GOBIERNO DE ESPAÑA
MINISTERIO DE TRABAJO Y ECONOMÍA SOCIAL
insst Instituto Nacional de Seguridad y Salud en el Trabajo

Hardwood dust

CARCINOGENS AT WORK:
Know to prevent

Information about the substance and where it can be found

Wood dust is formed by the particles released from this raw material when certain mechanical operations such as sawing, sanding, grinding, etc., are performed on it. Although it is a natural source material, it is not harmless since it can cause damage to health when it comes into contact with the respiratory tract, skin or eyes. On the other hand, it can also create other risks, such as fires and explosions.

The composition of wood dust is highly variable and will depend on the species of tree from which the wood originates. In general, it consists of cellulose (approximately 40-50%), polyoses, lignin and a large number of low relative molecular mass substances that vary greatly between species (IARC, 2012).

Wood can be classified into two basic types, depending on the species of tree from which they originate. On the one hand, there are the so-called softwoods, which come from gymnosperm species such as pine, fir and other conifers; on the other hand, there are hardwoods, which come from angiosperm species such as oak, beech, some tropical woods and the vast majority of deciduous species. This classification is purely botanical and does not refer to the actual hardness of the wood.

Besides the natural components of the wood, wood dust may also contain chemicals from wood treatment products such as preservatives, dyes or fixatives, sometimes containing metals such as chromium. It may also contain biological agents such as different types of fungi and their metabolic products.

Wood dust is also considered to be wood dust generated after mechanical operations on composite wood materials, such as particle board or plywood. In this case, besides wood, the dust generated will contain particles of the resins, usually formaldehyde-based, from which the boards are made.

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Table 1
Hardwood examples

Genus – species	Common name
Acer	Maple
Alnus	Alder
Betula	Birch
Carpinus	Hornbeam
Carya	Hickory
Castanea	Chestnut
Fagus	Beech
Fraxinus	Ash
Juglans	Walnut
Platanus	Sycamore
Populus	Cottonwood, aspen poplar
Prunus	Cherry
Quercus	Oak
Salix	Willow
Tilia	Linden, basswood
Ulmus	Elm

Health effects

Exposure to hardwood dust can cause nasal cavity and paranasal sinus cancer. These cancers are often referred to in the literature as “sinonasal or nasonasal cancer”.

Nasosinus cancers are rare, accounting for 0.2% to 0.8% of all malignant tumours in humans. However, more than 90% of adenocarcinomas of the ethmoid sinuses, a type of sinonasal cancer, are attributable to wood dust exposure (Ministerio de Sanidad, 2019).

The International Agency for Research on Cancer (IARC) classified wood dust as group 1: carcinogenic to humans, since there is strong association between sinonasal cancer to wood dust exposure in epidemiological studies. Some studies associate adenocarcinomas with hardwood exposure and squamous cell cancer (two histological types of sinonasal cancer) with softwoods; however, IARC believes it is not appropriate to differentiate between wood types (IARC, 2012).

The IARC (iarc.who.int) is an autonomous agency of the World Health Organization of the United Nations. It seeks to promote international collaboration in cancer research. It runs studies that are widely recognised for their quality and independence.

The latency period for this type of cancer is very long, the average is around 40 years, and most diagnosed cases are in people in their 60s. However, one year’s exposure to wood dust is believed to suffice to create a possibility of developing these tumours in the future (Ministerio de Sanidad, 2019).

Workers exposed to wood dust are estimated to be 500 times more at risk than the unexposed male population and almost 900 times more at risk than the general population (Ministry of Health, 2019).

Although people who work with wood may have co-exposure to other chemicals, such as wood preservatives, dyes, glues, varnishes, etc., the carcinogenic potential is attributed to wood dust itself. On the other hand, it has been observed that co-exposure to formaldehyde, which is a component of the resins from which most boards are made, increases the risk of nasopharyngeal cancer (IARC, 2012).

