An evidence based review of legislation, compliance duties and risk reduction in water damaged buildings in the UK

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Abstract
Mould is recognised as a potential health hazard although many believe there are no legally enforceable exposure levels. The absence of definitive maximum exposure levels has led to a mistaken belief that mould exposure is unregulated. This paper sets out the legal position of exposure, risk, hazard and responsibility. The paper also provides the risk manager and contractor with the information on which to base a competent and supportive risk and hazard assessment for water damaged and mould contaminated buildings. Although I have singled out mould as a water damage indicator there are many more co contaminates which are identified in this paper.

1. Summary

What is the mould hazard?

Mould is the fifth kingdom of life and is generally seen as several hundred thousand different genus and species with many yet to be identified. Moulds are known to be a health hazard and chemically active producing secondary metabolites known as mycotoxins.
All moulds are allergenic and confirmed to be asthmagens while some are recognised as carcinogenic.

The specific mould hazard

The spore case and contents contain potent allergens and chemicals. The chemicals can produce mycotoxins which are used as a defence against other moulds and bacteria. Some moulds can invade the human body and cause fatal disease in susceptible people.

Susceptible people are often considered as the very young, old and those with a reduced immune system from disease or medical treatment such as long term prescription drugs, radio and chemo therapies.

A genetic difference HLA gene (Human leukocyte antigen) in approximately 20% of population is recognised as a potential susceptibility known as atopic.

2. The Health hazard

While active mould growth can produce Volatile Organic Compounds (VOCs) and release spores and possible mycotoxins, dead spores, fragments and mycelia is recognised as perhaps 40 times more hazardous than whole spores. (See Bulletin 77)

Live mould spores range from 10 to 20 micron and the human body has a normal defence against particulates down to 7.5 micron. Below 7.5 micron fragments of spores can bypass the human defence's and pass directly to the lower respiratory system (the alveoli) where blood oxygen transfer occurs. This means chemicals on fragments may be introduced directly into the bloodstream.

3. UK legislation and Standards

3.1. HHSRS Housing Health and Safety Rating System 2006

HHSRS Operating Guidance 2004

Chapter 1 1.01 This regulation (law) is the governments approach to the evaluation of the potential risks to health and safety from any deficiencies identified in dwellings.

Chapter 1 1.03 The Rating System is concerned with the assessment of hazards, that is the potential effect of conditions

Note – *Research on the relationship between housing and health is a continuing process, and it is the responsibility of professionals using the HHSRS to keep up-to-date on current evidence*

Chapter 1 1.06 The HHSRS concentrates on threats to health and safety.

Chapter 1 1.07 The Rating System has been developed to allow assessment of all the main potential housing related hazards. By focusing on potential hazards, it places the emphasis directly on the risk to health or safety**.**

Chapter 1 1.08 As the range of potential housing hazards have differing characteristics, the Rating System uses a formula to generate a numerical score which allows comparison of the full range of hazards.

Chapter 1 1.17 The HHSRS provides a means of assessing dwellings which reflects the risk from any hazard, and allows a judgment to be made as to whether that risk, in the particular circumstances, is acceptable or not.

Chapter1 1.18 The feasibility, cost or extent of any remedial action is irrelevant to the assessment.

Chapter 2 2.11 For the purposes of the HHSRS, the possible Harms that may result from an occurrence are categorized according to their perceived severity into four Classes of Harm. These are harms of sufficient severity that they will either prove fatal or require medical attention and, therefore, be recorded in hospital admissions or GP records. See section 3

Pg. 46 Sec 3 Class of Hazard

Class 1 Lung cancer, regular severe pneumonia, malignant lung tumours

Class 11 Cardio-respiratory disease; Asthma; Non-malignant respiratory disease

Class 111 E**y**e disorders; Rhinitis; Hypertension; Sleep disturbance; Neuro-psychological impairment; Sick building syndrome; Regular and persistent dermatitis, including contact dermatitis; Allergy; Gastro-enteritis; Diarrhoea; Vomiting; Chronic severe stress;

Class IV This Class includes moderate harm outcomes which are still significant enough to warrant medical attention. Examples are:
Pleural plaques;
Occasional severe discomfort;
Benign tumours;
Occasional mild pneumonia;
Broken finger; Slight concussion; Moderate cuts to face or body; Severe bruising to body;
Regular serious coughs or colds.

Page 49 Hazards and Groups

(A) Physiological Requirements including Hygrothermal conditions and pollutants **(non- microbial)**

- *It should be noted non-microbial (mould and bacteria) are specifically excluded from the HHSRS 2006 Page 49 annex D*

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The statistical averages have been calculated for the age range of the population most vulnerable to that particular hazard.

- *The WHO recognise the atopic population of between 20-25% and this disrupts total averages*

Page 53 Damp and Mould Growth

1.01 This category covers threats to health associated with increased prevalence of house dust mites and mould or fungal growths resulting from dampness and/or high humidity's. It includes threats to mental health and social well-being which may be caused by living with the presence of damp, damp staining and/or mould growth

1.02 Most vulnerable age group and statistical averages
The most vulnerable age group is all persons aged 14 years or under.

This of course goes against all medical evidence but HHSRS ignores microbial contamination

Pg. 54 sec 1.05 Physiological health effects
Both the detritus from house dust mites and **mould spores are potent airborne allergens**. Exposure to high concentrations of these allergens over a prolonged period will cause sensitisation of atopic individuals (those with a predetermined genetic tendency to sensitisation), and may sensitise non-atopic individuals. Once a person is sensitised relatively low concentrations of the airborne allergen can trigger allergic symptoms such as rhinitis, conjunctivitis, eczema, cough and wheeze. For a sensitised person, repeated exposure can lead to asthma, and it appears that the severity of the asthma intensifies with increasing humidity, house dust mite and mould levels.

Pg. 54 1.08 Mould growth
Although less significant statistically in health terms, spores of many moulds and fungi (including timber attacking fungi) can be ***allergenic***. The spores can also be **carcinogenic**, **toxic** and cause infections; the potential health effect varying with species. Toxins from some moulds (mycotoxins) can cause nausea and diarrhea, can ***suppress the immune system,*** and have been ***implicated in cancers***. Although uncommon, these are serious if they occur.

Pg 57 1.26 Hazard assessment
The many variables mean that, perhaps more so than for other hazards, the assessment is one of professional judgement rather than measurement.

The term professional judgement is outlined by HSE and should not be confused with a job tittle or qualification to use the HHSRS.

HSE Note on professional Judgement and competence

HSE recognise ACGIH as reference document where UK guidance is unavailable
Section 2.5 Bio aerosols Assessment and Control 1999 Ref Indoor Environmental Hygienist (IEH)

"Investigators (IEH) should act only within their areas of competence as qualified by their education, training, experience or demonstration of competency. Investigators should follow the standards of practice and comply with any restrictions pertaining to the practice of their profession, occupation trade or business"(see IICRC S520 & BSI PAS 64) Membership of a professional organisation. (Chartered Institute of Environmental Hygienists)

3 COSHH Control of Substances Hazardous to Health ISBN 978 0 7176 2785 1 and

Although COSHH assessments are a legal requirement for the employer of a workforce typically engaged in water damage restoration, its implications can be seen to extend to other visitors or occupants

Pg 4 The principal regulations governing substances hazardous to health are the COSHH Regulations.

The central requirements are:

- regulation 6(1) - you should carry out a suitable and sufficient assessment of the risks to the health of your employees and ***any other person who may be affected by your work***, if they are exposed to substances hazardous to health;

- regulation 7(1) - you should ensure that exposure is prevented or, when this is not reasonably practicable, adequately controlled.

- The legal requirement for monitoring ***inhalation exposure*** is given in regulation 10 of the COSHH Regulations. It requires you to carry out monitoring if:

- it is not immediately obvious to you whether there is a risk to the health of your employees; and

- there is a suitable procedure which you can use to measure exposure.

- Regulation 10 is clarified in detail in the COSHH Approved Code of Practice. This states that monitoring is required when:

- failure or deterioration of the control measures could result in a serious health effect;

COSHH amended http://www.hse.gov.uk/pubns/priced/hsg97.pdf

Pg.3 Introduction

Part 1 Gathering information about the substances, the work and the working practices 8

- Decide who will carry out the assessment 8 (see 3.2.5.1 Note 1)
- Identify the substances present or ***likely*** to be 9
- Identify how the substances are hazardous 11
- What effects could they have? 12
- Find out who could be exposed and how 13
- Find out who is doing what and what does and could really happen 15

Part 2 Evaluating the risks to health 18

- What is the chance of the exposure occurring? 18
- How often is exposure liable to occur? 19
- What levels are people exposed to and for how long? 20
- Draw conclusions about the risks to health 22
- When might exposure constitute a risk to health? 23

Part 3 Deciding the necessary measures to comply with regulations 7-13 of COSHH 25

- Selection of measures to prevent or control exposure 25
- Maintaining control measures 27
- Making sure control measures are used 28
- Plan for emergencies 30
- Monitoring exposure 32
- Health surveillance 34
- Information, instruction and training for employees 35

Part 6 Competence

- What are the basic skills for someone doing an assessment?

Note on competence

HSE recognise ACGIH as reference document where UK guidance is unavailable
Section 2.5 Bio aerosols Assessment and Control 1999 Ref Indoor Environmental Hygienist (IEH)
"Investigators (IEH) should act only within their areas of competence as qualified by their education, training, experience or demonstration of competency. Investigators should follow the standards of practice and comply with any restrictions pertaining to the practice of their profession, occupation trade or business"(see IICRC S520 & BSI

PAS 64) Membership of a professional organisation. (Chartered Institute of Environmental Hygienists)

Note 2 *See ISO Standard S520 third edition Mould remediation 2015 Reference guide*

Chapter 10 *The term IEP (IEH) (Indoor Environmental Professional) are used in this document and remediation industry to generically describe individuals having advanced technical competency in a wide range of subjects related to mould in the built environment. The qualifications required are often gained through years of formal study at university level, specific training related to mould and indoor environment and years of on the job work experience.*
The IEH will be able to verify a number of years of experience involving various mould investigation projects(with additional knowledge of other IAQ issues) and experience in sampling, and designing remediation protocols or technical specifications. Other indicators of the qualified IEH include participation industry related professional societies and associations, writing standards and guidelines, publishing magazine or trade journal articles and developing training and certification programs and exams.

Pg.12 Could the substance cause sensitization, allergic reactions ,asthma?
Pg.19 Could they disturb deposits of the substance on surfaces (eg during cleaning) and make them airborne?

Pg.19 Could they come into contact with contaminated surfaces?

Pg. 41 Understanding limitations
Air testing should only be undertaken by people who have trained in the techniques and procedures and planning /monitoring strategy requires fairly high level of professional training.

