Thank you for choosing Restoration Sciences Academy for your educational opportunities. Our mission is to provide the best restoration solutions for you, our customer. We look forward to getting to know you better during the class. To help you prepare for your upcoming class, we are providing this study guide. Familiarize yourself with the material in this study guide. It is material you should remember from your previous courses and experience.

Until then,

The RSA Staff

General Information

**Class Time:** 8:00 am – 5 pm

- **Monday, Tuesday, Wednesday, Thursday** - 8 am – 5 pm The WRT test will begin Thursday around 2 pm.
- **Friday 8:00 am** the ASD test will begin around 2 pm.

If you are already WRT Certified you are not required to re-test, however you must attend all 5 days of a COMBO class.

**Attire:** Dress comfortably; this is a hands on class.

- Room temperature will vary; wearing layers will provide more comfort.

**IICRC Test Fee:** $65.00 per test is not included in your registration fee.

- You may use Visa, MC and AMEX or check payable to IICRC. **No Cash Please.**
### Numbers and Letters to Remember

- One pound of air is approximately 14 cubic feet in size
- 7000 grains are in 1 pound
- 1 cubic foot of water contains 7.48 gallons
- One gallon of water weighs 8.34 pounds
- One ton of air conditioning is approximately 12,000 BTUs
- All structure items should be dried to within 4% points of EMC
- 16% MC and higher supports mold growth on the surface of wood.
- 20% MC supports dry rot in wood
- 30% MC is wood fiber saturation point and supports wet rot
- 80°F / 60% RH is the AHAM test condition for dehumidifiers
- 80% rule – Don’t use more than 80% of the available power on a circuit.
- HEPA filters 99.97% of all particles down to 0.3 microns
- 55 GPP is the lower limit for performance from conventional dehumidifiers
- 34 GPP is the lower limit for performance from LGR dehumidifiers
- S-500 is the Standard of Care in the water restoration industry
- IEP = Indoor Environmental Professional
- ACM = asbestos containing material
- EMC = equilibrium moisture content
- MDF = medium density fiberboard
- AHAM = Association of Home Appliance Manufacturers
- AFD = air filtration device
- CFM = cubic feet per minute
- ACH = air changes per hour = AEH = air exchanges per hour

### Formulas to Remember

<table>
<thead>
<tr>
<th>Performance of a dehumidifier from grain depression and CFM</th>
<th>Grain depression x CFM ÷ 71 = Pints per day</th>
</tr>
</thead>
<tbody>
<tr>
<td>BTUs of heat produced by equipment</td>
<td>Amps x volts x 3.4 = BTUs per hour</td>
</tr>
<tr>
<td>Electrical cost per day for equipment</td>
<td>Amps x volts x 24 ÷ 1000 x cost per kwh = cost per day</td>
</tr>
</tbody>
</table>
Definitions to Remember

Relative Humidity: The amount of water vapor in air expressed as a percentage of the air sample’s total holding capacity.

Humidity ratio: a measurement of water vapor weight in a given volume of air. Measured in grains per pound (GPP)

Dew Point: Temperature at which air can hold no more moisture. (Relative humidity at dew point is 100%.)

Vapor Pressure: Pressure of water vapor on surrounding surfaces and objects, measured in inches of mercury. Directly related to GPP and dew point.

Vapor Diffusion: Movement of water vapor through a material.

Permeance: A measure of the ability for vapor to travel through a material.

Vapor Barrier: material with a permeance of 1.0 or less.

Grain Depression: Difference in GPP of the air entering and air leaving a dehumidifier – an indicator of dehumidifier performance.

Closed Drying System: System of drying where the structure is kept closed to outside air. Used because of security reasons and/or unfavorable outdoor air, or when access to outdoor air is prevented.

Open Drying System: System of drying where outdoor air is used. Among other considerations, outdoor air should have a significantly lower GPP than the indoor air.

Combination Drying System: System of drying where some outdoor air is used with dehumidification to accelerate drying. System can include flushing the air, negative pressurization and/or utilizing a small opening to the outside.

Sanitizer: A chemical which reduces the amount of microorganisms on a surface, but does not eliminate all microbial life.

Disinfectant: A chemical which kills all forms of microbial life, but not the microbial spores.

Sterilizer: A chemical which kills all forms of microbial life, including their spores.

Moisture Content: Percentage of moisture in wood when compared to an oven-dried sample. Expressed in percentage of the dry weight.

Hygroscopic: Materials that readily absorb or release moisture based on the surrounding humidity.

AHAM: Association of Home Appliance Manufacturers. Publishes test results for water removal of dehumidifiers at conditions of 80°F/60%RH over 24 hours.

Delamination: the separation of the primary and secondary backing of carpet

Shall: A guide word in an IICRC standard that means that the practice of procedure is mandatory due to natural law or legal requirements.

Should: A guide word in an IICRC standard that means that the practice is a critical procedure to be followed, but not required by natural law or legal requirements.

Recommended: A guide word in an IICRC standard that means that the practice is advised or suggested, while not a part of the standard of care.

Moisture content: The amount of moisture in a material compared to the material’s oven dried weight.

Moisture content gradient: differences in moisture in different areas of a material

Evaporation: Liquid changing to a vapor

Condensation: vapor changing to a liquid

Infiltration: When air comes in to a structure through cracks and openings in the building. Usually due to a negative pressure.