Table 2
Examples of softwoods

Genus - species	Common name
Abies	Fir
Chamaecyparis	False cypress
Cupressus	Cypress
Larix	Larch
Picea	Spruce
Pinus	Pine
Pseudotsuga menziesii	Douglas fir
Seqquoia sempervirens	Redwood
Thuja	Thuja
Tsuga	Hemlock

Table 3
Examples of tropical hardwoods

Genus – species	Common name
Dalbergia	Rosewood
Diospyros	Ebony
Khaya	African mahogany
Tectona grandis	Teak

Besides sinonasal cancer, wood dust can cause other respiratory pathologies such as nasal obstruction, epistaxis (nosebleeds) and rhinitis, asthma, pulmonary fibrosis and colds being more prolonged. Exposure to wood dust has been observed to lead to altered nasal mucociliary clearance function, which may lead to sensitisation and irritative damage to these tissues since they remain in contact with toxic agents for longer (Andersen, Andersen and Solgaard, 1977; Lofstedt et al., 2017). Skin conditions, such as eczema or dermatitis, and eye conditions, such as conjunctivitis, have also been reported (INRS, 2014).

When the wood dust has a very small particle size (diameter less than or equal to 10 μm or respirable fraction) it can affect the lower respiratory tract, and it is possible to develop asthma, alveolitis and the other aforementioned lung pathologies. This fine dust is mainly generated during sanding work. On the other hand, larger particles will be retained in the upper airways and can cause rhinitis, nasal obstruction, sinonasal cancer, etc.

Table 4
Other risk factors for nasal cavity cancer and sinuses classified in group 1 IARC
Source: IARC, 2012

Agent/ Occupational situation	Monographic year IARC
Manufacturing and repair of footwear	1987, 2012b
Formaldehyde	1995, 2012d
Hexavalent chromium	1990, 2012b
Mineral oils	1987, 2012d
Mustard gas	1987, 2012d
Some nickel compounds	1990, 2012b

Where the exposure can take place

Hardwood dust, along with solar radiation, respirable crystalline silica and diesel engine emissions, is among the most common carcinogens to which people are exposed at workplaces in Spain.

The Woodex project (Occupational exposure to inhalable wood dust in the member States of the European Union) (Baran and Teul, 2007) concluded that, in the European Union, between 2000 and 2003, some 3.6 million workers (2.0% of the employed population of the EU-25) were occupationally exposed to inhalable wood dust. Of these, construction employed 1.2 million exposed workers (33%), mainly construction carpenters. The rest of the Woodex project estimates are set out in table 5.

The same study also measured and estimated the level of exposure of workers in the EU and concluded that the highest levels of exposure are in the construction and furniture industries. Moreover, it was estimated that about 560,000 workers (16% of those exposed) could be exposed to a level above 5 mg/m^3 and about 1.5 million workers (41%) to concentrations above 2 mg/m^3. The figures for exposed workers and estimated exposure levels for Spain are set out in table 6.

Table 5 Estimate of the number of workers exposed to wood dust in the European Union (EU25) according to the Woodex project			
Productive sector	Estimate of the number of exposed workers	Percentage of the total working population	Number exposed to >5 mg/m^3
Construction	1.200.000	33	254.000
Furniture manufacture	713.000	20	86.500
Carpentry	330.000	9	42.000
Sawmills	196.000	5	20.000
Forestry	148.000	4	<100
Manufacture of other wood products	97.000	2,7	15.500
Manufacture of wood-based panels	92.000	2,6	8.400
Manufacture of wooden containers	57.000	1,6	8.600
Ship and boat building	31.000	0,9	9.600
Other jobs	709.000	19,9	118.000
Total	3,6 million	--	563.000

The highest exposure levels are generally found in the wood furniture manufacturing industry during machine sanding or similar tasks. High levels of exposure also occur in the finishing sections of panel and plywood mills.

Besides the aforementioned industries or sectors, there are others where exposure may occur, including installation and finishing of wood flooring, pattern and model making, pulp and pellet manufacturing and biomass for combustion (pellets).

