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HVAC&R FOR A BETTER WORLD

**Draft Code of Practice**
**Managing the risks of biological hazards at work**

The Australian Institute of Refrigeration, Air Conditioning and Heating (AIRAH) is grateful for the opportunity to provide feedback on the draft Code of Practice for managing the risks of biological hazards at work.

As a leading industry body representing professionals in the heating, ventilation, air conditioning and refrigeration (HVAC&R) and building services industry, AIRAH is committed to safeguarding the wellbeing of building occupants, particularly by improving indoor air quality. Through our technical resources, training courses, conferences and events and advocacy work, we are building knowledge in this space and driving the conversation about how Australia can lift the quality of our indoor spaces.

But improving indoor air quality relies on more than awareness and expert knowledge – it relies on action from building owners and operators, which is in turn driven by market incentives and legal requirements. This Code of Practice sets out clear requirements for persons conducting a business or undertaking, and we believe it represents a vital lever in our quest for better buildings and healthier occupants.

In reviewing the draft Code of Practice, AIRAH has called on members of our Indoor Air Quality Special Technical Group. The group is made up of leading professionals from a wide range of backgrounds, including mechanical engineering, microbiology, occupational hygiene and more.

If you have any questions or would like to discuss these comments further, please do not hesitate to get in touch.

Best regards,

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**Introduction**

Page 6 - “implementing routine cleaning”
The term ‘implementing routine cleaning’ assumes that existing cleaning practices are adequate. However, many employers may be unaware of whether their cleaning effectively addresses biohazards. Likewise, many HVAC cleaning contractors lack clarity on what constitutes a hygienically clean system.

Page 6 - “encouraging vaccination for vaccine preventable diseases that may be present in your workplace”
Vaccination assists in reducing the impact of infection on individuals but does not prevent all transmission. Workers with transmissible infections should avoid attending the workplace unless critical, as exclusion removes the risk at its source.

The Code should include a concise list of risk mitigation measures and outline the risk hierarchy at the outset. It should also direct attention to additional measures for reducing infection spread, including mask-wearing. Further guidance should be included on the use of accredited supplemental air-cleaning technologies to mitigate airborne disease. Reference to international standards, such as ASHRAE Standard 241 on Infection Control, is recommended.

**1.1 Where can biological hazards be found in the workplace?**

General comment – Significant biological hazards can arise in HVAC systems through the growth of biofilms that contaminate workplaces and pose particular risks in healthcare settings. At-risk surfaces include filters, louvres, coils, drain pans, plenums, ducts, and diffusers. Microbial contaminants originate from occupants, can be resuspended from surfaces in dust or skin flakes, and may also enter with outdoor air. Mould and bacteria on surfaces – including settled dust – can amplify under high humidity, meaning many workplaces are at risk if these hazards are not managed correctly.

Where biofilm forms on HVAC surfaces that contact moving air, conditioned air may entrain biofilm material and supply it into occupied spaces. This is a particular risk where vulnerable individuals are present.

Other biofilm risks include plumbing dead legs, cooling towers, dry floor drains, and sink sumps, where staff may be exposed to building-derived biohazards.

Air quality inside conditioned spaces is influenced by HVAC airflow, microbial growth within the space, outdoor air ingress, and aerosolised pathogens from occupants.

**1.2 How are workers exposed to biological hazards in the workplace?**

Page 7 – “Transmission through the air”

We suggest adding the word “resuspended” in front of “dust.”

Biohazard levels change within the HVAC system, including as a result of microorganisms settling, growing and becoming aerosolised from HVAC surfaces.

General comment - This section would benefit from a clearer description of biofilm risks. Degrading and resuspended wet and dry biofilms should be added to the list. Antimicrobial-resistant organisms warrant particular mention, and their development is accelerated in biofilms which is further intensified under a changing climate.

