

## Study Guide – Applied Microbial Remediation Technician (AMRT)

This study guide is provided to you to complement the lecture and hands-on learning environment of the AMRT course. Please use this guide to become familiar prior to class with terms, formulas and basic information. When combining this pre-course study guide with classroom instruction and homework assignments, your exam should be easier with higher retention.

### Microbiology

#### Factors Effecting Fungal Growth

- Temperature
  - Most water damaged molds are categorized as Mesophilic because they grow best at room temperature. Optimal temperature range is 59°F – 86°F (15°C – 30°C)
- Light
  - Usually mold grows better in dark environments because there is more moisture available on surfaces and reduced airflow.
- pH
  - Most molds prefer a slightly acidic environment (slightly less than a pH of 7).
- Nutrients
  - Fungi cannot produce their own food and must rely on an external food source that is high in cellulose.
- Water
  - Unbound water is the most important factor that determines mold growth. Every species of mold requires a different amount of available moisture in order to grow.

#### Classifications of Mold

- Hydrophilic (Water Loving)
  - These molds require a water activity greater than  $a_w > 0.90$ . Some examples are *Fusarium*, and *Stachybotrys chartarum*. These molds require a tremendous amount of moisture. *Stachybotrys sp.* grows slower than other molds and usually takes 7-12 days to become visible. The presence of hydrophilic molds such as *Stachybotrys sp.* indicates chronic water damage
- Mesophilic
  - These mold types prefer moderately wet conditions and grow best at a water activity of 0.80 – 0.90 with an optimum  $a_w$  at 0.90. Examples of mesophilic molds are *Penicillium*, *Aspergillus*, *Cladosporium*, *Epicoccum* and *Alternaria*. Species of *Penicillium* and *Aspergillus* produce very small spores (between 2 and 7 microns) that are considered to be respirable. **Respirable particles** are 5 microns or less in size and can be breathed deeply into the lungs. *Penicillium* and *Aspergillus* molds can colonize (be visible) as soon as 48 – 72 hours and certain species are capable of producing potent mycotoxins. Some species of *Aspergillus* produce aflatoxins which are the most potent carcinogen (cancer causing) chemical known to man. Certain species of *Aspergillus* are considered to be pathogenic (can cause disease in humans) e.g. Aspergillosis is a respiratory disease caused when susceptible individuals are exposed to concentrations of

*Aspergillus fumigatus* which results in a “fungus ball”, a large fungal mass, growing in the respiratory system.

- **Xerotolerant**
  - These mold types prefer relatively dry conditions with a minimum  $a_w < 0.8$  optimum  $a_w > 0.8$ . Some examples of these mold types are *Aspergillus glaucus* and some species of *Penicillium*.
- **Xerophilic**
  - These mold types prefer very dry conditions with  $a_w < 0.80$  and can colonize dry materials such as high-sugar foods and some building materials. A few examples of Xerophilic molds are some species of *Aspergillus* and *Penicillium*.

### Occupational Exposure

- **Dermal** - Exposure occurs from absorption through the skin or mucous membranes such as the eyes, nose and mouth or abrasions of the skin.
- **Inhalation** - This is the primary route of exposure to mold.
- **Ingestion** - This is the primary route of entry to category 3 water due to poor hygiene practices (not washing hands, eating, and smoking on the job site).
- **Injection** - This is an injury that punctures the skin and allows for pathogens to enter into the body.

### Common Health Effects Associated with Water Damaged Environments

- **Allergic disease** - Common cold and flu-type symptoms, asthma and chronic sinus infections are the most common types of health effects reported from mold exposure.
- **Toxic disease** - Histoplasmosis and meningitis can occur by inhaling the spores present in bird and bat droppings.
- **Infectious disease** - Ringworm and athlete’s foot are both fungal infections.
- **Hypersensitivity disease** - When the individual is removed from the environment, their symptoms disappear. Each time they are re-exposed to the contaminated environment their symptoms may appear much quicker and become more severe because the individual is hypersensitized.