Exposure to wood dust can occur in any of the operations or processes in the life cycle of wood products, from felling to installation and final finishing. The greatest quantity of dust will be produced in operations on dry wood, such as cutting, sanding, turning, grinding, etc. In wet or damp operations, such as debarking or mechanical debarking, little exposure should be expected. On the other hand, if dust that has settled on stored products, on the floor or on surfaces is not cleaned, it can be re-suspended by air currents or other activities.

Secondary tasks in the activity, such as cleaning the facilities or bagging the dust collected by the localised extraction system, can release large quantities of wood dust into suspension if they are not performed correctly and according to an established procedure to prevent inhalation of dust and contact with skin and eyes.

Table 6 Results of workers exposed and estimated exposure levels in the Woodex project for Spain		
Active workers	16.258.000	
Workers exposed to wood dust	433.000	
Percentage of exposed workers in active employment	2,7	
Exposure level	Exposed workers	Percentage of those exposed
< 0,5 mg/m^3	79.000	18,2
0,5 – 1 mg/m^3	73.000	16,9
1 – 2 mg/m^3	97.000	22,1
2 – 5 mg/m^3	114.000	26,4
> 5 mg/m^3	70.000	16,3

Exposure assessment

Work involving exposure to hardwood dusts is included in Annex I to Royal Decree 665/1997 on the protection of workers from the risks related to exposure to carcinogens or mutagens at work and is therefore within its scope. Thus, the exposure assessment and control measures to be applied must take into account the requirements of this regulation, which also includes a binding occupational exposure limit value (8-hour OEL) of 2 mg/m³ (3 mg/m³ until 17 January 2023) for the inhalable fraction, indicating that, if hardwood dust is mixed with dust from other woods, this limit value must be applied to the total wood dust present in the mixture.

For carcinogens or mutagens for which an occupational exposure limit value has been established, the assessment of inhalation exposure is based on measuring the concentration of the chemical agent in the breathing area of the worker, weighting the result according to the reference period, usually 8 hours, and comparing it with the established reference criterion, in this case the occupational exposure limit value (8 hour-OEL).

Along with the design of the sampling strategy, the first step in taking personal wood dust samples for subsequent laboratory analysis is the choice of a method suitable for the object of measurement, bearing in mind the specific conditions of the working environment.

INSST has validated the method MTA/MA-014/A11: *Determination of particulate matter (inhalable, thoracic and respirable fractions) in air - Gravimetric method*, for the gravimetric determination of airborne particulate matter (aerosol) in the workplace. This method is applicable to all types of particulate matter, including wood dust, for the analysis of which a gravimetric determination is required.

In the case of wood dust, the inhalable fraction, that is, the fraction of the mass of the aerosol particles that is inhaled through the nose and mouth, must be sampled. By agreement, as defined in the UNE-EN 481:1995 standard *"Workplace atmospheres - Size fraction definitions for measurement of airborne particles"*, it is considered that about 50% of particles with a diameter of 100 µm are able to reach the upper airways. Larger particles will be deposited in this first part of the respiratory tract and smaller particles will be able to penetrate beyond the larynx (thoracic fraction) or into the lung alveoli (respirable fraction).

The greatest quantity of dust will be produced in operations on dry wood, such as cutting, sanding, turning, grinding, etc.

Regulatory references

Work involving exposure to hardwood dusts was added to Annex I of Royal Decree 665/1997 by Royal Decree 349/2003 amending the previous one and transposing Directive 1999/38/EC. In this regulatory amendment, a occupational exposure limit (8 hour-OEL) of 5 mg/m³ was also added for the inhalable fraction, which has been in force until the amendment made by Royal Decree 1154/2020, which has established a new binding 8 hour-OEL of 2 mg/m³. This Royal Decree established a transitional period, until 17 January 2023, during which the 8 hour-OEL is 3 mg/m³.

Various samplers are available on the market that allow sampling of the inhalable fraction of aerosols. It is important to select the most suitable for the object of measurement and to take into account its behaviour in relation to each of the factors that may condition the sampling (see table 7). More information on this aspect can be found in criterion CR-03/2006: *Aerosol sampling. Samplers of the inhalable fraction of particulate matter* (INSHT, 2006).