Pg.42 Reasonable Practicality

Regulation 3 The extension of duties for the benefit of non-employees
Regulation 7 Duty to prevent exposure to hazardous substances
Regulation 7(5) and 7 (6) duties to control exposure to carcinogens and mutagens and control of biological agents.

P42. 130 Reasonably practicable has a specific meaning in law, outlined below. However, deciding what is or is not reasonably practicable depends on individual circumstances and cannot be subjected to standard formulae.

P42 131 Reasonable practicability is essentially a matter of balancing the degree of risk against the time, trouble, cost and physical difficulty of the measures necessary to avoid it. Clearly the greater the risk the more reasonable it is to do something about it; and vice versa. It is important to remember that the judgement is driven by the risk and not the size or financial position of the employer concerned.

Monitoring strategies for toxic substances

www.hse.gov.uk/pubns/books/hsg

173.htm Authors note

While this legislation refers in the main to workplace exposure levels, (8 hour working day) there is an additional responsibility and requirement to protect occupants and visitors to the property COSHH Reg 6 sec 1

Introduction

Pg 4 (5) The Control of Substances Hazardous to Health Regulations 2002 (as amended) (COSHH),1 regulation 2, states that substances and preparations (mixtures of two or more substances) hazardous to health include:

- substances in Part 1 of the *Approved supply list*2 as dangerous for supply within the meaning of the Chemicals (Hazard Information and Packaging for Supply) Regulations 2002 (CHIP)3 and for which an indication of danger specified for the substance is very toxic, toxic, harmful, corrosive or irritant;
    - biological agents;
    - dusts of any kind in substantial concentrations; and
    - any substance that creates a risk to health because of chemical or toxicological properties.

P4. (7) You need to be aware that substances hazardous to health can enter the body by ingestion (ie swallowing the substance) and skin absorption (ie through the skin) as well as by inhalation. This means that in some situations you may also need to measure the total amount of a substance that has entered an employee's body.

P5 Legislative requirements

- **(10**) The principal regulations governing substances hazardous to health are the COSHH Regulations. The central requirements are:

- regulation 6(1) - you should carry out a suitable and sufficient assessment of the risks to the health of your employees and any other person who may be affected by your work, if they are exposed to substances hazardous to health;

- regulation 7(1) - you should ensure that exposure is prevented or, when this is not reasonably practicable, adequately controlled

Pg.5 (**12**) The legal requirement for monitoring inhalation exposure is given in regulation 10 of the COSHH Regulations. It requires you to carry out monitoring if:

- it is not immediately obvious to you whether there is a risk to the health of your employees; and
- there is a suitable procedure which you can use to measure exposure.

Pg 6 Exposure Limits

Pg6 (17) To comply with the requirements in COSHH regulation 7(7)(c) (exposure to asthmagens and carcinogens) to reduce exposure so far as is reasonably practicable, employers may need to carry out a program of air monitoring in accordance with regulation 10.
This will be generally be necessary unless the risk assessment shows the exposure is unlikely to ever exceed the WEL.

Pg6 (18) The majority of substances used in industry have not been given WELs, but this does not mean that they are safe. In these circumstances you need to ensure that exposure is controlled to a level to which nearly all the working population could be exposed day after day, without adverse effects on their health.

Pg6 (19) To judge whether there is a risk to the health of your employees in these circumstances, you may be able to use limits produced by other bodies, such as *Guide to occupational exposure values 200*8 from the American Conference of Governmental Industrial Hygienists. In all cases, principles of good control practice should be applied in the first instance.

Pg. 6 Inhalation exposure monitoring

(21) As an employer, you may wish to develop a monitoring strategy. There are a number of good reasons to do this, including:

- health risk assessment;
- compliance with WELs;
- to help towards the design of exposure control measures;
- checking the effectiveness of your control measures;
- informing your employees of the pattern of exposure and level of risk;
- to indicate the need for health surveillance;
- establishing in-house exposure standards, where necessary;
- for insurance purposes; and
- to contribute to epidemiological studies

Pg. 7 (25) Remember, exposure monitoring is not an alternative to the adequate control of exposure and programs can be time-consuming, labor-intensive and expensive. Therefore, it is important that you establish:

- a clear need for monitoring;
- an understanding of the factors likely to influence the exposure;
- a strategy which is fit for the purpose.

Pg7 Fixed place monitoring

Pg.7 (26) Most WELs refer to personal exposures. You can also use fixed place or static monitoring to obtain information on the likely sources contributing to the exposure. However, fixed place monitoring does not usually reflect the amount that one of your employees could breathe in, which determines the risk to health.

Pg7 (27) You may take fixed place samples:

- to check the effectiveness of your control measures;
- to identify emission sources;
- to determine background workplace contaminant concentrations;
- if there are no suitable personal monitoring methods available,
- when wearing personal monitoring equipment may introduce additional hazards;
- when continuous monitoring alarm systems are installed; and
- in the case of vinyl chloride.

Pg.9 (33) The scope of the exposure assessment will depend on how complicated the process is. However, in many situations it may be possible to determine the likely level of exposure without taking measurements. Figure 2 illustrates a structured approach for evaluating exposure by inhalation.

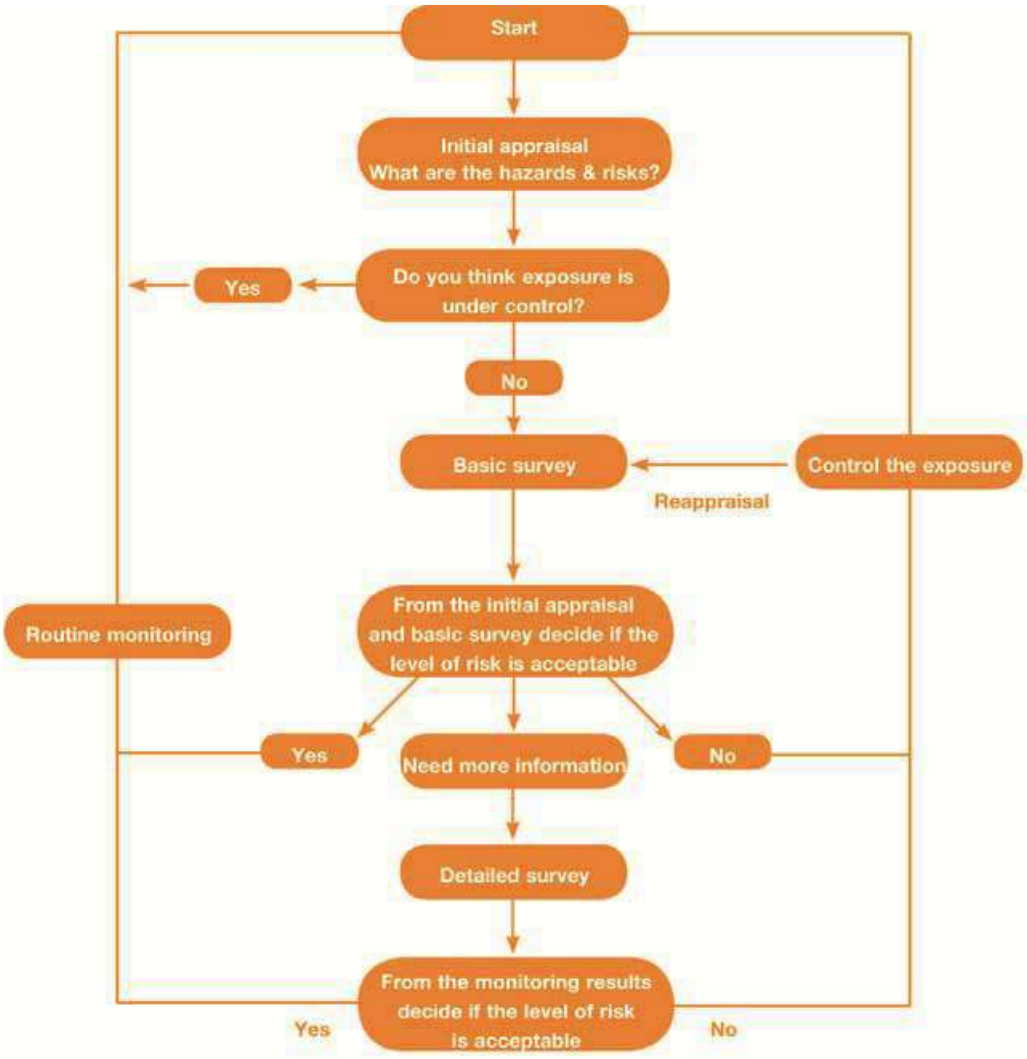

Table 2

Pg.10 (36) You may consider combining aspects of the basic and detailed surveys. This may involve the simultaneous use of smoke tubes, air velocity meters, chemical indicator tubes and personal sampling equipment.

Pg.10 Initial appraisal

Pg10 (38) The initial appraisal is an important part of the strategy described in Figure 2. It helps you establish the need for, and the extent of, exposure monitoring. This will help you to decide on:

- the hazards;
- the potential risks; and
- whether more information is needed (eg do you need to carry out monitoring to obtain an estimate of the exposure of your employees to substances hazardous to health?).

Pg. 11 (39) The first stage of the initial appraisal requires you to find out information on a variety of factors, for example:

- the substance that your employees are exposed to;
- the hazardous and physical properties of the substance;
- the airborne forms of the substance;
- the processes or operations where exposures are likely to occur;
- the number, type and position of the sources from which the substance may be released;
- which groups of employees are most likely to be exposed;
- the pattern and duration of exposure;
- work practices;
- the means by which the release of the substance is controlled;
- whether respiratory protective equipment and/or other personal protective equipment are worn and their effectiveness; and
- what are the WELs, limits or in-house standards for the substance involved

Pg. 11 (43) Remember, the level of exposure of your employees to a substance hazardous to health can change. This means that your initial assessment may no longer be valid. You should always be aware of the need for exposure monitoring.

Pg.12 (48) You can use semi-quantitative methods to estimate personal exposure. These give you a rough numerical estimate of exposure. Some semi-quantitative methods are comparatively inexpensive and easy to use.

Pg. 12 (49) Semi-quantitative methods range from simple techniques, such as chemical indicator tubes (where the absorbent granules in the tube change colour when a known amount of air, containing a chemical, is drawn through) to more complex methods which require specialist knowledge, including:

- computer exposure modelling; and
- organic vapour analysers such as photoionisation detectors, portable gas chromatographs and infra-red analysers.

Pg.12 (50) Alternatively, validated laboratory-based sampling and analytical techniques can be used (see Appendix 2). If you are unsure how to use such techniques, you could consult a health and safety professional such as an occupational hygienist.