Page 7 – “Workers can be exposed to biological hazards in more than one way. For example, seasonal influenza can be spread through direct contact with an infected person, breathing in contaminated air and contact with contaminated materials (e.g. door handles and lift buttons).”

There is minimal evidence supporting surface transmission as a dominant pathway for influenza. Influenza is therefore not an ideal example of surface spread. We suggest instead using gastrointestinal infections, which spread readily via surfaces.

**1.3 How can biological hazards cause harm?**

General comment – Microbial colonisation on coils, drain pans, and duct surfaces is common. Colonisation can elevate concentrations of airborne spores, cellular fragments, allergens, mycotoxins, endotoxins, β-glucans, and microbial volatile organic compounds (mVOCs) within HVAC systems. Excessive release of these bioaerosol constituents from contaminated HVAC components is recognised as a potential health hazard. While the precise causal agents of adverse outcomes are still being elucidated, these products contribute to respiratory irritation, hypersensitivity reactions, and infection in immunocompromised individuals.

Page 8 – “Exposure of a worker or other person at the workplace to biological hazards to which they don’t have immunity can result in injury, illness and disease.”

The term “immunity” applies to infectious agents; a person does not become immune to allergens. We suggest separating the discussion into infectious disease (requiring viable pathogens and immune response), and exposures that adversely affect the immune system regardless of infectivity. Cells, spores, and structural fragments of certain biological agents can cause asthma, autoimmune disease, toxicosis, and chronic inflammation. To aid clarity, consider classifying agents as:

1. Agents that come from the environment
2. Agents that come from another person and can be both contracted and passed on, including to a potentially vulnerable individual.
3. Agents that cause direct infection
4. Agents that make a person susceptible to secondary infection
5. Agents that cause diseases other than through infection

Table 1 – The examples are helpful, but the table should state that other risks not listed may be present (e.g., blisters on hands/feet could be due to hand, foot and mouth disease or mpox). Excluding viruses under “sex worker” excludes HIV, for example.

Table 1, page 9 – The example of the poorly maintained cooling tower is not accurate. Cooling towers are installed on building rooftops, so it is very unlikely that water spray containing Legionella would enter an office. The spray will be carried to the outdoor environment.

**2 Work health and safety duties**

General comment – Building owners are responsible for providing a healthy workplace or living environment free of excess moisture and mould by ensuring proper construction and maintenance (WHO).

The notion of having “some” mould is incongruous given its replication. The risk of mould and bacterial growth in HVAC is high, and building managers should have a perpetual responsibility to remove mould consistent with WHO guidelines. Beyond social, economic, and fiscal risks, there is a material legal risk where significant mould and dampness present a health risk. Building owners have access to knowledge and solutions to mitigate this risk and operate under a duty of care.

Page 17 – “provision and maintenance of a work environment without risks to health and safety” May be changed to: "provision and maintenance of a work environment without risks to health and safety including provision and maintenance of safe air conditioning plant and structures”.

**2.1 Persons conducting a business or undertaking (PCBU)**

Page 18 – Facilities and Accommodation

General comment – When speaking about facilities and accommodation, attention should be drawn to sources and reservoirs of dampness-associated microbial growth. These considerations should be part of operating a facility where the main corridors of surface and airborne infection transmission and other risk factors are understood and managed. Risks include, in addition to toilets, those parts of the building where air moves in response to pressure differences between indoor locations, or between indoor and outdoor air.

Page 18 – “To meet the primary duty, you must eliminate health and safety risks at work so far as is reasonably practicable. If you are not able to eliminate risks, you must minimise these risks so far as is reasonably practicable.”

Where a biohazard has been identified and remediated, testing may be required to confirm the workplace is suitable for return to normal operation. Professional advice may be necessary to establish what constitutes a safe workplace regarding biological hazards, particularly after an outbreak or an event that released biological material into occupied areas.