Table 7
Main factors affecting the sampling efficiency of samplers. Source: Criterion CR-03/2006 (INSHT, 2006)

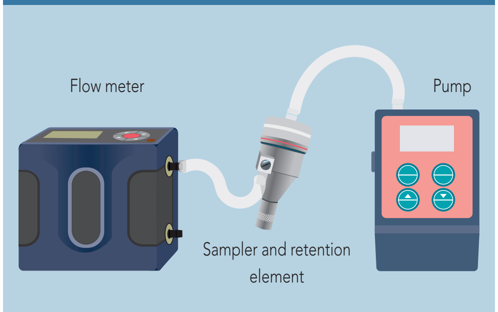
Factor	Nature of the effect
Size of the particles	Particle size selection.
Wind speed	The wind speed at the inlet orifice influences the suction, especially for high values and large particles.
Wind direction	The orientation of the wind at the inlet orifice influences the suction.
Composition of the aerosol	Rebound and re-entrainment of particles; breaking of agglomerates.
Sampled aerosol mass	Aerosol collection efficiency varies on heavily clogged surfaces.
Aerosol loading	Attraction or repulsion of surfaces.
Samplers variability	A small dimensional difference produces a large aerodynamic effect.
Variations in flow rate	The particle separation mechanism is strongly dependent on the flow rate.
Surface treatments	Collection efficiency may be affected by surface treatments of the samplers.

Controlling exposure

Exposure control or prevention measures are to be implemented in order of priority according to their effectiveness. The first option should always be substitution; when this is not possible, the possibility of working in a closed system should be considered; when this is not possible either, all measures should be taken to reduce exposure to a level as low as technically possible; and finally, when the above measures are not sufficient, personal protective equipment (PPE) should be used.

Representativeness of the samples

Whenever a quantitative assessment of inhalation exposure to a hazardous chemical agent is performed, a sampling strategy must be adopted to ensure the representativeness of the data obtained. The standard UNE-EN 689:2019+AC:2019, *Workplace exposure. Measurement of exposure by inhalation of chemical agents. Strategy for testing compliance with the occupational exposure limit values*, provides a possible strategy for comparing daily exposure with the occupational exposure limit values.



1. Substitution

The priority measure, and mandatory whenever it is possible, when working with carcinogens or mutagens, is always substitution with another agent or process not dangerous or is less dangerous. This measure is the most difficult to implement, especially when a production process is already in place, and many variables must be taken into account, but it must be planned and implemented whenever feasible, even if it is more costly, and it is necessary to keep up to date with technological advances in each sector.

Substitution may be based on changing an agent to a less hazardous agent or eliminating or changing procedures. In any case, the new risks that may be introduced with the substitution must always be assessed.

In the woodworking industry, paperworking industry and all industries in which wood is the raw material, substitution of this carcinogen is not an option, as wood cannot be used without machining for processing and assembly.

In the construction field, other materials could be used for structures, windows, etc.; however, this choice will not always depend on the companies, but rather be subject to the choice of the final recipient of the product. In any case, it is necessary to take into account the risk from using other materials which, as in the case of materials containing crystalline silica, could pose a risk similar to or greater than that associated with exposure to wood dust.

2. Closed system

It consists of preventing the dispersion of the agent into the air breathed by the worker by placing the process in which it is generated within a closed system with air evacuation, and a system of the treatment and evacuation to a safe environment to prevent the agents from harming the environment or public health.

Wood processing machines can be used in closed conditions if the process is fully or partly automated. Closure is possible, for example, on machines for the production of strips for parquet floors or other types of floor coverings. Machines that are manufactured with closure and dust extraction systems incorporated are very efficient and allow good dust control. Closed systems can also be installed on existing machines, although they tend to be less effective.

The automation of certain parts of the processes allows, besides efficient control of wood dust, the reduction of manual interventions with a consequent improvement in terms of accidents and musculoskeletal disorders.

Prioritisation of preventive measures for carcinogens:

1. Substitution
2. Closed system
3. Reduction of exposure to as low a level as is technically possible
4. Personal protective equipment

Resources for substitution:

More practical experiences of risk substitution or elimination can be found in the following links:

- Solutions, examples of substitution and good practice for carcinogens, from the Roadmap on carcinogens initiative.