Pg.12 (53) Detailed survey

- Can be used when; the extent and pattern of exposure cannot be confidently assessed by a basic survey;
- carcinogenic substances (risk phrase R45 and R49), respiratory sensitisers (risk phrase R42 and R42/43) or mutagens (risk phrase R46) are involved; NOTE R42 May cause sensitisation by inhalation and R43 sensitisation to skin

- the initial appraisal and basic survey suggest that:
- the time-weighted personal exposure may be very close to the WEL, limits from another body or in-house standard; and the cost of additional control measures cannot be justified without evidence of the extent of exposure variability;

HSW act

The HSW Act 1974 amended places direct responsibility onto employers to ensure the safety of employees and others at the work place. The domestic home becomes a workplace when undergoing post WDB restoration. The HSW act therefore requires the employer to ensure the building occupants are kept safe.
Regulation 3 also places responsibility on the employer to ensure the competence and suitability of employees and subcontractors. This may affect directors where contractors fail to manage or identify relevant risks and hazards.

EH40 Workplace exposure limits
http://www.hse.gov.uk/pubns/priced/eh40.pdf

Pg.8 Introduction

- Many people are exposed to a variety of substances at work (eg chemicals, fumes, dusts, fibers) which can, under some circumstances, have a harmful effect on their health. These are called 'hazardous substances'. If exposure to a hazardous substance is not properly controlled it may cause ill health in a number of ways. The substance may cause harm by:
- too much being taken into the body through breathing; being absorbed through the skin;
- being swallowed; or

- acting directly on the body at the point of contact, eg the skin.
- Some illnesses caused by exposure to hazardous substances in the workplace (occupational diseases) may not appear until a long time after the first exposure. Therefore, it is important to know in advance how to protect the health of people working with hazardous substances and also of other people who may be affected by the work being carried out.

Pg.9 Workplace Exposure Levels

- Sec 7 exposure to asthmagens, carcinogens and mutagens are reduced as low as is reasonably practicable.
- The absence of a substance from the list of WELs does not indicate that it is safe.

For these substances, exposure should be controlled to a level to which nearly all the working population could be exposed, day after day at work, without any adverse effects on health.

- (9) As part of the assessment required under regulation 6 of COSHH, employers should determine their own working practices and in-house standards for control of exposure. In some cases, there may be sufficient information available for employers to set an 'in-house' working standard, e.g. from manufacturers and suppliers of the substance, from publications of industry associations, occupational medicine and hygiene journals.(see ACGIH sec 3.3.4 sec 19)

Pg.33 Dust

- Sec 44 The COSHH definition of a substance hazardous to health includes dust of any kind when present at a concentration in air equal to or greater than 10 mg.m-3
- 8-hour TWA of inhalable dust or 4 mg.m-3 8-hour TWA of respirable dust. This means that any dust will be subject to COSHH if people are exposed above these levels. Some dusts have been assigned specific WELs and exposure to these must comply with the appropriate limit.

    - Sec 46 Inhalable dust approximates to the fraction of airborne material that enters the nose and mouth during breathing and is therefore available for deposition in the respiratory tract.
    - Respirable dust approximates to the fraction that penetrates to the gas exchange region of the lung. Fuller definitions and explanatory material are given in MDHS14/3.6

Pg.33-34 Substances which are special cases under COSHH Carcinogenic and mutagenic substances

- Sec 51 a Aflatoxins (mould)

Authors Note. Aflatoxin can be produced by Aspergillus *flavus* and is known to contaminate food. Aspergillus *flavus* can be found to grow in water damaged buildings.

(Ref Bulletin 77 WHO 1999) http://www.who.int/bulletin/archives/77(9)754.pdf?ua=1

- *Apart from Aflatoxins, Trichothecenes mycotoxins are possibly present and these have been found to be 40 times more toxic by inhalation than ingestion*

(Pg. 759)

- *Aflatoxins are acutely toxic, immunosuppressive, mutagenic, teratogenic and carcinogenic compounds. The main target organ for toxicity and carcinogenicity is the liver. Classified as class 1 carcinogen (Pg. 756)*

Pg.35 Sec 55 Occupational asthma (workers engaged in WDB

- Wherever it is reasonably practicable, exposure to substances that can cause occupational asthma should be prevented. Where this is not possible, the primary aim is to apply adequate standards of control to prevent workers from becoming hyper-responsive.

- For substances that can cause occupational asthma, COSHH requires that exposure be reduced as low as is reasonably practicable. Activities giving rise to short-term peak concentrations should receive particular attention when risk management is being considered. Health surveillance is appropriate for all employees exposed or liable to be exposed to a substance which may cause occupational asthma and there should be appropriate consultation with an occupational health professional over the degree of risk and level of surveillance.

Pg. 50-51 Sec 91a Synergistic substances

Considerably less common than the other types of behavior in mixed exposures. However, they are the most serious in their effects and require the most strict control. They are also the most difficult to assess and wherever there is reason to suspect such intervention, specialist advice should be obtained;

(c) **Independent substances:**
Where no synergistic or additive effects are known or considered likely, the constituents can be regarded as acting independently and the measures needed to achieve adequate control assessed for each separately. The controls needed for the mixture will be those for the component requiring the tightest control.

Pg. 50 sec 93 Monitoring Mixed Exposure (asthmagen)

- Information on monitoring airborne contaminants is given in Monitoring strategies for toxic substances.15 The number of components of a mixed exposure for which routine air monitoring is required can be reduced if their relative concentrations can be shown to be constant. **This involves the selection of a key or marker**, which may be one of the constituents, as a measure of the total contamination.

- Exposure to the marker is controlled at a level selected so that exposures to all components will be controlled in accordance with the criteria in paragraph

91 (a) and (b). However, if one of the components has been assigned a 'Carc' or 'Sen' notation or one of the risk phrases R42, R42/43, R45, R46, R49, or is listed in Schedule 1 of the COSHH regulations, or is listed in section C of **Asthmagen**?

- Critical assessments of the evidence for agents implicated in occupational asthma,7 or is a substance for which the risk assessment has shown to be a potential cause of occupational asthma, then the level of the exposure to that substance should always be reduced so far as is reasonably practicable. Monitoring should be under the guidance of suitable specialist advice.

  Ref Asthmagen? Critical assessments of the evidence for agents implicated in occupational asthma HSE 2006 www.hse.gov.uk/asthma/asthmagen.pdf

  Health and Safety Executive state that substance should always be reduced so far as is reasonably practicable. Monitoring should be under the guidance of suitable specialist advice.*15 Monitoring strategies for toxic substances HSG173 (Second edition) HSE Books 2006 ISBN 978 0 7176 6188 6* *www.hse.gov.uk/pubns/books/hsg173.htm*

Pg 51 Complicating Factors

b. the relevance of such factors as alcohol, medication, smoking and additional stresses;
c. exposure of the skin to one or more substances that can be absorbed by this route as well as by inhalation (see Schedule 2A of the COSHH ACOP);4 and
d. substances in mixtures may mutually affect the extent of their absorption, as well as their health effects, at a given level of exposure.

In each of these circumstances specialist advice should be obtained.

Construction Design Management regulations 2015 (CDM)

The CDM regulations are governed by legislation and require careful management of safety issues, risks and hazards in both commercial and domestic property repair contracts. The legislation places specific responsibilities on the client to organize duties.

This paper focuses on fire and water damage claims and in particular the use of insurers nominated contractors and loss adjusters. It should be noted that all works within the scope will be covered.

The Association of British Insurers (ABI) and Chartered Institute of Loss Adjusters (CILA) published a guidance document in May 2016
https://www.cila.co.uk/images/pdfs/CDM_Guidance_-_2016_Final.pdf

This document alerts the restoration industry to changes in CDM (2015) which now affect domestic property claims similarly to commercial claims. (section 1)

Significant responsibilities quoted from the document include: (section 3)

- The loss adjuster should advise the domestic and commercial client of their CDM duties
- The CDM duties automatically transfer to the contractor in the domestic claim
- The CDM responsibility lies with the insurer and the loss adjuster should ensure the contractor is competent and acting as Principle contractor and designer.
- The requirement for a Construction Phase Plan CPP (Section 4) http://www.hse.gov.uk/pubns/cis80.pdf

- Pre construction information "The insurer must satisfy themselves that "*nominated contractors are competent to undertake the work"* (Section 13)
- Health and Safety File should be produced and handed to the client (insurer) (Section 15)
- Obligation to remove or reduce all known hazards and risk (Section 18) & also CoSHH

Health and Safety Executive (HSE)

The HSE provide various guidance notes on how to comply with regulations and reduce or control risks and hazards of mould.

- The following web links are on the HSE web site and the referenced sites provides specific or relevant information on the health hazards of mould.

http://www.hse.gov.uk/construction/healthrisks/hazardous-substances/harmful-microorganisms/aspergillus.htm?lipi=urn%3Ali%3Apage%3Ad_flagship3_pulse_read%3BdHVQAUZ7Rg634DfdX7Y8Lg%3D%3D

- The HSE point to mould issues on the NHS web site https://www.nhs.uk/conditions/aspergillosis/

- HSE link to Aspergillus Centre https://www.aspergillus.org.uk/

- Asthmagen? Critical assessments of the evidence for agents implicated in occupational asthma http://www.hse.gov.uk/asthma/asthmagen.pdf

  Terminology and toxicological mechanisms
  The varying and sometimes overlapping definitions available for key terms, such as hypersensitivity, respiratory sensitisation, allergy and asthma, constitute an important source of possible confusion. Medical, regulatory, industrial and academic scientists may each have their own understanding of the meaning of these terms. The terms "asthma" and "respiratory sensitisation" have been used synonymously and interchangeably by some in the occupational health field, but are distinguished from each other in some minds. This lack of clarity surrounding definitions has been compounded by uncertainties

regarding the toxicological mechanisms underlying the disease processes involved in asthma. Thus, possible meanings for “respiratory sensitisation” in relation to effects in the lung include:

a) asthma induced by a proven immunological mechanism;
(b) asthma induced by an immunological mechanism which may be proven or simply presumed;
(c) asthma induced by a mechanism specific to the substance in question, but which may be immunological or non-immunological; or
(d) asthma induced by any means.

A further possible refinement to these definitions is the differentiation of immunological mechanisms into those mediated by immunoglobulin E (IgE) and those apparently not.

HSE The Approved List of biological agents

Advisory Committee on Dangerous Pathogens
http://www.hse.gov.uk/pubns/misc208.pdf

The Control of Substances Hazardous to Health Regulations 2002 (COSHH),make reference to the ‘approved classification’ of a biological agent, which is defined as the classification of that agent approved by HSE. The Approved List is the list of classifications of biological agents approved by HSE for this purpose. Biological agents are bacteria, viruses, parasites and fungi which can cause harm to human health, usually due to infection (***some are toxic or can cause an allergy)***

Note This section is specifically written by HSE for people who deliberately work with biological agents however several of the hazard groups are found in water damaged buildings**.**

When classifying a biological agent it should be assigned to one of the following groups according to its level of risk of infection to humans.

