

Electricity Industry Occupational Health Advisory Group



Guidance Note 4.3

Health Aspects of Burning Biomass in Power Generation

The Occupational Health Advisory Group for the Electricity Industry (OHAG) is an independent body of senior occupational physicians. They all have a professional role to provide advice to individual companies in the electricity industry and they meet together three times a year to discuss matters of common interest and to promote good practice in occupational health across the industry. The main route for doing this is by the preparation of guidance notes on topics of interest to the industry. The remit of OHAG and its guidance covers all aspect of the industry from generation, through transmission and distribution to retail and supply.

Until now the promulgation of this OHAG guidance has largely been by means of paper copies of the documents circulating within individual companies in the electricity industry. OHAG recognises that there is a need to make these papers more widely available and is grateful for the support provided by the Energy Networks Association (ENA) in hosting these documents on their website, and the links to them from the websites of the Association of Energy Producers (AEP) and the Energy Retail Association (ERA).

The guidance notes will be of interest to managers, employees and occupational health professionals within the industry. They give general advice which has to be interpreted in the light of local circumstances. Health professional using the guidance retain an individual responsibility to act in accordance with appropriate professional standards and ethics. This guidance is offered in good faith and neither the individual members of OHAG, the companies they support, the ENA, AEP or the ERA can accept any liability for actions taken as a result of using the guidance.



Health Aspects of Burning Biomass in Power Generation

1 Introduction

The Government's commitment to reduce carbon emissions includes support for the burning of biomass fuels in power generation.

Various types of solid biomass are being considered but essentially they fall into two categories:

- Wood – usually (but not always) softwood which is delivered as pellets, chips, sawdust or in natural form (such as the tips of trees) for milling on site.
- Various plant sources, all of which contain vegetable proteins, e.g., olive residues, nut residues, cereal co-products and grasses, all of which are delivered in ground form.

2 Aims of this Document

The aims of this document:

- To set out the likely health risks from storing, handling and burning solid biomass materials and to make recommendations for exposure monitoring, personal protective equipment and health surveillance. It does not cover, in any detail, engineering control measures which are clearly an important means of reducing dust exposure.
- As the advice is intended for management, only limited clinical details of the potential health problems are described.

3 Relevant Legislation

- The Control of Substances Hazardous to Health Regulations

4 Relevant Guidance

- *"Preventing asthma at work"*. HSE Books: ISBN 0 7176 06619
- Occupational asthma – Prevention, identification and management. Systematic review and recommendations. British Occupational Health Research Foundation (March 2010).

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5 Health Aspects

a Exposure to dust

- **Eye and nose irritation – dust**

In common with all dusts, irritation of the conjunctiva, cornea and nose can occur if the material blows into the eye or is inhaled.

- **Contact irritant dermatitis – dust**

Friction and defatting of the skin can occur but only with repeated or prolonged contact. It is unlikely to be seen at sites on the body other than the hands, forearms and above the socks.

- **Contact allergic dermatitis – wood dust**

Some wood dusts are potential sensitisers of the skin. Although in theory the first single exposure can induce the allergy, contact over several weeks or months is usually required. Once sensitisation has occurred, any contact will result in skin inflammation. This eczema can involve the face as well as the hands and forearms if the dust is airborne.

- **Allergic rhinitis and conjunctivitis – any biomass dust**

Amongst the various types of biomass, wood dust and the storage mite found in grain dust are known causes of allergic rhinitis and conjunctivitis. However, as with occupational asthma, it would be prudent to view all materials containing vegetable proteins as potential sensitisers of the nose and eyes. Although allergic rhinitis is not a serious condition *per se*, it is associated with an increased risk of occupational asthma.

Hence, any staff who develop rhinitis following exposure to biomass dust, should avoid further exposure or be subject to more frequent health surveillance. It is important to note that the onset of rhinitis or conjunctivitis is not a necessary precursor to the development of occupational asthma.

- **Occupational asthma – any biomass dust**

In the context of this paper, occupational asthma is an allergic reaction where the employee's airways become sensitised to an allergen inhaled at work after a period of exposure. Not all of those exposed develop the allergy but, where they do, typically this occurs during the first two years. However, the interval can be longer.



If the substance has been assigned a Workplace Exposure Limit (WEL), this indicates there is some scientific evidence to suggest sensitisation will not occur if exposure is maintained below this level. Once the airways are sensitised, however, an extremely low exposure (far below the WEL) can induce an attack of asthma.

Wood dust and grain dust are in the list of "Top 20 Allergens" reported to the UK's national work related lung disease reporting system – SWORD. However, there are several hundred other recorded causes of occupational asthma. Rape seed oil, castor bean, soya bean and coffee bean dust are amongst these. Although a literature search has not implicated olive residues, palm kernel extract or miscanthus grass, it would be prudent to view all other solid biomass material as a potential cause of occupational asthma.