- https://roadmaponcarcinogens.eu/solutions/good-practices/

- SUBSPORT Substitution Support Portal.

https://www.subsportplus.eu/

- OECD Substitution Toolkit Portal.

http://www.oecdsaatoolbox.org/

- INRS Substitution Fact Sheets.

http://www.inrs.fr/actualites/nouvelles-far-fas.html

3. Reduction of exposure to as low a level as is technically possible

The aim is to implement technical and organizational measures such that exposure is reduced as much as technically feasible. This obligation implies that it is not sufficient to achieve exposure levels below the established occupational exposure limit, but rather that it is necessary to go beyond it by applying all available measures.

Royal Decree 665/1997 lays down the obligation to adopt all necessary measures as set out in article 5.5. In general, these requirements are in line with the requirements of Royal Decree 374/2001 on the protection of the health and safety of workers from the risks related to chemical agents at work, adding the express mention of installing detection and warning devices in the event of situations that could generate abnormally high exposures, such as a failure in a local exhaust ventilation systems.

Local exhaust ventilation systems

The most widely applied measure to reduce exposure to wood dust is the use of local exhaust ventilation systems on machines that perform cutting, drilling, sanding and other operations that generate dust and put it into suspension. Local exhaust ventilation system can be incorporated into both stationary and portable machines and can be part of a general system, be connected to a single extraction system, or be individual to each machine. For certain portable machines or machines with difficult access to the general system, alternative systems such as filters or dust collection may be used; however, these systems are often less effective.

This type of dust tends to stick to the surface of the wood, so local exhaust ventilation systems may require an associated device such as brushes or air blast systems to blow the dust into the dust collectors of the extraction system. As in any other extraction system, the collection and entrainment elements, if any, must be located as close as possible to the point where the dust originates and is put into suspension.

In case of manual operations, for example, sanding, work tables with extraction systems on the table fronts can be used.

When designing wood dust collection systems, it must be taken into account that wood dust is a combustible dust and when it is confined in a closed system, such as in extraction ducts, there is a risk of explosion if the dust cloud is near a source of ignition. This risk must be assessed and measures must be put in place to reduce ignition sources and the formation of potentially explosive atmospheres. Thus, a simple measure to apply would be to keep the local exhaust ventilation system active for some time after the dust-generating operation is over, to prevent the dust from settling in the ducts and being resuspended when the system is operated again.

STP

For more information about the general requirements to be met by the local exhaust ventilation system in a fixed installation, please consult the BASEQUIM no. 017: Surface grinding of wooden parts by sanding in carpentry and joinery - exposure to wood dust, from the INSST portal on Hazardous Workplace Situations, in collaboration with the Autonomous Communities (INSST, 2014).

Sensors associated with warning devices are available to detect malfunctions in the wood dust local exhaust ventilation system. Besides having warning systems, they also make it possible to see whether the system is functioning correctly during the work. These devices are very useful since these types of ducts in the woodworking industry can easily become clogged, due to the accumulation of shavings or sawdust, and this debris must be removed before continuing work, to avoid exposure to high concentrations of the agent.

Local exhaust ventilation systems should be checked regularly, using systems such as dust visualisation lights and other available techniques (HSE). They must also have a preventative maintenance programme to ensure their proper functioning throughout the life of the system.