### Primary Sewage Biohazards

1. Virus
  - a. Rotavirus
  - b. *Hepatitis A*
  - c. Adenovirus
  - d. G.I. viruses
2. Bacteria
  - a. *E. coli*
  - b. *Salmonella*
  - c. *Shigella*
  - d. *Pseudomonas*
3. Parasites

### High Risk Populations

1. Elderly

2. Children Under 2
  - a. faster metabolic rate
  - b. lower body weight
  - c. faster respirations
  - d. immature immune/respiratory systems.
3. Pregnant women in the first trimester
4. Immunocompromised individuals

### **Terms and Definitions**

- **Mold** - A common term for filamentous fungi, often seen as a superficial or “wooly” growth of long chains of fungi cells formed on damp organic materials.
- **Mildew** - A white growth on plant surfaces produced by parasitic fungi.
- **Spores** - A dormant viable or non-viable reproductive unit from which fungi or bacteria germinate when appropriate growth conditions are met.
- **Hyphae** - Root like structures that grow in and on building materials, that have sufficient moisture and nutrients (cellulose) which allow the organism to grow.
- **Mycotoxins** - Toxic chemical that is located outside or inside of fungal spores and hyphae, which can cause adverse health effects when occupants are exposed.
- **Sporulation** - The process by which fungi produce and release fungal spores.
- **Microbial Volatile Organic Compounds (MVOCs)** - Chemicals that are produced during fungal metabolism as a waste by-product. The chemicals that are released cause the musty odor that is present in buildings with active or past fungal growth.
- **Viable** - Spores that have the ability to germinate given the right conditions.
- **Hydrophobic** – “Fear of water”
- **Exotoxins** - Proteins produced inside bacteria and are secreted into the external environment.
- **Endotoxins** - Complex carbohydrates and protein products that are present in the cell wall of certain bacteria.
- **Endospores** - Dormant bacterial structures that require a host to actively grow.

### **Structural Remediation**

#### **S500 and S520 Standard Definitions**

- **Shall** - When the term shall is used in this document, it means that the practice or procedure is mandatory due to natural law or regulatory requirement, including occupational, public health and other relevant laws, rules or regulations, and is therefore a component of the accepted “standard of care” to be followed.
- **Should** - When the term should is used in this document, they mean that the practice or procedure is a component of the accepted “standard of care” to be followed, while not mandatory by regulatory requirements.
- **Recommend(ed)** - When the term recommend(ed) is used in this document, it means that the practice or procedure is advised or suggested, but is not a component of the accepted “standard of care” to be followed.
- **May** - When the term may is used in this document, it signifies permission expressed by the document, and means that a referenced practice or procedure is permissible within the

limits of this document, but is not a component of the accepted “standard of care” to be followed.

- **Can** - When the term can is used in this document, it signifies an ability or possibility open to a user of the document, and it means that a referenced practice or procedure is possible or capable of application, but is not a component of the accepted “standard of care” to be followed

#### **Category of Water:** (the “source” of the **water intrusion**)

- **Category 1** – originates from a sanitary water source
- **Category 2** – contaminated; potentially causes discomfort or sickness
- **Category 3** – grossly contaminated; includes toxins, pathogens
- **Regulated or hazardous materials and mold** (creating special situations) – IEP recommended

#### **Conditions (Fungal Levels):**

- **Condition 1** – normal fungal ecology
- **Condition 2** – settled spore and fragments resulting from a Condition 3
- **Condition 3** – actual growth

#### **Minimal Microbial Remediation Sequence:**

- Identify and Correct the source
- Containment
- Negative air / Pressure differential
- Remove contaminated materials
- Clean
- Post-remediation evaluation / verification

#### **Content Inspection and Remediation**

- Complete detailed inventory
- Inspect and sort
- Avoid cross contamination in all processes
- Store in clean controlled environment