Group 1	**Unlikely to cause human disease.**
Group 2	Can cause human disease and may be a hazard to employees; it is unlikely to spread to the community and there is usually effective prophylaxis or treatment available.
Group 3	Can cause severe human disease and may be a serious hazard to employees; it may

	spread to the community, but there is usually effective prophylaxis or treatment available.
Group 4	Causes severe human disease and is a serious hazard to employees; it is likely to spread to the community and there is usually no effective prophylaxis or treatment available.

Biological Agent	Human pathogen group
Actinomyces spp	**2**
Escherichia coli (Ecoli) (*Black water flood*)	**2**
Enterococcus (*Black water flood*)	**2**
Streptococcus spp	**2**
Staphylococcus aureus	**2**
Aspergillus fumigatus	**2**
Aspergillus spp	**2**
Cryptococcus spp	**2**
Fusarium spp	**2**
Histoplasma	**3**

If a new biological agent does not have a hazard group classification, you should not assume it is Group 1 (unlikely to cause human disease). COSHH requires that a provisional hazard grouping must be determined by the person intending to work with the biological agent, by considering any available evidence and applying the most appropriate hazard group definition (see Information Box on page 7), taking into account the relevant factors used in carrying out the risk assessment. If you are in doubt as to which of two alternative groups is most appropriate, you should use the higher of the two.

4. BS 12999 Damage Management 2015

This document is a British Standard and contains key indicators to ensure that competent and safe restoration is achieved. The following key words and issues are referenced multiple times as follows:

- 15 references to mould
- 12 references health vulnerabilities of occupants
- 28 references to contamination other than mould or biological
- 8 references to Indoor Air Quality
- 5 references to Environmental conditions

2.1.8 **environmental stabilization** to bring **environmental** conditions under control so that secondary damage is avoided or reduced, and that **environmental** conditions are suitable to return normal use to the property

2.1.15 secondary damage
damage resulting from the residual effects of the original incident or peril but not directly caused by the incident itself at the time of occurrence
EXAMPLE Damage, such as ***mould growth*** and timber distortion, caused by continued elevated humidity, or corrosion or staining caused by extended exposure to highly acidic fire residues

3.1 Initial information
b) evidence of any special circumstances/**vulnerabilities** that might necessitate prioritised response (*risk and hazard* ***assessments for IAQ*****)**

3.4 Information for desk-top triage and response
decision b) the current perceived levels of damage/**contamination**/disruption

i) the current environmental conditions within the affected property; NOTE 2 In order to determine the control measures required to mitigate the damage and prevent the onset of **secondary damage** (Mould Ref v2.1.15)

viii) the nature of the contents affected, and the observable damage or **contamination**

xviii) any **health** and safety issues that might need to be taken into account;

4 On-site damage assessment
4.1 Purpose of the on-site damage assessment and preparedness to commence work
The purpose of the initial site visit is to verify that the information already

received is accurate and up-to-date, to carry out a visual and technical inspection of the damage, and to determine which measures need to be applied immediately to mitigate the damage and prevent the onset of **secondary damage (Mould Ref v2.1.15)**

4.2 Initial site visit introductions and risk assessments
The site visit should provide a first opportunity to validate the client's understanding of the situation and **their needs.** This applies to personal priorities and **vulnerabilities,**

4.3 Damage assessment and triage
"***detailed technical*** assessment of the extent, severity and **consequence**s of the damage should be carried out and communicated to the **incident owner",**

"Using all the information gained, the DMP should identify inspection methodology and equipment for investigating the extent, **severity, and impact** of the damage or **contamination** to the property and contents"

The specific types of activities described in Annex C should be applied to all aspects of the damaged and **contaminated** areas to determine what has been affected, how it has been affected, and if the affected material can be economically restored and returned to a pre-incident condition.

"The DMP should inspect all affected construction elements, surfaces, material, and contents and equipment, etc. where instructed and document their damage and **contamination condition**".

"During this inspection and on completion the DMP should update their **hazard** and risk assessments to satisfy themselves that they **understand the risks** that they and the **incident owner might face"**

5 Stabilization

5.1 Objective
The objective of this phase is to ensure that **environmental** conditions within the damaged property are brought under control to prevent further deterioration and the onset of **secondary damage**

5.3 Health and safety and stabilization works
Prior to commencement of stabilization work the DMP should ensure they understand and comply with all **health and safety requirements** pertaining to the work to be undertaken (see Annex D for information about on-site health and safety issues).(***ref COSHH etc)***

"In addition, personal belongings that have been heavily

contaminated during flooding can, in many cases, be returned to those affected in time."

5.5 Stabilizing environmental conditions to prevent secondary damage
On completion of the initial stabilization works the DMP should check the **environmental** conditions to ensure that they have been altered sufficiently to prevent secondary damage and to slow the rate of deterioration (***mould and accepted continuing decay)***
Scheduled checks should be made and operating parameters altered as and when required to ensure that the environmental conditions established remain stable (***monitoring requirements for known or suspected secondary damage***)(**Mould**)

6 Damage scoping
6.1 The action plan should comprise outcomes of works to be carried out against agreed objectives for any longer term stabilization, drying, **decontamination** and restoration of the affected property and contents that might be required

6.2 Scopes of work (SOW)
Dependent upon the nature of the incident, SOW should be prepared, setting out, for example, how the property is to be fully dried**, decontaminated, de-odorized or sanitized**

"If required, they (*contents*) should be removed for off-site restoration/storage, **decontaminated"**

7.4 Quality assurance
During the works, and at their completion, the DMP should carry out quality assurance testing against the previously defined acceptance criteria appropriate to the incident and work type to ensure and demonstrate the work has been carried out correctly**.(**see annex H **Contamination and pollution)**

Annex A Pg. 16 Role of insurance sector stakeholders

A.6 Claims management – other aspects
As well as the damage management specialist, other experts might be involved in the following areas:

b) Forensic investigation;
h) Environmental conditions (internal and external);

NOTE These specialists might also be engaged directly by the property or 'incident' owner, usually after consultation with the insurer**.**

Annex C Inspection methods and equipment (normative

C.1 Water damage

C.1.1 Environmental conditions

The DMP should measure the humidity and temperature conditions within the affected property and the ambient external conditions, where relevant. The DMP should be capable of interpreting these measurements, and evaluating the specific humidity and the effect of this on the stabilization and recovery strategy.

NOTE 1 This is especially important with materials that are especially vulnerable to damage from elevated moisture,(***Mould***) and consideration needs to be given to interstitial voids where moisture might be trapped.

C.1.2 Grey and black water contamination assessment

This assessment should initially be carried out with a visual inspection of the affected areas. Any concerns about **contamination** in interstitial spaces should be further
investigated,
NOTE Assessment of the standard of **decontamination** achieved

Materials that are capable of absorbing contaminated water, such as textiles, should be viewed differently from other, non-absorbent materials, where **decontamination can more easily be achieved**

D.2 Pg 21 Exposure to contamination from grey and black water incidents Typical hazards are potentially infectious micro-organisms and other **contaminated** materials that might have been picked up by the water.

D.5 Air quality

Poor **air quality** following a fire and some water damage incidents is a potential hazard. The potential risk following fires is from exposure to **particulates, aerosols** and off-gassing condensed fire residues. There is a potential **poor air quality risk** following contaminated water incidents and in the **case of aged water damage incidents** (see K.3.2) **the presence of airborne mould particulates might be a risk for some individuals.**

D.6 Pre-existing health issues

Unexpected incidents often cause disruption and associated stress which can potentially have an **effect on health.**
NOTE. **Predisposed** individuals might be more **vulnerable** in these circumstances.

Annex E Pg 22 Description of damage stabilization works

E.1 Water damage – control of relative humidity conditions

The control of the relative humidity conditions following water damage

incidents is particularly critical. Hygroscopic materials, many of which are vulnerable to elevated moisture levels, have a moisture content in equilibrium with the relative humidity of their environment.
NOTE 1 The post water damage incident environment inevitably has elevated humidity conditions, and these should be returned to **an appropriate humidity level for the property** and its environment as **soon as reasonably possible, preferably within a few hours or a day or two, to avoid damage to vulnerable materials**.

If investigation reveals trapped interstitial moisture associated with vulnerable building materials (materials which would rapidly deteriorate in elevated moisture conditions, such as plasterboard where **mould growth very rapidly** occurs) then action should be taken within the stabilization phase to prevent deterioration and environmental impact by suitably targeted remedial actions

"If RH levels remain high some hygroscopic materials, such as paper and plasterboard, quickly increases in moisture content to a point where there is sufficient moisture in the material to support **mould growth**."

G2 Grey and black water contamination

The **decontamination** techniques should achieve a result as close as possible to the pre-incident condition when the item is returned to the owner.

The owner might in some circumstances, depending on their use or significance of the item, and the financial aspects involved, be willing to accept the presence of residual staining or visual evidence of the **contamination**

Pg. 22 K.2.2 Clean water (category 1)
Typically an escape of potable water from the mains supplied water system where the escape occurs within the building. It is possible that a clean water escape could **become contaminated** in certain types of buildings if it travels through **contaminated** areas, in which case it can be identified under appropriate alternative category.

PG 22 K.2.3 Grey water (category 2)
An escape of water from within the property where there is **some degree of contaminatio**n and/or where the water quality will deteriorate and become **increasingly contaminated** with time. Examples would be the wastewater from a washing appliance, or from sinks and baths. Water from these sources often escape unnoticed into building voids where, in the right temperature and other conditions,

bacterial growth can result in reclassification as a black water **contamination.**

K.2.4 Black water (category 3)
Usually external floodwater or storm or **sewage contamination** flooding into the building but an escape of foul-water from the internal sewage system, or backing up of that system, would also be categorized as black water. Fire suppressant water used by the fire service will usually be **contaminated** with the products of combustion so this too will be categorised as black water. The **black water** category includes sewage, storm flooding, river-water, seawater and run-off water from rain storms.
The levels of some **biological contaminants**, especially in black and grey water, can increase **where decontamination** is delayed.

K.3 Other useful categories of water damage incidents K.3.1 Vertical incidents
Additionally, it can pick up **contamination** from within some types of building voids.

K.3.2 Aged incidents
Incidents where there has been a delay in the discovery of the problem, perhaps because of an escape of water that is hidden in the building structure, or where an incident has not been adequately stabilized early enough. With the delay present in aged incidents there is a much greater likelihood of secondary damage ***(mould)*** having occurred. For example, if the delay was very prolonged there could be timber rot and even with shorter delays, **mould growth** on vulnerable materials. Prolonged high humidity in a building alters the equilibrium moisture content of all the hygroscopic materials in that **environment**. This can result in there being sufficient moisture in those materials to support **mould growth**

British Standards PG.33 Bibliography

- PAS 64, Mitigation and recovery of water damaged buildings

Association of British Insurers (ABI)

The Association of British Insurers have been involved with the development and apparently ratified both BS12999 and BS PAS 64 which require detailed evidence regarding scope of works and clearance and legal compliance.