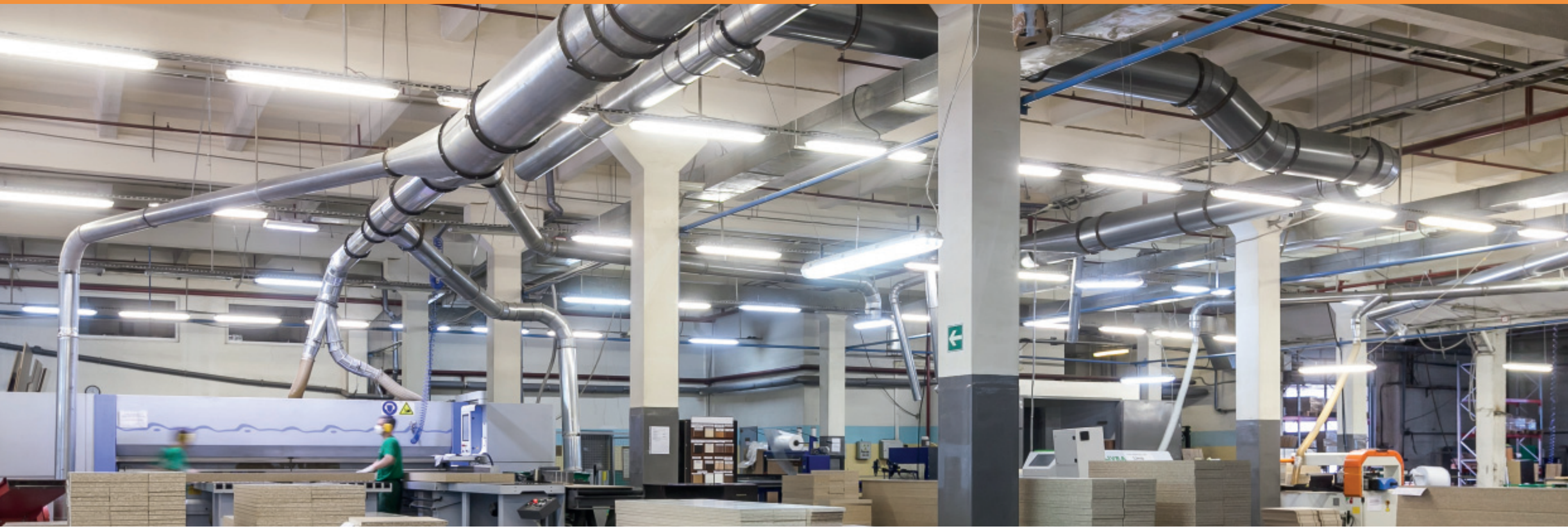
Separation of dirty areas

The operations that generate the most dust with the smallest particle size are sanding operations. Separation of the areas where these operations are performed, as long as it is not in enclosed automatic machines, can be useful in reducing the quantity of dust in the facilities, as it is easier to implement stricter control measures in smaller areas. Separation can be achieved using building elements or physical or air curtains, among other means.

Cleaning of the facilities

The cleaning of the workplaces is essential to prevent exposure to airborne dust and also to prevent fires in the facilities. Cleaning schedules must be put in place that are commensurate with the quantity of dust that is deposited, including daily cleaning of the most accessible places and periodic cleaning of less accessible items where dust may also accumulate.

It is very important to eliminate air blowers and sweeping. Cleaning operations must be performed with sweepers and vacuum cleaners equipped with high efficiency (HEPA) filters. Air blowing and conventional sweeping are bad practices that significantly increase workers' exposure to wood dust and work must be done to eliminate them. Thus, information, training and awareness raising of workers and managers is essential.



4. Personal protective equipment

Respiratory protective equipment should not be used as the sole preventive measure. They must be the last preventive option and as many of the above technical measures as possible must have been applied first.

The results of the risk assessment will be the basis for determining the need for personal protective equipment (PPE) and for selecting the most appropriate equipment.

PPE that may be necessary to protect against the hygiene risks associated with exposure to wood dust includes:

- Eye and skin protection: protective goggles, protective gloves against chemical and biological agents, for example, nitrile gloves.
- Respiratory protection: masks or half masks fitted with P3 filters.

Moreover, when selecting equipment, the anatomy of the workers who will be using it should be taken into account and, in the case of respiratory protective equipment, it is highly recommended that a fit test be performed on each person. For this selection, workers should be consulted. Besides being a legal requirement, their participation in the choice has a positive influence on the use and preservation of the equipment.

Health surveillance

The health surveillance of exposed workers is performed according to the Protocol for the specific health surveillance of adenocarcinoma of the nasal cavities and paranasal sinuses in workers exposed to wood dust, set out by the Ministry of Health (Ministerio de Sanidad, 2019).