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**2.6 Other legal frameworks applying to biological hazards**

Page 23 – General comment – Indoor air quality is increasingly recognised in Australia as an accessibility issue. We suggest listing accessibility regulation immediately after workplace relations.

**3 The risk management process**

Page 28 – “To manage the risks of biological hazards in your workplace, just as for any other hazard, you can apply the risk management process described in the Code of Practice: How to manage work health and safety risks.“

“You can apply” is too permissive for risk management. We suggest “you should apply,” as no alternative decision mechanism is provided.

**4 Identifying biological hazards**

Page 27 – “Identifying the potential sources of biological hazards and how people may be exposed to them will help you identify risks and determine the control measures you will need to put in place to manage the risks.”

Suggest expanding “potential sources” to “potential primary sources and temporary reservoirs of biological hazards” to accommodate settled and resuspended biological hazardous particulate matter.

Page 27 – “testing of potential sources may be required to identify biological hazards (e.g. testing sick animals, cooling tower water or an air sample for airborne contaminants).”

Testing “airborne contaminants” is very often a poor proxy for infection risk. Testing of surfaces may be more effective in locating areas that are acting as sources or reservoirs of biological agents of concern. Bioaerosols are not normally generated in the air but are released from a solid surface, whether it be settled dust, biofilm growth, or mucous when an infective person sneezes. Airborne microbial (bioaerosol) concentrations are dominated by surface disturbances; therefore, air testing should occur only under controlled conditions. Surface and settled-particulate testing are often better predictors of airborne exposure. Real-time and near-real-time pathogen detection is emerging and currently functions as a detection tool rather than continuous monitoring.

**4.1 How to identify hazards**

Page 27 – “Understanding the common sources of biological hazards in your industry, and how people are exposed to them, can assist with identifying specific hazards which may arise from the work carried out by your business or undertaking.”

There may be a large number of at-risk environmental sources of biological hazards in a healthcare setting. Examples include HVAC components, floor drains and plumbing outlets, including sink sumps. Used endoscopes are particularly challenging.

It is very well known that inadequately managed HVAC systems pose a perpetual risk of microbial growth/biofilm. Armed with this knowledge, PCBUs should consider a poorly controlled HVAC system a hazard by default for those entering or working around these systems, without the need for prior risk assessment. This comment also applies to Section 5.

Where mould-like staining is present and associated with growth conditions, the environment may be treated as posing a biohazard risk without first identifying the microorganisms.

Caution and care should be taken entering into and working around HVAC equipment.

Local weather patterns in the vicinity of the workplace may affect biohazard levels. Tropical locations face high summertime risks of dampness-associated proliferation, potentially worsened by increased ventilation during high infection risk. Conversely, cold/dry locations may see increased infectivity and transmissibility in winter where low humidity drives changes in aerosol properties, airborne pathogen survival, and drying of mucous membranes.

Page 30 – Table 2 – "Is there adequate ventilation in the workplace?'

Ventilation implies dilution, which should be considered only when the biohazard source cannot be removed. Local extraction and negative pressure are common when handling materials with aerosolisation potential (e.g., asbestos-containing materials), which may also contain microbial hazards. Understanding the suitability and type of ventilation to solve a particular biohazard risk requires a strong understanding of airflows, infection transmission models and the hazard itself.

Of concern, the only mention of mould/HVAC contamination relates to ventilation as the solution to mould issues. Ventilation is not recommended under the Australian guidance aligned with IICRC S520 for Professional Mould Remediation. The Code should align with relevant standards and include requirements for inspection and cleaning of ducts, drain pans, and coils.

**Exposure Limits**

General comment – The proposed approach could allow workplaces to avoid setting acceptable conditions where no exposure limit exists. It should be pointed out in this section that in the absence of a workplace exposure limit a suitable surrogate or method of assessing risks may be provided. An example may be the adoption of the ASHRAE 241 and/or the currently proposed IAQ standards put forward by Morawska et. al. (2024) in the absence of a WES for an infectious agent.