A water damaged property is known to be affected by at least 30 different contaminates, however we focus on mould in this abstract. There is a legal obligation to remove the health hazards of mould. The issue here revolves around key legislation which is CDM and in particular the legal requirement for a phase plan which includes a CoSHH assessment. This legislation states allergens and carcinogens must be reduced to the lowest practical levels regardless of project cost.

As the physical contamination is chemical carried sub-micron fragments from spores and mycelia there is a clear legal duty to remove even what you can't see but which can be measured and of course be assumed to be present unless proved to the contrary.

The ABI and CILA in their joint paper state they are responsible for their contractor actions and indeed even warn contractors of their need for compliance to CDM and phase plan (CoSHH) .

See ABI CILA joint paper https://www.cila.co.uk/images/pdfs/CDM_Guidance_-_2016_Final.pdf
This paper accepts the board of directors and CEO of insurance companies are responsible for the competence and actions of their nominated contractors and loss adjusters.

See also ABI paper on Water damage which identifies the British Standards BS12999 and Pas 64
http://www.bdma.org.uk//wp-content/uploads/2016/12/ABI_BRO3419_MOISTURE_MEASUREMENT_GUIDE_FINAL-lo.pdf

6 British Standards Institute BS PAS 64

(Public Aware Specification) Industry code of best practice.

This document is compiled and published by British Standards Institute and although not a standard it is a recognised code of best practice and is included in the reference bibliography of the British Standard 12999
The PAS 64 and contains key indicators to ensure that competent and safe restoration is achieved. The following key words and issues are referenced multiple times as follows:

- 15 references to mould
- 23 references health vulnerabilities of occupants
- 27 references to contamination other than mould or biological
- 29 references to Indoor Air Quality
- 8 references to Environmental conditions

Pg. iv Introduction
Cleaning protocols and assessment of **indoor air quality** might also be required depending on the profile of the water damage incident.

1 Scope
b) setting drying and cleaning goals (including **air quality goals**);

2.5 cleaning goal
pre-determined target **cleanliness level** based on suspected **contamination**, presence of odour, staining and measurement of actual **levels of pollutants** by an established method

2.6 contaminant
substance that could cause **harm to humans**, animals, wildlife and the **environment** or property
NOTE Examples of **contaminants** include **mould, mildew, fungi, bacteria, viruses**, asbestos, lead, arsenic, oil, sewage and effluent.

2.8 decontamination
removal, neutralization or dilution of surface or **air borne particles** that could be **harmful to** humans, animals, wildlife and the **environment**

2.18 indoor air quality
air quality within and around a building
NOTE This is particularly relevant to the **health** and **comfort of the occupants** of the building. The **indoor air quality** can be affected by **gases, particulates**, **microbial contaminants** or any mass or energy stressor that can induce adverse **health conditions**.

2.27 primary damage
damage sustained as a result of direct contact with water or **contaminants**
NOTE 1 Examples of primary damage include staining, swelling, dissolving, cupping and buckling of hard wood, delamination of furnishings and fixtures, migration of dyes, weakening of adhesives, rusting and corrosion and **microbial contamination**.

2.36 secondary damage
damage to structural materials sustained from indirect or prolonged exposure to **contaminants** migrating or absorbed moisture or humidity and **mildew growth**

2.41 vulnerable individuals (health)
individuals being unusually **severely affected** by a substance either as a result of susceptibility to the effects of these **substances** or as a result of a greater than average exposure following a water damage incident
SOURCE: WHO Europe [9].

3.1 General

g) selecting indoor **air quality cleaning** techniques (see 3.7);
j) verifying **indoor air quality** goals have been met (see 3.10);

NOTE the **pollution** of the **indoor air** as a direct result of the water damage when compared to **typical building in normal use**

3.2 Initial inspection
NOTE 2 The initial inspection is usually performed as soon as possible (within 24 hours) following the discovery of the water damage. Some incidents benefit from a faster response time (**2 to 4 hours**) as this will increase the effects of mitigation measures (e.g. if standing water is present; when the source of water is immediately likely to be **harmful for occupants health;**

xiii) an **assessment of the effect** of the water damage on **indoor air quality**;
xiv) potential **health risks** to **employees**, **visitors** and **occupiers** during and **post** remediation, and any mitigation measures incorporated into the restoration plan as a result;

3.4 Setting cleaning goals and the time frame to achieve these cleaning goals

3.4.2 Indoor air quality
Where **poor indoor air quality is suspected**, the restorer should set a target level **of indoor air** quality within the building and refer to this as the **indoor air quality goal(s).** The **indoor air** quality goal(s) should be documented within **48 hours of the initial inspection.**

NOTE 1 This can be done by reference to a **predetermined indoor air quality goal** for the structure or by comparing to external conditions or structurally similar but unaffected parts of the building.

3.7 Selecting the indoor air quality cleaning techniques.
NOTE After a water damage incident, **microbial activity** can increase which in turn can affect the **quality of the air** within the **indoor environment**.

f) whether an occupant or other person exposed to the indoor **environment claims symptoms** which can be attributed to **poor indoor air quality**;
g) the presence and levels of visible **mould** and **microbial growth**;
h) the likely presence and levels of **mould and microbial growth** in hidden voids such as partition walls;
i) the presence of a **person that is especially vulnerable** to **poor indoor air quality**

3.10 Verifying indoor air quality goals have been met
Where remedial action has been undertaken to improve the **indoor air quality** within the building, a completion inspection should be undertaken and documented to verify the **indoor air quality** goals have been met.

This should include:
a) removal of odour specific to the water damage incident;

b) visual inspection to include the reduction or removal of visible particulates such as dust;
c) air sampling using suitable sampling and analysis techniques. 4

Documentation for provision to the customer

3) a statement confirming indoor air quality assessments undertaken and the evidence to confirm the indoor air quality conditions have been met;

Annex B (informative)
Sources of water damage and their health risks for occupants

B.1 General

The length of time the water is in situ in a building can increase the level of risk as water can be a stimulus for accelerated **biological activity. Bacteria**, **viruses** and **mould** spores are commonly present in a building but lay dormant until water triggers the growth cycle. Therefore the likelihood of the rate of increase in **biological activity** is related to the following conditions:
a) pre-existing site conditions (e.g. levels of cleanliness at the building); **b)** the source of the water (e.g. from a clean or **unsanitary** source);
c) the circumstances after the loss has occurred (e.g. time without mitigation, temperature and humidity).

Annex G (informative)
Indoor air quality

G.1 Exposure to poor indoor air quality after water damage incident

Current research suggests that some groups are especially **vulnerable to exposure** of **microorganisms** in damp **environment** and these are documented as:
a) children;
b) the elderly;
c) pregnant women;
d) those with cardiovascular or respiratory problems; e) persons with immunodeficiency;
f) atopic individuals (those with allergies).

NOTE 2 For further information on **indoor air quality** and the effect of **dampness and mould** on **vulnerable people**,

see the European Union's publication Indoor **air quality** [14] and WHO guidelines for **indoor air quality**: dampness and **mould** [15].

NOTE 3 Indoor air quality can **deteriorate** over time depending on the prevailing **environmental conditions**. Monitoring of **indoor air quality** may therefore be considered on an ongoing basis and not only conducted at the beginning and end of the project.

G.2 Indoor air quality surveying techniques

Environmental sampling should be conducted and recorded by a technically competent person, who is trained in the sampling methods and is aware of the limitations of the methods used.
NOTE Test laboratory accreditation. Users of this PAS are advised to consider the desirability of selecting test laboratories that are accredited to BS EN ISO/IEC 17025 by a national or international accreditation body. It is important to seek assurance that the laboratory used can demonstrate proficiency and quality control standards commensurate with the analysis being carried out.
It is equally important that where UKAS or other accreditation is displayed it should be specific to the task at hand. Typically labs may be UKAS accredited for water sampling or legionella but not for mould sampling etc**.**

6 Mould Remediation

International Standards IICRC S520 Third edition ANSI 2015

1.2. Provide for the safety and health of workers and **Occupants**

4.2.1 **Assessments** Where **mould** is a considered risk, an independent IEH should be used

4.2.3 **Post remediation documentation** Clearance to condition 1 should be obtained prior to restoration -rebuild

4.4 Contamination removal **Contamination** should be removed and attempts to kill or encapsulate or inhibit mould growth are not adequate (Ref ACGIH)

Throughout this document there is a clear emphasis on the following issue:

- Use of a third party professionally competent Indoor **Environmental Hygienist (professional)** unless condition 3 where visible mould is present.

- In situations where mould growth is suspected or a risk an **IEP** should be used to investigate.

- To confirm condition 1 or more importantly assess clearance or removal of other **contaminants** to suitable or comparative levels.

- While this document provides the contractor with a working guide in **mould** removal it clearly emphasises the need for a third par**ty IEP**

- It should be recognised mould is only one of many different **contaminates** likely to be present in a water damaged building.

7 Risk and Hazard Assessments

7.1 The contractor or IEP must undertake a risk and hazard assessment regarding potential exposure to contamination during and after the decontamination works.

7.2 They should assess their own potential exposure and make every effort to reduce eliminate, control and or reduce that contamination by source removal, engineering controls and finally PPE.