#### **Remediation tools and equipment:**

- **Air Filtration Device** – air moving device with pre-filter, secondary filter and HEPA filter. Can be configured as an air scrubber or negative air machine.
  - **Negative Air Machine** – air filtration device configured to create negative pressure by exhausting air from a contained area. Recommended at -5 Pascals (-0.02 Inches water column)
  - **Air Scrubber** – air filtration device configured to filter and recirculate air within an area to remove contamination from the air
- **Manometer** – measures the static air pressure differential between two spaces
- **HEPA Vacuum** – HEPA filtration vacuum used to remove contaminants from materials and contents

## Hazards of Negative Air Pressure

- Back Drafting - Bringing carbon monoxide into containment
- Flame roll-out - Drawing natural gas from gas appliances into containment
- Collapse - Insufficient make-up air results in containment failure
- Cross Contamination - Bringing in contamination or moisture from undesirable places

## Definitions and Terms:

- Source – May be used to address relatively small areas of mold growth or in combination with other engineering controls.
- Local – May be used when moderate levels of fungal growth are visible or suspected.
- Full – Used when significant or extensive mold growth is present or suspected.
- Decontamination Chamber – Transition between contaminated and non-contaminated areas, also used to decontaminate equipment, don and doff PPE.
- Supplemental Air Filtration – Engineering control providing a source of filtered make up air to enter into the containment chamber.
- Contaminant – Any physical, chemical, biological, or radioactive substance that can have an adverse effect on air, water, soil, or on any interior or exterior surfaces.
- Limitations – Restrictions that are placed upon the remediator resulting in a limit on the scope of work.
- Complexities – Conditions that cause the project to become more difficult, but does not prevent the work from being performed.
- Complications – Conditions that arise after the start of the work that cause a change in the scope.
- Conflicts – A disagreement between the remediator and the customer.
- Respirable - Particles that are 5 microns or less in size and can be breathed deeply into the lungs.

## Moisture

Equilibrium Relative Humidity (ERH) can be compared to the water activity ( $a_w$ ) of a material and may be considered another name for water activity. ERH is the relative humidity taken at the surface (a.k.a. boundary layer). When calculating between ERH and water activity, the ERH is always reported as a %. To convert to water activity, divide the ERH by 100. For example, 80% ERH at the surface =  $a_w$  of 0.8

## Numbers and Acronyms

- **Micron ( $\mu$ )** – 1/1,000,000 of a meter
- **2 – 20 microns** – Size of spores common in water damaged buildings
- **20%** – Moisture Content for rotting fungi growth *IN* wood
- **16%** – Moisture Content for non-rotting fungi growth *ON* wood)
- **AFD** – Air Filtration Device
- **ACH** – Air Change per Hour
- **CFM** – Cubic Feet per Minute

- **IAQ** – Indoor Air Quality
- **NAM** - Negative Air Machine
- **LCCC** – Limitations, Complexities, Complications, Conflicts
- **PAPR** – Powered Air Purifying Respirator
- **APR** – Air Purifying Respirator
- **HEPA** – High Efficiency Particulate Air
- **NADCA** – National Air Duct Cleaners Association
- **HVAC** – Heating Ventilating Air Conditioning
- **IEP** – Indoor Environmental Professional
- **ERH** – Equilibrium Relative Humidity

## **Safety and Health**

Due Diligence: Employers must provide a safe work environment free from hazards that could result in employee injury, illness or death.

Protection Factor: How respirators are rated based on the protection they provide to the wearer

Respiratory Protection Programs Shall Include:

- Written plan
- Medical Evaluation
- Fit Testing / Training

Proper doffing sequence of PPE

- Remove disposable coveralls and attached outer gloves
- Remove respirator
- Remove inner gloves

## **Chemicals / Biocides (Antimicrobial Biocides)**

### **Definitions and Terms**

- **Biocide:** A chemical or physical agent (pressure or heat) capable of killing or inactivating one or more groups of microorganisms.
- **Sanitizers:** A chemical or physical agent that reduces the number of vegetative environmental bacteria that are of public health importance.
- **Disinfectants:** A chemical or physical agent that kills or inactivates at least 99.9% of disease producing (pathogenic) microorganisms on surfaces.
- **Sterilizers:** A chemical or physical agent that completely kills or inactivates all forms of microbial life including fungi, viruses, and all forms of bacteria and their spores.
- **Antimicrobial Agents:** A chemical formulation incorporated or applied onto a material or product to suppress bacterial and fungal growth as it occurs. (Biostat, Bacteriostat, fungistat etc.)
- **Chemical Release** - Written informed consent to customer; advise occupants to leave during application; document
- **Government-registered disinfectants** – Document application details; apply only per label directions

**Mold Remediation Formulas – Imperial (USA or Canada)**

Note: Canada uses both the imperial and metric formulas.