Cancer related to exposure to carcinogens is generally characterised by long latency periods. Thus, Royal Decree 665/1997 lays down a right for workers who have been exposed to these agents to the extension of health surveillance beyond the end of the exposure or of the employment relationship. In the case of adenocarcinoma of the nasal cavity and paranasal sinuses, the latency period is particularly long.

The various pathologies associated with exposure to wood dust are listed in various points of Royal Decree 1299/2006, approving the list of occupational diseases. On the one hand, in group 6, there is malignant neoplasm of the nasal cavity associated with the agent hardwood dust and work with hardwood recognised as a carcinogenic agent, such as:

Regulatory references

To select, use and maintenance of the personal protective equipment, the requirements set out in Royal Decree 773/1997 on the minimum health and safety provisions concerning the use by workers of personal protective equipment must be complied with.

Further information can be found in the Technical Guidance for the Use by Workers of Personal Protective, prepared by the INSST to clarify technical aspects of this royal decree.

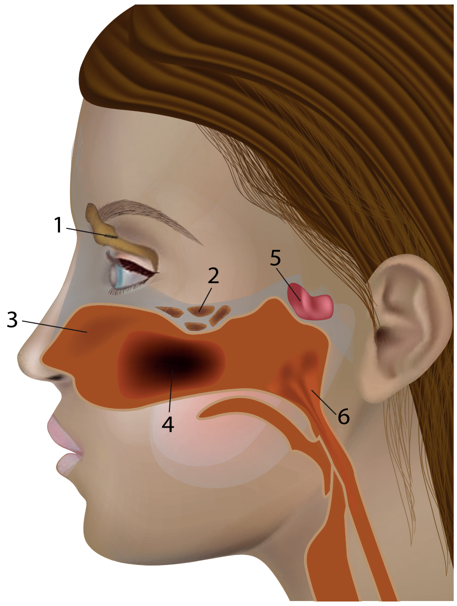
- Furniture manufacture.
- Tree felling works.
- Work in sawmills.
- Wood shredding in the paper industry.
- Wood modellers.
- Wood pressing.
- Machining and assembly of wooden parts.
- Finishing work on wood, plywood and chipboard products.
- Sanding of parquet, flooring, etc.

Group 4 covers occupational diseases caused by inhalation of substances and agents not covered elsewhere. They include those caused by the inhalation of low molecular weight substances, including wood dusts. Occupational diseases related to work in the woodworking industry (sawmilling, wood finishing, carpentry, joinery, manufacture and use of wood conglomerates) include:

- Rhinoconjunctivitis.
- Urticaria and angioedema.
- Asthma
- Extrinsic allergic alveolitis (or hypersensitivity pneumonitis).
- Reactive airways dysfunction syndrome.
- Diffuse interstitial fibrosis.
- Metal fume fever and other fever due to low molecular weight substances.

Finally, wood dust as an agent associated with occupational diseases appears in group 5: Occupational skin diseases caused by substances or agents not covered elsewhere, associated with low molecular weight substances below 1,000 daltons, including wood dusts and the woodworking industry: sawmilling, wood finishing, carpentry, joinery, manufacture and use of wood conglomerates.

For specific health surveillance related to this type of pathologies, other than adenocarcinoma of the nasal cavity and paranasal sinuses, there are other protocols approved by the Ministry of Health, such as those covering occupational dermatoses, occupational asthma and extrinsic allergic alveolitis.



Paranasal sinuses

1. Frontal sinuses
2. Ethmoid sinuses
3. Nasal cavity
4. Maxillary sinuses
5. Sphenoid sinuses
6. Pharynx (throat)

Other preventive measures

At works involving the risk of exposure to hardwood dusts, another series of preventative measures set out in Royal Decree 665/1997 must be complied with, such as the following:

- Personal hygiene measures (article 6).

- Measures to be taken in the event of accidental and non-regular exposures (article 7).
- Obligations with regard to documentation (article 9).
- Information for the competent authorities (article 10).
- Consultation, information and training workers (articles 11 and 12).

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