Tolerance levels can change when other controls reduce risk. For instance, adherence to an 800ppm $CO_2$ threshold may be relaxed where supplemental air filtration/purification increases effective ventilation in compliance with ASHRAE Standard 241. In such cases, higher $CO_2$ may be acceptable because other interventions reduce exposure risk.

**6 Controlling the risks**

Page 39 – “For example, if you identify multiple potential biological hazards in your workplace which are transmitted through the air, in addition to ventilation it may be appropriate to require workers to wear a respirator as part of managing the risks of these hazards.”

It should not require multiple airborne biohazards to justify respiratory protection. Protection may be necessary for a single airborne hazard. Other exposure routes (dermal, ocular) may also be relevant. The section should direct assessment of all relevant routes and provision of controls individually or collectively.

Fit-testing should be referenced here if respirators are recommended.

Short- and long-range transmission both need control. Masks address short-range and assist at longer distances; mid-/long-range risk can also be reduced with tested, certified in-room air cleaners or local exhaust. Alternative mechanical ventilation strategies (e.g., displacement ventilation) and in-system measures (e.g., germicidal UV, alternative filtration technologies) are emerging controls that are not occupant driven and can substantially reduce health risks, costs, and environmental impacts.

Page 36 – “Seeking advice from reliable sources (e.g. health, agricultural, biosecurity or WHS authorities) may assist you to identify evidence-based control measures appropriate for managing the risks in your workplace.”

Professional bodies especially those whose members are qualified in occupational hygiene, indoor air quality and microbiology can provide reliable sources of information. They are often up to date with research and technology developments in Australia and internationally, which may assist with solving specific problems.

**6.1 How to control risks**

Page 37 – “preventing outbreaks of harmful levels of biological hazards, such as the growth of mould and yeast, by ensuring routine building maintenance to prevent leaks which cause moisture build up and ensuring ventilation systems are operating effectively”

The draft lists “ventilation systems” but omits “air-handling systems.” A mechanical air conditioning system designed for cooling a building will also provide the optimal conditions for microbial incursion. Cooling systems often strip moisture that deposits on coils, fins, ducts, and registers, creating optimal conditions for microbial growth. Wall-mounted split systems similarly encourage mould/bacterial growth released to air and surfaces and later resuspended.

To eliminate risk, it is necessary to prevent and remove mould and bacterial contamination from HVAC surfaces. Further, it is important to recognise that the role of biofilms in HVAC is leading to increased virulence and antimicrobial resistance. It is important to reduce pathogen concentrations in occupied spaces by removing or inactivating them in the conditioned airflow.

Page 38 – “using alternative cleaning methods (e.g. vacuuming rather than dry sweeping) which minimises the generation of dust and aerosols which may contain biological hazards”

When recommending vacuuming, specify HEPA-rated vacuum devices. Standard vacuums can increase exposure compared with sweeping by resuspending settled dust and associated biological agents. Back-mounted vacuums can cause particularly high exposures.

Page 39 – Engineering controls

“ensuring adequate ventilation and air cleaning to reduce the concentration of, or remove, biological hazards from the air, such as:

- using an HVAC system to filter the air and improve the level of ventilation (increase fresh air or dilute biological hazards transmitted through the air) in an indoor workspace

HVAC systems are not designed to filter the air to control biohazards; their purpose includes preventing deposition on cooling coils where biofilms may form. The Code should not recommend strategies for infection control without the expertise of filtration specialists. Infection control efficacy varies with filter grade, air volumes, and flow rates. Increasing filtration efficiency typically increases energy use and, in tropical climates, moisture loads. Filters generally cannot be “upgraded” in existing systems without engineering impacts; doing so may not reduce infectious aerosol transmission.

Page 40 –

- using Local Exhaust Ventilation (LEV), extraction systems or an air purifier to filter the air and remove the hazard from the worker’s breathing space
- installation of mechanical ventilation for confined animal facilities to draw contaminated air away from workers and other people.”

