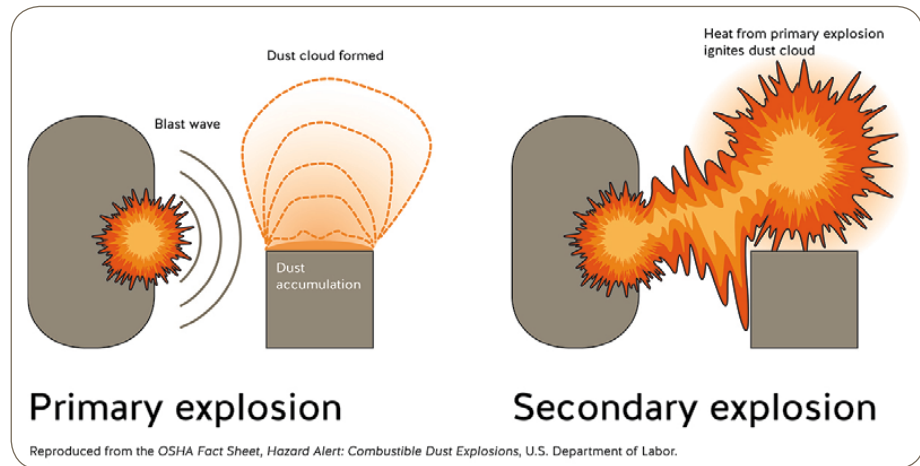
Secondary dust is the finer, drier wood dust that is broadly dispersed and settles away from the production area (usually on rafters, ceilings, beams, ductwork, walls, joints, and machinery). A significant fire and explosion hazard can exist when there is as little as 3 mm (1/8 in.) of deflagrable secondary dust over 5 percent of a given work area, including elevated surfaces (e.g., rafters, beams, and equipment).



Secondary dust on floors, equipment, and other surfaces

Secondary explosion

A secondary explosion can occur when the initial or primary explosion dislodges accumulated combustible wood dust in surrounding areas and structures and this dust ignites. These explosions are often more powerful than the initial explosions because of the increased amount and concentration of combustible wood dust.



Tramp metal and other foreign contamination

Tramp metal (e.g., filings, nuts and bolts, nails, and broken machinery parts) is a common source of mechanical sparks within a dust collection system. Sparks provide an ignition source – a key element in the production of fires and explosions.

Hot embers represent a thermal ignition source. If other types of foreign contamination (e.g., organic vapours) mix with combustible dust, the temperature required to ignite the mixture is lowered.

Applicable legislation, standards, and more information

Applicable legislation and standards

OHS Regulation, Prevention Policies, and OHS Guidelines

- OHS Regulation sections 4.42(1), 5.61, 5.71, 5.81
- Prevention policies D3-115-3, D3-116-2, and D3-117-3
- OHS Guideline G5.81

BC Fire Code

- Section 2.8, Emergency Planning, including Fire Safety Plans
- Section 5.3, Dust-Producing Processes
- Article 5.1.2.1, Hazardous Locations

BC Electrical Code

- Hazardous Locations, Section 18, Canadian Electrical Code Part 1

BC Natural Gas and Propane Code

- Hazardous Locations, Section 4.9, Natural Gas and Propane Installation Code
- Hazardous Locations, Section 4.7, Propane Storage and Handling Code

NFPA

- NFPA (primary standards)
- NFPA 664 (5 percent rule: 3 mm or [1/8 in.] of combustible wood dust)

ACGIH

ACGIH Industrial Ventilation Manual

For more information

WorkSafeBC

Fire Inspection and Prevention Initiative

Council of Forest Industries

Resources and references

Combustible wood dust (WorkSafeBC)

OHS Guidelines (WorkSafeBC)

- G4.42(1), Cleaning with compressed air – Hazards of combustible dusts
- G5.71(3), Location and construction of dust collectors
- G5.81, Combustible dust

NFPA 664, Standard for the Prevention of Fires and Explosions in Wood Processing and Woodworking Facilities (U.S. National Fire Protection Association)

Wood dust mitigation and control audit (Manufacturers' Advisory Group)

Wood dust mitigation and control audit: Auditor worksheet, questionnaire and guideline (MAG)

Fire Inspection and Prevention Initiative (FIPI)

Combustible dust (BC Safety Authority)

Combustible dust: An insidious hazard (U.S. Chemical Safety Board video)

Combustible dust in industry: Preventing and mitigating the effects of fire and explosions (OSHA)

Visit our website at worksafebc.com.

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