1.  $CFM \times 60 \div \text{Cubic Footage} = \text{Total ACH}$

CFM	x 60	÷ Cubic Footage	= <b>Total ACH</b>

2.  $\text{Cubic Footage} \times \text{ACH} \div 60 = \text{Total CFM Recommendation}$

Cubic Footage	x ACH	÷ 60	= <b>Total CFM</b>
		÷ 60	

3.  $\text{Cubic Footage} \times \text{ACH} \div 60 = \text{Total CFM Recommendations}$   
 $\text{Total CFM Recommendation} \div \text{AFD rating} = \# \text{ of AFDs}$

Cubic Footage	x ACH	÷ 60	= Total CFM
		÷ 60	

Total CFM Recommendation	÷ AFD Rating	= <b>Total Number AFDs</b>

**CF = cubic footage (ft<sup>3</sup>) \*\*ACH = air changes per hour \*\*CFM = cubic feet per minute**

**Mold Remediation Formulas – Metric (Canada, Australia, New Zealand, and Japan)**

For many in areas of Australia, New Zealand and Japan, Air Filtration Devices arrive still in CFM. So, this creates a drama as they are measuring the area of space in metric.

Metric measurement to Imperial conversion for those that have AFDs in CFM will need to convert cubic meterage into cubic feet.

**Conversion - Multiply the cubic meterage volume by 35.31 to achieve cubic feet.**

1.  $CFM \times 60 \div (m^3 \times 35.31) \text{ ft}^3 = \text{Total ACH}$

CFM	x 60	÷ (m <sup>3</sup> x 35.31) ft <sup>3</sup>	= <b>Total ACH</b>

2.  $(m^3 \times 35.31) \times ACH \div 60 = \text{Total CFM Recommendation}$

(m <sup>3</sup> x 35.31)	x ACH	÷ 60	= <b>Total CFM</b>
		÷ 60	

3.  $(m^3 \times 35.31) \text{ ft}^3 \times ACH \div 60 = \text{Total CFM Recommendations}$   
 Total CFM Recommendation ÷ CFM of Machine = # of AFDs

(m <sup>3</sup> x 35.31) ft <sup>3</sup>	x ACH	÷ 60	= Total CFM
		÷ 60	

Total CFM Recommendation	÷ CFM of Machine	= <b>Total Number AFDs</b>

**\*\*ACH = air changes per hour \*\*CFM = cubic feet per minute**

**Mold Remediation Formulas – Metric (UK and Europe)**

Since these areas above, Britain and Europe get Air Filtration Devices in CMH, this needs allowance for.

**Metric measurement for those using AFDs in CMH**

1.  $CFM \times 60 \div \text{Cubic Meterage} = \text{Total ACH}$

CFM	x 60	$\div m^3$	= <b>Total ACH</b>

2.  $\text{Cubic Meterage} \times \text{ACH} \div 60 = \text{Total CFM Recommendation}$

$m^3$	x ACH	$\div 60$	= <b>Total CFM</b>
		$\div 60$	

3.  $\text{Cubic Meterage} \times \text{ACH} \div 60 = \text{Total CFM Recommendations}$

$\text{Total CFM Recommendation} \div \text{AFD rating} = \text{\# of AFDs}$

$m^3$	x ACH	$\div 60$	= Total CFM
		$\div 60$	

Total CFM Recommendation	$\div$ AFD Rating	= <b>Total Number AFDs</b>

**\*\*ACH = air changes per hour \*\*CFM = cubic feet per minute**