7.3 Controls and exposure assessments for exposure to carcinogens, asthmagens skin and respiratory sensitizers together with specific particulate inhalation should follow legislative requirements. The following government and national standards should be seen as a minimum reference to compliance:

7.3.15 HSE Controlling Substances hazardous to health COSHH 20006 http://www.hse.gov.uk/coshh/

7.3.16 HSE EH40/2005 Workplace exposure limits - HSE 2012 www.hse.gov.uk/coshh/table1.pdf

7.3.17 Monitoring Strategies for Toxic Substances 2006 www.hse.gov.uk/pubns/books/hsg173.htm

7.3.18 Housing Health and Safety Rating System2006 https://www.gov.uk/government/publications/housing-health-and-safety-rating-system-guidance-for-landlords-and-property-related-professionals

7.3.19 British Standard and Code of practice for Damage

management2015http://shop.bsigroup.com/ProductDetail/?pid=00000000 0030296352

7.3.20 PAS 64:2013. Mitigation and recovery of water damaged buildings. Code of practice. http://shop.bsigroup.com/SearchResults/?q=PAS64

7.3.21 HSWA 1974 amended http://www.hse.gov.uk/legislation/hswa.htm

7.3.22 Asthmagen http://www.hse.gov.uk/asthma/asthmagen.pdf

7.3.23 HSE removing dust fom an enclosure http://www.hse.gov.uk/asthma/asthmagen.pdf

7.3.24 **HSE Hazards of Nano particles** http://www.hse.gov.uk/nanotechnology/understanding-hazards-nanomaterials.htm

7.3.25 HSE Duty to ensure subcontractors or nominated contractors are competent . http://www.hse.gov.uk/enforce/hswact/index.htm

7.3.26 Health effects (Conditions) related to biological agents in WDBs ACGIH Table 3.2 pg. 3-3 Bio-aerosols assessment and control

7.4 These assessments must assess the implications and consequences of the contractors work estimated results and health consequences to other building occupants or visitors as per COSHH requirements. (Regulation 6 sec 1)

7.5 The building occupants may be at differing risk to healthy workers and health and safety assessments should be made to assess possible vulnerabilities. A health assessment may be formal or informal, depending on the situation and circumstances and does not always require the direct participation of medical professionals as members of the investigation team (ACGIH section 1.4 Approaches)

7.6 The following direct UK legislative reference sources (HHSRS –COSHH-EH40) indicate that water damaged buildings will have a synergistic and harmful health effect on occupants and visitors, through exposure to:

7.6.15.1 Carcinogens –
7.6.15.2 Asthmagens
7.6.15.3 Respiratory and skin sensitizers
7.6.15.4 Particulates and bio-aerosols

7.7 These hazards will cause varying risks to occupants depending on: 7.7.15 Age of occupant
7.7.16 Immune system **7.7.17** Sensitisation
7.7.18 Acute and or Chronic exposure **7.7.19** Genetics
7.7.20 Synergistic effects of contaminants present

7.8 The normal risk and hazard assessment criteria should be used by both contractors undertaking remediation and on behalf of visitors and occupants of the property.

7.9 Table 3 shows a typical risk and hazard assessment.

7.10 Risk & Hazard Assessment for post water damage event (48 hours)

7.10.15 Table 3 shows a skeleton risk and hazard assessment as required by HSWA and COSHH. The presence of any and all contaminants can be expected and is confirmed within 48 hours of water damage. While personal health and medical condition can to some minor extent be assessed, the genetics and susceptibility of building occupants cannot be known until exposure and therefore exposure should be avoided.

7.10.16 The law on the overall hazards and contaminants A-H is clear and identified as possible, carcinogens, skin and respiratory sensitizers, allergens and asthmagens through EH40 – COSHH-HHRS and HSWA.

7.10.17 Most importantly in the prevailing legislation two major issues are identified, where:

7.10.17.1 Where the synergistic effects of mixtures or compounds are unknown the highest risk factor must be applied in the case of water damaged buildings this would be the carcinogen aflatoxin.

7.10.17.2 In the absence of comprehensive and very expensive testing, the presence of contamination within 48 hours must be presumed.

7.12 Risk assessment conclusion

7.12.15 There are no safe levels of exposure to the contaminates listed in Table 3 **7.12.16** Total removal of these contaminates may be required although practically impossible and possibly unnecessary.

7.12.17 The synergistic effect of concomitants makes generalised risk and hazard assessments of people with varying immune response impossible.

7.13 Hazard assessment conclusion

7.13.15 The difference between hazardous and normal exposure should be recognised.

7.13.16 All of the hazardous contaminates listed in Table 3 exist naturally and normally

7.13.17 The hazard difference between the water damaged property and ambient normal conditions, are the levels and concentration of contaminates 7.13.18 The specific contaminates of concern are typically below levels of detection in outside ambient air.

7.13.19 The WDB will see escalating levels of some or all contaminates and

8 What is Water Damaged Building (WDB) Health Effects

Excerpt from Internal review performed by The Professionals Panel

https://www.survivingmold.com/docs/IEP_CONSENSUS_04_12_16.pdf

8.1 Microbial metabolites and fragments present to the innate immune system as pathogen associated molecular patterns (PAMPs) [22]. In those genetically susceptible to poor clearance of these contaminants, the resultant ongoing inflammation can lead to the production of danger associated molecular patterns (DAMPs). This uncontrolled inflammation involves multiple bodily systems in a well-described sequence that can lead to multiple symptoms in a matter of hours [26-29].

***PAMPS Ref**

- *Kartottki DG, Spilak M, Frederiksen M, Jovanovic AndersenZ, Madsen AM, Ketzel M, Massling A, Gunnarsen L Moller P, Loft S. Indoor and outdoor exposure to ultrafine, fine, and microbiologically derived particulate matter related to cardiovascular and respiratory effects in a panel of elderly urban citizens. International Journal of Environmental Research and Public Health. 2015 Feb 2; 12(2): 1667-86.*

***DAMPs Ref**

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Range of toxins, inflammagens, and microbes found in WDBs		
Mycotoxins[33]	Gram-negative bacteria[38,40-42]	Hemolysins[13,35]
Bioaerosols[34]	Gram-positive bacteria[38,40-42]	Proteinases[13,35]
Cell fragments[35]	Actinomycetes[43]	Chitinases[13]
Cell wall components[35]	Nocardia[38]	Siderophores[13]
Hyphal fragments[36]	Mycobacteria[44]	Microbial VOCs[46-49]
Conidia[36]	Protozoa[43]	Building material VOCs[46]
Beta Glucans[35,37]	Chlamydia[45]	Coarse particulates[13]
Mannans[13,38]	Mycoplasma[45]	Fine particulates[13]
Spirocyclic drimanes[35]	Endotoxins[37,38]	Ultrafine particulates[57,58]
Inorganic xenobiotics[39]	Lipopolysaccharides[40]	Nano-sized particulates[57,58]

References for WDB contaminates
20 References to contaminates and health effects in WDB

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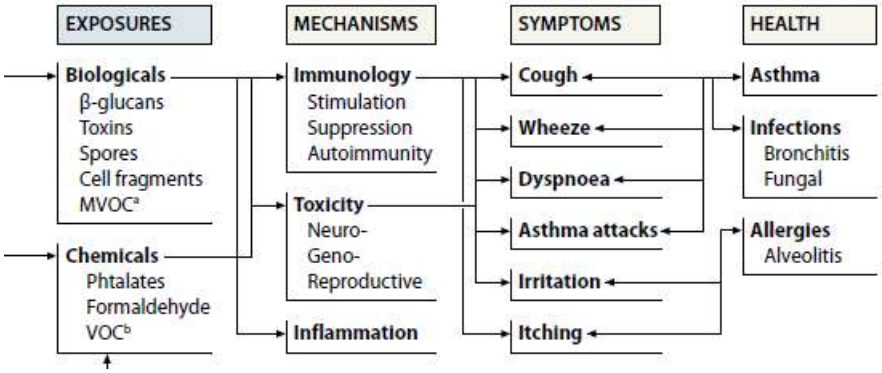
9 Water Damaged Buildings a review of World Health Organisation (WHO)

30 + references to health related research in WDB

Ref World Health Organisation (WHO) in their Guidelines on Dampness and Mould 2009
http://www.euro.who.int/__data/assets/pdf_file/0017/43325/E92645.pdf?ua=1

	Page no	Item
1	1.1 page 2	Strong evidence regarding hazards posed by posed by several biological agents that pollute indoor air; however, the WHO working group convened in October 2006 concluded that the individual species of microbes and other biological agents that are responsible for health effects cannot be identified. This is due to people often being exposed to multiple agents simultaneously, to complexities in accurate estimation of exposure and to the large numbers of symptoms and health outcomes due to exposure.
2	1.1 page 3	Excess moisture on almost all indoor materials leads to growth of microbes, such as mould, fungi and bacteria, which subsequently emit spores, cells, fragments and volatile organic compounds into indoor air. Moreover, dampness initiates chemical or biological degradation of materials, which also pollute indoor air. Dampness has therefore been suggested to be strong, consistent indicator of risk of asthma and respiratory symptoms (e.g. cough and wheeze). The health risks of biological contaminants of indoor air could thus be addressed by considering dampness as the risk indicator.
3	**1.2 page 5**	 **Note exposure to and symptoms**

4	**2.2 page 9**	Indoor environments contain a complex mixture of live (viable) and dead (nonviable) microorganisms, fragments thereof, toxins, allergens, volatile microbial organic compounds and other chemicals. The indoor concentrations of some of these organisms and agents are known or suspected to be elevated in damp indoor environments and may affect the health of people living or working there. • Dampness may also promote bacterial growth and the survival of viruses • Excess moisture may also result in increased chemical emissions from building materials and floor covers
	2.2 page 11	Fungi not only have adverse effects on health but also cause considerable damage to buildings,
5	2.3.1 Page 13-14	All agents that can induce specific immune responses (resulting in the production of specific antibodies) are also potential allergens. The latter can be dead material, like mite faecal particles, or viable propagules, such as bacteria or mould spores
6	2.3.1.2 Page 14	Many fungal species produce type I allergens, and immunoglobulin (Ig)E sensitization to the commonest outdoor and indoor fungal species, like Alternaria, Penicillium, Aspergillus and Cladosporium spp., is strongly associated with allergic respiratory disease, especially asthma. Fungi are also well-known sources of type III (or IgG-inducing) allergens. The species involved include many common genera such as Penicillium and Aspergillus, which can be found in most houses. At high concentrations, fungi may also be involved in combined type III and IV allergic reactions, including hypersensitivity pneumonitis. They (allergens) are found in spores, hyphae and fungal fragments but are released in greater amounts during germination and mycelial growth, which may occur inside the airways (Green et al., 2006).
7	2.3.1.2 page 15	Spores are typically 2–10 µm in length. They can stay airborne for long periods and may deposit in the respiratory system, some smaller spores reaching the alveoli (Eduard, 2006). Fungi also release even smaller fungal fragments (Gorny, 2004), which are derived from broken or fractured spores and hyphae and can be categorized into submicron particles (< 1 µm) or larger fungal fragments (> 1 µm). Even more fungal fragments than spores may be deposited in the respiratory tract (Cho et al., 2005); like spores, they are known to contain allergens (Green et al., 2006) and mycotoxins (Brasel et al., 2005a). Both spores and fungal fragments may therefore be involved in mould-related adverse health effects.
8	2.3.5 page 18	Mycotoxins, or fungal toxins, are low-relative-molecular-mass biomolecules produced by fungi, some of which are toxic to animals and human beings. Mycotoxins are known to interfere with RNA synthesis and may cause DNA damage