There is also a potential risk of asthma from inhalation of fungi if there were disturbances of large quantities of mould (see Decomposition Issues).

- **Nut allergy**

There is a theoretical risk that anyone with nut allergy (causing a severe, potentially fatal reaction – anaphylactic shock) could experience an attack if they ingested nut particles. This could follow dust settling on the lips or being transferred from the fingers to the mouth. For this reason, it is recommended that no employee with known nut allergy should work with biomass materials containing nut extract.

- **Wood dust carcinogenicity**

Wood dust is classified as a Group 1 Carcinogen by the International Association for Research on Cancer. Several epidemiological studies in different countries have shown that an unusual type of nasal cancer is clearly associated with exposure to hardwood dust. There are too few studies of any type to evaluate the cancer risks attributable to exposure to softwood alone. Because of its carcinogenic potential, HSE has assigned a "Carc" annotation to the Workplace Exposure Limit (WEL) for hardwood dust. The WEL for softwood relates to its sensitisation potential but also takes into account uncertainty over its carcinogenicity. Softwood has a "Sen" annotation (indicating it can cause sensitisation and therefore allergic reactions).



b Decomposition Issues

Biomass material contains vegetable proteins and is, therefore, prone to decomposition, especially if subject to warmth and dampness. Thus, spores from fungi and endotoxins from gram negative bacterial breakdown can be released.

- **Infection**

Fungi are ubiquitous and the inhalation of spores is a normal daily occurrence. For example, pillows release thousands of fungi into the breathing zone. Fungi are opportunistic pathogens and cause no harm in healthy people who do not have major pre-existing respiratory disease or impaired immune systems through medication or severe disease.

- **Organic Dust Toxic Syndrome (Toxic Febrile Reaction) (ODTS)**

This is a non-allergic transient flu-like illness, sometimes with mild respiratory symptoms which is seen in those handling large quantities of organic dusts. The syndrome has been reported among farmers (following single heavy exposures to mouldy dusts), those in the grain and cotton industries and waste-water and refuse workers. The precise cause of ODTS is often unclear but many cases are thought to be due to inhalation of endotoxin from the breakdown of gram negative bacteria. However, the incidence of ODTS is correlated with high concentrations of airborne fungal spores and actinomycete bacteria and thus airborne spore counts can be used to aid risk assessment.

Recovery from ODTS is rapid (1 to 3 days) and rarely requires treatment other than simple analgesia.

It is likely that exposure to airborne mould in power stations co-firing biomass is insufficient to cause this disease.

- **Extrinsic Allergic Alveolitis (EAA)**

This is an allergic respiratory disease which can occur in a number of occupations including those that can lead to inhalation of certain fungi and actinomycete bacteria from mouldy organic material.

Normally, repeated daily exposures over several weeks are required and it does not affect all who are exposed. In agriculture, exposure is to mouldy hay, grain or straw dust and the disease is then called Farmer's Lung. The annual incidence (new cases) in farming is low but not known precisely. Only 20 new cases per year are reported to SWORD.



Symptoms are of a flu-like illness but with breathlessness and a dry cough. It lasts 3 to 7 days and often requires treatment (unlike ODTS). Diagnosis should be made with the assistance of specialist help. Recurrent attacks should be avoided as chronic disabling lung disease can follow. Recovery is normally complete after a single episode but, in general, no further exposure to the particular dust should be allowed.

- **Occupational Asthma.**

Although biomass material is more likely to cause respiratory sensitisation, inhalation of some fungal spores can also cause allergic occupational asthma. If a case of occupational asthma were to occur in the fuel handling plant within a power station burning solid biomass, and it was known there was substantial overgrowth of mould, it would be important to consider whether the cause could be inhalation of bioaerosol.

c Risk Assessment

- **Biomass Dust**

The aim is to prevent sensitisation of the respiratory tract. To ensure airborne levels are sufficiently low to achieve this, personal exposure monitoring is required. The exposure limit used depends on the material in question:

- those with a Workplace Exposure Limit (WEL) (wood dust, grain dust)
- exposure should be as far below the WEL as is reasonably practicable. It is important to note that WELs in the context of asthma are only very weakly (if at all) related to the capacity of the materials to cause respiratory sensitisation but there is a legal duty imposed by the WEL;
- those substances on HSE's list of common sensitisers (includes castor bean and coffee bean dust) without a WEL;
- exposure should be as low as reasonably practicable but always below the COSHH Standard of 10mg/m³ total inhalable dust and 4mg/m³ respirable dust;
- the absence of a WEL imposed by HSE reflects the paucity of UK data on risk;
- substances with no or very low potential to sensitise (where no or very few cases of occupational asthma have been described worldwide);
- exposure should be below the COSHH Standard for low toxicity dust of 10mg/m³ total inhalable dust and 4mg/m³ respirable dust.