Local Exhaust Ventilation (LEV), extraction or air purifiers can remove hazards from the breathing zone. AIRAH can provide guidance to strengthen this section for practical adoption.

**7 Implementing control measures**

Page 44 - “After selecting control measures to manage risks, if time permits, testing them through a trial period can assist you to assess their effectiveness and make adjustments as required.”

A wide range of monitoring and testing options is available for evaluating worker and environmental health. Trials should include assessment of secondary risks.

For example, using an in-room far-UV device with incorrect intensity, without a diffuser or operated outside recommended conditions and that has not been tested and certified as ozone-safe may release ozone. This ozone can react with the vapours from pine-scented and other cleaning and air freshening products to generate aldehydes which could be carcinogenic.

There are reportedly only a few types of UV-C device that emit ozone, and most substantial suppliers provide equipment that has been proven to not emit ozone. Far-UV lamps, for example, can have filters installed to prohibit the emission of ozone.

Ozone forms at UVC wavelengths below ~240nm, most notably around 185nm. Many high-quality germicidal UVC lamps use quartz that blocks 185nm to prevent ozone production.

Control measures should be intrinsically safe. Where safety of far-UV cannot be verified, prefer established technologies such as UVGI (~254nm) and HEPA filtration.

**8 Reviewing control measures**

General comment – many controls are listed, but few review triggers are given.

A table linking controls to performance indicators would help (e.g., pressure drop or runtime as proxies for portable filter replacement; electrostatic media charge loss). We suggest identifying conditions that may cause early failure (e.g., filters blocking rapidly during bushfire smoke events).

**Appendix B**

Page 58 – "Adequate ventilation can:

- dilute the concentration of biological hazards generated by people or animals which travel through the air in indoor spaces, such as infectious respiratory particles containing viruses or bacteria emitted by occupants of the space"

Page 58 – Increasing ventilation while cooling humid air can increase risks of mould/bacterial growth in HVAC and occupied spaces. Mould and bacteria proliferate in settled dust at high ambient humidity.

Raising outdoor air during periods of high pollution (e.g., vegetation fires), high pollen, or near combustion sources may increase health risks.

Outdoor air, return air, filters, coils, drain pans, plenums, and ducts all contribute to biohazards. Measures should focus on the delivered air quality, considering all sources.

Page 58 – "You should ensure ventilation in your workplace complies with Australian national standards and Codes, such as the AS/NZ 1668 series"

Note that AS 1668.2 does not currently target moisture control to prevent mould and bacterial growth; its ventilation requirements target general air quality and bioeffluent control.

Page 58 – “Where this is the case, alternative ventilation options can be used, such as local exhaust ventilation”

Local exhaust ventilation is critical in settings with high risks of infectious aerosol generation such as in toilets and washrooms. Its adoption in a workplace setting facilitates removal of pathogens from the air a person is exhaling or inhaling.

Page 58 – “Natural ventilation can help reduce the risk of exposure to biological hazards in outdoor settings and in large open buildings. However, its effectiveness is dependent on the weather and wind direction.”

Natural ventilation is a useful complement to reducing airborne disease transmission, depending on ambient temperature and humidity. Bioaerosol concentration decline will be governed by air exchange rates, and in still air even openable windows may show lower levels of dilution and impact on infection risk than anticipated. Mathematical models are available to predict the effectiveness of different infection reduction strategies such as different types of ventilation under different occupant densities and activities.

**Mechanical ventilation**

The claim that increasing fresh air supply is the best way to reduce biological hazards needs caveating. The impact of ventilation on health protection depends on the quality of the make-up air in terms of pollutant load as well as moisture content.

While this section notes exhausting contaminated air, it lacks guidance on verifying feasibility or tracing pathogen transport. Understanding this may require building-management system data or airflow/pathogen movement assessment.