		Some fungal species may produce various mycotoxins, depending on the substrate. In the case of Penicillium, one such compound is penicillin, a strong antibiotic. Several mycotoxins, e.g. aflatoxin from Aspergillus flavus and Aspergillus parasiticus, are potent carcinogens. Many mycotoxins are immunotoxic, but the trichothecene mycotoxins are immunostimulating at low doses (Eduard, 2006). The mycotoxins that have perhaps received most attention are the trichothecenes, produced by Stachybotrys chartarum. Bloom et al. (2007) showed that several mycotoxins produced by S. chartarum and Aspergillus versicolor (i.e. macrocyclic trichothecenes, trichodermin, sterigmatocystin and satratoxin G) could be present in most samples of materials and settled dust from buildings with current or past damage from damp or water.
9	2.3.6 Page 19	Several fungi produce volatile metabolites, which are a mixture of compounds that can be common to many species, although some also produce compounds that are genera- or species-specific. Microbial volatile organic compounds are often similar to common industrial chemicals. To date, more than 200 of these compounds derived from different fungi have been identified. Damp concrete floors have been shown to increase chemical degradation of the plasticizer in polyvinyl chloride floor coatings and glues, resulting in emissions of volatile organic compounds such as 2-ethyl-1-hexanol (Norbäck et al., 2000; Tuomainen, Seuri, Sieppi, 2004). Similarly, damp concrete floors may emit ammonia from the self-levelling flooring compound used in the late 1970s and early 1980s in Europe. Furthermore, the offgassing of formaldehyde from composite wood products and the rate of formation of ozone increase with relative air humidity (Arundel et al., 1986; Godish, Rouch, 1986) Formaldehyde concentrations may also be elevated in damp indoor environments because moist air holds more formaldehyde. The levels of semi-volatile compounds, such as pentachlorophenol (a wood preservative) and other pesticides, may also be elevated in damp indoor environments.
10	2.4.2 Page 21	The assessment of indoor concentrations of microorganisms presents distinct challenges. Pathogenic microorganisms may be hazardous at extremely low levels, while other organisms may become important health hazards only at concentrations that are orders of magnitude higher. Furthermore, not all the biological agents that might be associated with damp indoor environments and their health effects may have been identified.
11	2.4.2.1 Page 22	**Air Sampling** Airborne concentrations of microorganisms can be studied by counting culturable propagules in air samples or settled dust samples. Colonies are counted manually or by image analysis techniques. To date, no

		standard methods are available for detecting and enumerating fungi in indoor environments, which significantly limits the potential for comparing data from different studies. International standards are, however, being prepared by the International Organization for Standardization (ISO) technical committee 147/SC on indoor air for sampling by filtration and impaction and for the cultivation of fungi ***SEE (ISO 16000-16, -17,-18***) Counting culturable microorganisms has some serious limitations. These include poor reproducibility; selection of certain species because of, for example, the choice of sampling method, culture media or temperature chosen; and the lack of detection of non-culturable and dead microorganisms, cell debris and microbial components, although they too may have toxic or allergenic properties. Traditional culture methods have proven to be of limited use for quantitative assessment of exposure. Culture-based techniques thus usually provide qualitative rather than quantitative data.
12	2.4.4 Page 25	**Questionnaire and testing hypothesis** In addition to questionnaires, personal or environmental monitoring is commonly used for exposure assessment. Although monitoring can potentially result in a more valid, accurate assessment, this may not always be the case. Validity is strongly dependent on the sampling strategy chosen, which in turn depends on a large number of factors, including: the type of exposure and disease or symptoms of interest; whether the health outcomes are acute or chronic (e.g. exacerbation versus development of disease); whether the approach is population- or patient based; suspected variations in exposure over both time and space and between diseased and reference populations; the methods available to assess exposure; and the costs of sampling and analysis.
13	2.4.4.5 page 26	**Should settled dust or airborne samples be taken**? In many studies, reservoir dust from carpets or mattresses is collected, and the concentrations are usually expressed in either weight per gram of sampled dust or weight per square metre. Although both measures are generally accepted, the advantage of settled dust sampling is the presumed integration over time that occurs in deposition of the pollutant on surfaces (Institute of Medicine, 2000). Micro organisms can also proliferate in carpets, provided there is sufficient access to water; however, surface samples allow only a crude measure that is probably only a poor surrogate for airborne concentrations.
14	2.4.5 Page 27-28	**Problems in measuring indoor exposure** Exposure to microorganisms in the indoor environment is most frequently assessed by counting culturable spores in settled dust or the air, but this approach has serious drawbacks (see section 2.4.2).

		Thus, unless many samples are taken per house, sampling of culturable organisms will probably result in a poor quantitative measure of exposure, leading to a nonspecific bias towards the null. This might explain why most studies that included measurements of culturable fungi found no association with symptoms (in contrast to reported mould). The issue is particularly relevant for measurements of viable microorganisms; Surface sampling, however, may be a poor proxy for airborne concentrations (see above). As no health-based exposure limits for indoor biological agents have been recommended, interpretation of concentrations is difficult, particularly in case studies. Therefore, strategies to evaluate indoor concentrations (either quantitatively or qualitatively) should include comparisons of exposure data with background levels or, better, comparisons of the exposure levels of symptomatic and non-symptomatic persons or in damp and non-damp buildings. A quantitative evaluation involves comparisons of concentrations, whereas a qualitative evaluation could consist of comparisons of species or genera of microorganisms in different environments.
15	2.5 page 29	**Summary** If methods for culturable organisms are used, comparisons with outdoor microbiota might provide further qualitative evidence of potential indoor sources of contamination.
16	Page 70	**Evidence of house dampness** The overall evidence shows that house dampness is consistently associated with a wide range of respiratory health effects, most notably asthma, wheeze, cough, respiratory infections and upper respiratory tract symptoms. These associations have been observed in many studies conducted in many geographical regions (Brunekreef et al., 1989)
17	4.2.1 Page 78	**β-glucans** Numerous studies have shown that β-glucans have important effects on the human immune system. β-glucan was identified as the biologically active component of immune-stimulating yeast cell extracts in 1961 (Riggi, Di Luzio, 1961). Since then, their effects, particularly in relation to infection and cancer, have been investigated extensively
18	4.2.2 Page 81	**Mycotoxins** Mycotoxins are secondary metabolites produced by fungi, which can cause a toxic response in animals and human beings, often at very low concentrations. Many studies in vitro and in experimental animals have demonstrated the toxic potential of a variety of mycotoxins, including trichothecenes and sterigmatocystin (Institute of Medicine, 2004; Rocha, Ansari, Doohan, 2005).

19	4.2.5 Page 83	**Infection with mould** Infection with Aspergillus and other fungi such as Fusariuum spp. is a well known complication in the treatment of patients who are immune compromised due, for example, to treatment for cancer or infection with human immunodeficiency virus. Aspergillus appears to be the most aggressive of these fungi, giving rise to infections also in patients with less severe airway disease, such as cystic fibrosis, asthma and chronic obstructive pulmonary disease.
20	4.3.2 Page 86	**Cytotoxicity and immunosuppression** Increased frequencies of common respiratory infections have been observed in people living or working in damp buildings (Åberg et al., 1996; Pirhonen et al., 1996; Kilpeläinen et al., 2001), suggesting that agents present in the indoor air of these buildings can suppress immune responses, leading to increased susceptibility to infections.
21	4.3.4 Page 87	**Irritation** Spores and other particulate material, as well as volatile organic compounds produced by microorganisms, building materials, paints and solvents, are potentially irritating. In epidemiological studies, the prevalence of respiratory and irritative symptoms has been associated with perceived mould odour, possible indicating the presence of microbial volatile organic compounds
23	4.3.5 Page 88	**Neurotoxicity** Such health effects as fatigue, headache and difficulties in concentration (Johanning et al., 1996; Koskinen et al., 1999b) indicate that microbes or other agents present in damp buildings have neurological effects. Many pure microbial toxins, such as the products of Fusarium (fumonisin B1, deoxynivalenol), Stachybotrys (satratoxin G), Aspergillus (ochratoxin A) and Penicillium (ochratoxin A, verrucosidin), have been shown to be neurotoxic in vitro and in vivo No study has shown, however, that people living in damp buildings who complain of nervous system symptoms are exposed to effective levels of mycotoxins. **Jeff Note See WHO bulletin 77**
24	4.3.8 Page 89	**Microbial interactions** The immunostimulatory properties of the fungal and bacterial strains typically found in moisture-damaged buildings are synergistically potentiated by microbial interactions during concomitant exposure in vitro
25	5.3 Page 94	**Guidelines** As the relationships between dampness, microbial exposure and health effects cannot be quantified precisely, no quantitative, health-based guideline values or thresholds can be recommended for acceptable levels of contamination by microorganisms. Instead, it is recommended that dampness and mould-related problems be

		prevented. When they occur, they should be remediated because they increase the risk of hazardous exposure to microbes and chemicals

10 **Quotes from WHO** Dampness and Mood IAQ 2009

WHO Abstract:

"Indoor air pollution is caused by hundreds of species of bacteria and fungi, in particular filamentous fungi (mould), growing indoors when sufficient moisture is available."

10.1 **WHO Executive Summary:**

10.2 **Pg. xi-xii**:

"There is strong evidence regarding the hazards posed by several biological agents that pollute indoor air; however, the WHO working group convened in October 2006 concluded that the individual species of microbes and other biological agents that are responsible for health effects cannot be identified. This is due to the fact that people are often exposed to multiple agents simultaneously, to complexities in accurately estimating exposure and to the large numbers of symptoms and health outcomes due to exposure. "The presence of many biological agents in the indoor environment is due to dampness and inadequate ventilation. Excess moisture on almost all indoor materials leads to growth of microbes, such as mould, fungi and bacteria, which subsequently emit spores, cells fragments and volatile organic compounds into indoor air.

10.3 **WHO Exec Summary, Pg. xiii:**

"Toxicological evidence obtained in vivo and in vitro supports these findings, showing the occurrence of diverse inflammatory and toxic responses after exposure to microorganisms isolated from damp buildings, including their spores, metabolites and components."

10.4 **WHO Exec Summary, Pg. xiv:**

"The amount of water on or in materials is the most important trigger of the growth of microorganisms, including fungi, actinomycetes and other bacteria. "Health hazards result from a complex chain of events that link penetration of water indoors,

excessive moisture to biological growth, physical and chemical degradation, and emission of hazardous biological and chemical agents."

Executive Summary, page XIII."Microbial growth may result in greater numbers of spores, cell fragments, allergens, mycotoxins, endotoxins, β-glucans and volatile organic compounds in indoor air. The causative agents of adverse health effects have not been identified conclusively, but an excess level of any of these agents in the indoor environment is a potential health hazard."

"Toxicological evidence obtained in vivo and in vitro supports these findings, showing the occurrence of diverse inflammatory and toxic responses after exposure to microorganisms isolated from damp buildings, including their spores, metabolites and components."

10.5 **WHO Exec Summary, Pg. xv:**
"As the relations between dampness, microbial exposure and health effects cannot be quantified precisely, no quantitative health-based guideline values or thresholds can be recommended for acceptable levels of contamination with microorganisms. Instead, it is recommended that dampness and mould-related problems be prevented."