In addition to operators working on plant used for the bulk handling of biomass, it is important to consider the risk to the health of maintenance and cleaning personnel. Exposure in the latter group is generally higher than in operators.



In all cases, the exposure limit in question must be reviewed if health surveillance were to detect occupational asthma or rhinitis.

The risk of eye contamination and repeated skin contact should also be assessed.

- **Mould**

Assessment of the health risks from any mould resulting from decomposition of biomass is more problematic. Factors to be taken into account include:

- the amount of spilt material
- conditions that favour decomposition, i.e., dampness and warmth
- storage and transit time to the boiler
- the presence of visible mould
- amounts of fungi cultured from spilt or compacted biomass
- airborne levels of spores in the breathing zone as measured by personal monitoring.

Currently, there are no Workplace Exposure Limits for bioaerosols (whether fungal spores, bacteria or endotoxins) but information is available from specialist occupational hygiene sources (such as the Health and Safety Laboratory [HSL] in Buxton) on typical airborne levels found in various occupations.

For example, in farming, levels are lowest in farms without recorded cases of febrile reactions or alveolitis and highest in those where toxic febrile reactions (ODTS) have occurred. Specialist Occupational hygiene units (including HSL) can carry out air sampling for bioaerosols.

Generalised fungal infections are extremely unlikely to be a problem because the particular organisms that grow in decomposing vegetable matter do not cause ill health in healthy people. As a precaution, health surveillance (see below) should ensure that those who could be susceptible to infection are excluded from working with biomass.

d Control Measures

Some biomass dust is more prone to fly than coal dust. Hence, dust is emitted during the bulk handling process especially at the delivery stage, where hoppers are filled, at transfer points between coal conveyors and from the final conveyor into the coal bunkers. In general, coal plants were not designed to handle such material and additional engineering control measures will be necessary if monitoring shows that personal exposure exceeds the applicable limits.

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Controlling dust release is also important in order to minimise the accumulation of biomass on floors, equipment and inaccessible areas.

Respiratory protective equipment should only be used:

- as a temporary control measure during short trials of burning biomass when it would not be reasonably practicable to build new plant, or;
- if, despite reasonably practicable engineering measures, exposure is still unacceptably high, or
- as a temporary measure should engineering control measures fail.

6 Recommendations

In view of the uncertainties over the risk of respiratory sensitisation, and difficulties quantifying the risk of ODTS and alveolitis, it is recommended that health surveillance is performed on all who work with biomass including maintenance staff and plant cleaners.

It should always be performed prior to beginning work with biomass and periodically thereafter. The level of health surveillance and its frequency depends on the outcome of risk assessment. For example with regular exposure to a known sensitiser, it would be appropriate to arrange "face to face" encounters with an occupational health nurse after 6 weeks, then after 12 weeks and, thereafter, annually unless there were clinical indications for more frequent assessments. With a lower level of risk (such as occasional exposure to a known sensitiser or regular exposure to a potential sensitiser) 6 monthly or annual "paper based" health surveillance would be adequate. It should be carried out by a qualified Occupational Health Nurse who is in a position to refer individuals to an Occupational Physician.

a The aims of the pre-exposure surveillance are as follows:

- To ensure there are no contraindications to working with biomass. For example:
 - severe existing asthma
 - known respiratory sensitisation to the particular material
 - severe chronic obstructive bronchitis or emphysema
 - immunosuppression through medication or certain diseases



Lung function testing has an important role in the assessment of severity of existing asthma or chronic bronchitis. It is of little value either as a “baseline” measure or in pre and post shift testing because of the normal “within person” variations in lung volumes and the delay after exposure before an attack of asthma occurs.

- To establish baseline respiratory health using a specific questionnaire.
- b** The aims of periodic health surveillance are to detect any changes that might suggest:
- Rhinitis/conjunctivitis
 - New or worsening asthma
 - ODTS
 - Extrinsic Allergic Alveolitis

The OH Nurse should refer the employee to the Occupational Physician if any of these conditions may be present. Where occupational asthma is a possibility, it is likely the physician will request tests to confirm the diagnosis. These usually include 2 hourly lung peak flow monitoring by the employee over a number of weeks. If this confirms work related asthma, it will usually be necessary to refer the employee to a specialist chest physician for specific allergy tests.

7 Summary

The use of solid biomass in power stations leads to exposure of operators and maintenance staff to dusts with the potential to cause respiratory sensitisation and sometimes to spores and bacteria from mould. Thus, respiratory health surveillance conducted by competent Occupational Health Nurses and Occupational Physicians is an important aspect of control of health risks.