**Heating, ventilation and air conditioning (HVAC) systems**

“HVAC systems should be well maintained and regularly serviced in accordance with manufacturers’ instructions.”

Note that many HVAC systems are designed and installed by engineers and mechanical contractors and they are not “off the shelf” products with manufacturers’ instructions for maintenance. In Australia, AIRAH’s DA19 is widely regarded as the industry benchmark for HVAC system maintenance.

**Local exhaust ventilation**

When discussing local extraction, address the quality of make-up air.

ASHRAE 241 allows for verified “effective clean air” to be used to mitigate pathogen load at times of high infection risk – recommend referencing ASHRAE 241 and replacing this section with a more robust and balanced approach to infection transmission, energy consumption and sustainability.

“Local exhaust ventilation (LEV) is designed to remove airborne contaminants from the air before they reach the breathing zone of workers. It is most effective as a control when it is applied close to the source of the biological hazard, so it can be removed before it has a chance to spread throughout the space”

When talking about local extraction ventilation, care must be taken with the quality of make-up air.

**Case study 14 – Laboratory technician**

Consider including an example of a commercial kitchen, with the kitchen exhaust system the LEV in this case. Commercial kitchens are far more common workplaces than laboratories.

Page 61 – “Air changes per hour (ACH) refers to the number of times the volume of air in a space is completely replaced per hour. Measuring a workspace’s ACH can help you determine how effective the ventilation in that space is.”

The unit of ACH does not take into account occupant density or duration in a building. A better metric employed under ASHRAE 241 is litres per second per person. Using this metric enables achieving targets (e.g., ~14–15 L/s per person, per Morawska et al. and ASHRAE 241) without necessarily increasing energy use via large make-up air volumes or deploying excessive portable units during high-risk periods. This unit of ventilation rate is recommended by both Morawska et. al. and ASHRAE for this reason.

**Air cleaning**

Page 62 – “high-efficiency particulate air (HEPA) filters can be used to filter larger particles, such as pollen, pet dander, dust and mould spores. HEPA filters can be installed into HVAC systems and portable air cleaning devices to improve indoor air quality when the system is operating.”

When talking about HEPA filters, their efficiency is high with small particles – the use of the word “larger” particles may be misleading.

Critically, a HEPA device must be correctly sealed. A HEPA filter installed in an unsuitable device or leaky housing will not deliver HEPA performance. Many mechanical systems are not designed for HEPA retrofits; adding them can alter building airflow.

Air-purification devices may create secondary pollutants unless tested; ozone-based devices can pose health risks unless proven intrinsically safe. This should be noted explicitly.

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**Appendix G**

Page 78 – Transmission through the air

General comment – There should be reference to airflow management and where this is not understood in a building, guidance given to mechanisms for assessing its flow.

We suggest providing guidance on airflow management and, where unknown, methods to assess airflow. Inclusion of a section on inspection and routine cleaning of HVAC (coils, drip pans, ducts, supply registers) against current practice standards appropriate to building use is important. As mentioned above, AIRAH's DA19 manual is the most widely used industry reference in Australia for maintenance of HVAC&R systems.

Procedures should be emphasised for inspection and routine cleaning of HVAC systems, particularly around cooling coils, drip pans, ducts and supply air registers, which may include inspection against current standard practices depending on the building use.

There needs to be a section on correctly managing events when buildings become contaminated through leaks, water ingress, flooding or high humidity and/or condensation to show compliance with IICRC S520 as it evolves.

**Appendix H – Examples of occupations at higher risk**

Page 84 - Under "Contact with contaminated environments..." add:

Occupational hygienists
Building biologists
Indoor air quality specialists
Restoration contractors
Insurance claim assessors
Construction / demolition contractors
Builders as high-risk groups when handling flood- and mould-contaminated materials.
Disaster relief workers
Add mechanical contractors and refrigeration and air conditioning technicians to ventilation engineers.