10.6 **WHO Introduction, Pg. 5:**
"Mechanisms of injury include exposure to β-glucans, toxins, spores, cell fragments and chemicals followed by immune stimulation, suppression and autoimmunity as well as neurotoxic effects."

10.7 **WHO Chapter 2, Pg. 9:**
"Indoor environments contain a complex mixture of live (viable) and dead (non-viable) microorganisms, fragments thereof, toxins, allergens, volatile microbial organic compounds and other chemicals. The indoor concentrations of some of these organisms and agents are known or suspected to be elevated in damp indoor environments and may affect the health of people living or working there."

10.8 **WHO Chapter 2, Pg. 15:**
"Many fungi and some yeast replicate by producing numerous spores that are well adapted to airborne dispersal....They can stay airborne for long periods and may deposit in the respiratory system, some smaller spores reaching the alveoli. Fungi can release even smaller fungal fragments, which are derived from broken or fractured spores and hyphae and can be categorized into submicron particles...Even more fungal fragments than spores may be deposited in the respiratory tract; like spores, they are known to contain allergens and mycotoxins."

10.9 **WHO Chapter 2, Pg. 16:**

“Mycobacteria have also been shown to be common in moisture-damaged buildings, theirpresence increasing with the degree of fungal damage (Torvinen et al., 2006). Cell wall components of mycobacteria are known to be highly immunogenic, and exposure to mycobacteria may cause inflammatory responses (Huttunen et al, 2000, 2001).” “In the environment, airborne endotoxins are usually associated with dust particles or aqueous aerosols. “Indoor fungal fragments are not commonly measured in field studies, but a study with an aerosolization chamber showed that submicron fungal fragments from culture plates and mould-contaminated ceiling tiles aerosolized simultaneously with spores but at substantially higher concentrations

(320 - 524 times higher). This suggests that indoor exposure to fungal fragments is at least as important as exposure to fungal spores."

10.10 **WHO Chapter 2, pg 17:**
"Fungal (1→3)-β-D-glucans. (1→3)-β-D-glucans are non-allergenic, water-insoluble structural cell-wall components of most fungi, and may account for up to 60% of the dry weight of the cell wall of fungi.... (1→3)-β-D-glucans have immunomodulating properties and may affect respiratory health."

10.11 **WHO chapter 2, pg 18:**
"Mycotoxins, or fungal toxins, are low-relative-molecular-mass biomolecules produced by fungi, some of which are toxic to animals and human beings. Mycotoxins are known to interfere with RNA synthesis and may cause DNA damage. Some fungal species may produce various mycotoxins...Several mycotoxins, e.g. aflatoxin from *Aspergillus flavus* and *Aspergillus parasiticus*, are potent carcinogens. Many mycotoxins are immunotoxic....The mycotoxins that have perhaps received most attention are the trichothecenes, produced by *Stachybotrys chartarum*.....[Mycotoxins] could be present in most samples of materials and settled dust from buildings with current or past damage from damp or water."

10.12 WHO Chapter 2, Pg. 19:
"These studies demonstrate that mycotoxins are present in the indoor environment and that the levels may be higher in buildings affected by mold and damp."*S. chartarum* trichothecene mycotoxins can become airborne in association with both intact conidia and smaller fungal fragments....These studies demonstrate that mycotoxins are present in the indoor environment and that the levels may be higher in buildings affected by mould or damp." "Several fungi produce volatile metabolites, which are a mixture of compounds ....Microbial volatile organic compounds, are often similar to common industrial chemicals. To date, more than 200 of these compounds derived from different fungi have been identified, including various alcohols, aldehydes, ketones, terpenes, esters, aromatic compounds, amines and sulfur-containing compounds." "Some exposures with adverse health effects associated with damp indoor environments include emissions of volatile organic compounds from damp and mouldy building materials."

10.13 **WHO Chapter 4, Pg.63**
"Microbiological organisms are considered among the most plausible explanations for the health risks associated with indoor dampness."

10.14 **WHO Chapter 5, Pg. 75:**
"The exposures that cause dampness-related illness have not yet been determined. A study of an association between health effects and the concentration of a specific microorganism or microbial compound is in fact testing a hypothesis. In the studies in our review, such hypothetical causal exposures included all culturable fungi, all

fungal spores, species-specific spores, all fungal biomass (ergosterol) (Robine et al., 2005), the total mass of specific organism (*Aspergillus* and *Penicillium* extracellular polysaccharides) and specific toxic compounds (endotoxins, β-glucans)."

10.15 **WHO Chapter 4, Pg. 78:**
"Numerous studies have shown that β-glucans have important effects on the human immune system.

10.16 **WHO Chapter 4, Pg. 80:**
"Concomitant exposure to endotoxins and curdlan, a (1-3)-β-glucan, was shown to diminish the acute neutrophil response but to augment chronic inflammatory effects (Fogelmark, Sjostrand, Rylander, 1994; Rylander, Fogelmark, 1994). Thus, the effects of inhalation of β-glucans apparently depend on the type of glucans as well as on concomitant exposures."

10.17 **WHO Chapter 4, Pg. 85:**
"In damp buildings, people are exposed to constantly changing concentrations of different microbial species, their spores, metabolites and components, and other compounds in indoor air, including chemical emissions from building materials. This complex mixture of exposures inevitably leads to interactions, which affects outcomes in different situations. Furthermore, the effects of microorganisms, microbial substances or dampness-related chemical compounds seen in experimental animals or cells often result from exposure that are orders of magnitude higher than the average doses that reach the human lungs under normal conditions in indoor air.

Nevertheless, the surface doses within the lungs of patients with respiratory conditions can vary a thousand fold, due to uneven particle deposition (Phalen et al., 2006), thus resulting in even larger maximal surface doses in human lungs than in those used in experimental toxicological studies. Moreover, many other factors, such as exercise, can result in larger-than-average doses in the human lung." "Many of the health effects may result from recurrent activation of immune defense, leading to exaggerated immune responses and prolonged production of inflammatory mediators. Overproduction of these compounds damages the surrounding tissue and may manifest itself as chronic inflammation and inflammation-related diseases."

10.18 WHO Chapter 4, Pg. 86:
"Furthermore, it has been shown in an animal model that immunological status plays an important role in airway inflammation induced by *Stachybotrys chartarum*, enhancing the effects of the mold (Leino et al., 2006). The results imply that sensitized people are more susceptible to exposure to mold than non-atopic people.

Different microbial species differ significantly in their immunostimulatory potency in both mouse and human cells in vitro (e.g. Huttunen et al., 2003). Furthermore, it has been clearly demonstrated that different growth conditions and competition between microorganism for the same habitat in vitro change their inflammatory potency, protein expression and toxin production (Ehrlich, 1987)." "The immunostimulatory activity of Gram-negative bacterial lipopolysaccharide is well established, but several other bacteria, fungi and isolated mycotoxins associated with damp buildings have been shown to induce inflammatory responses in vitro. In line with the findings in

vitro, the same microbial species activate acute and sustained inflammation in the lungs of experimental animals."

10.19 WHO chapter 4, Pg 87:
"Fungal spores appear to have toxic effects other than those that cause the inflammatory reaction. Studies of Gram-positive and -negative bacteria (e.g. *Streptomyces californicus*, *Pseudomonas fluorescens*, *Mycobacterium terrae*, *Bacillus cereus*) have shown that that significant difference in cytoxicity among strains is due at least partly to differences in inflammatory activity. Spores and toxins of the fungus *S. chartarum* have been shown to activate the apoptotic pathway.

Studies in experimental animals with the same fungal or bacterial species confirm the in vitro findings for cytotoxic effects...as well as lung tissue damage." "Microbial fragments can...cause autoimmune reactions by molecular mimicry, acting as microbial superantigens or by enhancing the presentation of autoantigens."
"Spores and other particulate material, as well as volatile organic compounds produced by microorganisms, building materials, paints and solvents, are potentially irritating.

In epidemiological studies, the prevalence of respiratory and irritative symptoms has been associated with perceived mould odour, possible indicating the presence of microbial volatile organic compounds."

10.20 WHO Chapter 4, Pg. 88:
"Such health effects as fatigue, headache and difficulties in concentration (Johanning et al., 1996; Koskinen et al., 1999b) indicate that microbes or other agents present in damp buildings have neurological effects."

10.21 WHO Chapter 4, Pg. 89:
"The immunostimulatory properties of the fungal and bacterial strains typically found in moisture-damaged buildings are synergistically potentiated by microbial interactions during concomitant exposure in vitro (Huttunen et al., 2004).
"Interactions during co-cultivation stimulate these microbes to produce highly toxic compounds, which can damage DNA and provoke genotoxicity (Penttinen et al., 2007). In addition, concomitant exposure in vitro with amoebae potentiates the cytotoxic and inflammatory properties of the microbial spores of S. californicus or Penicillium spinolosum isolated from damp buildings (Yli-Pirila et al., 2007). These findings point to the importance of considering microbial interactions when investigating the causative agents and mechanisms of the adverse health effects observed in damp buildings."

10.22 WHO Chapter 4, Pg. 90:
"It is clear, however, that no single mechanism can explain the wide variety of effects associated with dampness and mold. Toxicological studies, by investigating the ability of microbial agents associated with damp buildings to activate certain toxicological mechanisms, provide insight into the multiple biological mechanisms

that might underlie the observed associations between health effects and dampness and mold. In vitro and in vivo studies have demonstrated diverse inflammatory, cytotoxic and immunosuppressive responses after exposure to the spores, metabolites and components of microbial species found in damp buildings, lending plausibility to the epidemiological findings."

11 Conclusion

11.1 Water damaged buildings escalate normal biological and fungal ecology to levels which must be assumed to have varying negative health implications to different people.

11.2 UK legislation specifically identifies legal responsibilities and duties to assess and control and or remove to lowest possible levels the hazardous components found in water damaged buildings

11.3 UK legislation specifically identifies contamination hazards as carcinogenic, skin and respiratory sensitizers and asthmagens.

11.4 British Standards in damage management confirms the hazards and risks present and requires verification of control and removal

11.5 The water damaged building has over 30 different types of recognised and measurable contaminates supported by over 20 peer reviewed papers.

11.6 The WHO has raised awareness regarding the health impact of water damage in buildings and provided a list of over 30 separate health hazards in their 2009 document Dampness and Mould.

11.7 All agencies including HSE and WHO recognise inhalation as the greatest single exposure route.

11.8 The HSE has published a specific document that shows the historic method of air filtering does not effectively remove contamination.

11.9 UK legislation warns that contractors must consider the health impact of their works on visitors and occupiers of premises they work on.

11.10 UK legislation holds employers responsible for the actions of their employees or contractors.