Exfiltration: When air leaves a structure through cracks and openings in the building. Usually due to a positive pressure.

Moisture Map: drawings of affected rooms or areas with corresponding moisture levels
**Important Concept: Determining the Category of Water**

The category of water loss describes the amount of contamination in the loss area. Water category is the basis for decision making on materials which should be dried. It is also important for determining safety procedures on each water loss.

**Category 1** - Category 1 water originates from a sanitary water source and does not pose substantial risk from dermal, ingestion, or inhalation exposure. Examples of Category 1 water sources can include: broken water supply lines; tub or sink overflows with no contaminants; appliance malfunctions involving water-supply lines; melting ice or snow; falling rainwater; broken toilet tanks, and toilet bowls that do not contain contaminants or additives.

Category 1 water can deteriorate to Category 2 or 3. Odors can indicate that Category 1 water has deteriorated.

**Category 2** - Category 2 water contains significant contamination and has the potential to cause discomfort or sickness if contacted or consumed by humans. Category 2 water can contain potentially unsafe levels of microorganisms or nutrients for microorganisms, as well as other organic or inorganic matter (chemical or biological). Examples of category 2 water can include, but are not limited to: discharge from dishwashers or washing machines; overflows from washing machines; overflows from toilet bowls on the room side of the trap with some urine but no feces; seepage due to hydrostatic pressure; broken aquariums and punctured water beds.

Category 2 water can deteriorate to Category 3.

**Category 3** - Category 3 water is grossly contaminated and can contain pathogenic, or other harmful agents and can cause significant adverse reactions to humans if contacted or consumed. Examples of Category 3 water can include, but are not limited to: sewage; waste line backflows that originate from beyond any trap regardless of visible content or color; all forms of flooding from seawater; rising water from rivers or streams; and other contaminated water entering or affecting the indoor environment, such as wind-driven rain from hurricanes, tropical storms, or other weather-related events. Category 3 water can carry trace levels of regulated or hazardous materials (e.g., pesticides, or toxic organic substances).

**Regulated, Hazardous Materials, and Mold** - If a regulated or hazardous material is part of a water damage restoration project, then a specialized expert may be necessary to assist in damage assessment. Regulated materials posing potential or recognized health risks can include, but are not limited to: arsenic, mercury, lead, asbestos, polychlorinated biphenyls (PCBs), pesticides, fuels, solvents, caustic chemicals and radiological residues. For situations involving visible or suspected mold, refer to the current version of IICRC S520 *Standard and Reference Guide for Professional Mold Remediation*. Qualified persons shall abate regulated materials, or should remediate mold prior to restorative drying.

Determining the Class of Water

**Class of water intrusion** - a classification of the estimated evaporation load; is used when calculating the initial humidity control (e.g., dehumidification, ventilation). The classification is based on the approximate amount of wet surface area, and the permeance and porosity of affected materials remaining within the drying environment at the time drying is initiated. Information needed to determine Class should be gathered during the inspection process. The Classes are divided into four separate descriptions, Class 1, 2, 3, and 4.

**Class 1** - (least amount of water absorption and evaporation load): Water intrusion where wet, porous materials (e.g., carpet, gypsum board, fiber-fill insulation, concrete masonry unit (CMU), textiles) represent less than ~5% of the combined floor, wall and ceiling surface area in the space; and where materials described as low evaporation materials (e.g., plaster, wood, concrete, masonry) or low evaporation assemblies (e.g., multilayer wallboard, multilayer subfloors, gym floors, or other complex, built-up assemblies) have absorbed minimal moisture.

**Class 2** - (significant amount of water absorption and evaporation load): Water intrusion where wet, porous materials (e.g., carpet, gypsum board, fiber-fill insulation, concrete masonry unit (CMU), textiles) represent ~5% to ~40% of the combined floor, wall and ceiling surface area in the space; and where materials described as low evaporation materials (e.g., plaster, wood, concrete, masonry) or low evaporation assemblies (e.g., multilayer wallboard, multilayer subfloors, gym floors, or other complex, built-up assemblies) have absorbed minimal moisture.

**Class 3** - (greatest amount of water absorption and evaporation load): Water intrusion where wet, porous materials (e.g., carpet, gypsum board, fiber-fill insulation, concrete masonry unit (CMU), textiles) represent more than ~40% of the combined floor, wall and ceiling surface area in the space; and where materials described as low evaporation materials (e.g., plaster, wood, concrete, masonry) or low evaporation assemblies (e.g., multilayer wallboard, multilayer subfloors, gym floors, or other complex, built-up assemblies) have absorbed minimal moisture.

**Class 4** - (deeply held or bound water): Water intrusion that involves a significant amount of water absorption into low evaporation materials (e.g., plaster, wood, concrete, masonry) or low evaporation assemblies (e.g., multilayer wallboard, multilayer subfloors, gym floors, or other complex, built-up assemblies). Drying may require special methods, longer drying times, or substantial water vapor pressure differentials.

Determining How Many Airmovers to Place
Determining the proper number of airmovers is a simple, step-by-step process thanks to the S500 4th edition. Always determine airmovers by individual room, not by zone or entire affected area, and always round decimals up. Small rooms, less than 25 SF, may only need a single airmover, especially if walls and ceiling are not affected. The steps are:

1. Place one airmover for each area affected, PLUS
2. Add one airmover for every 50-70 square feet, PLUS
3. Add one airmover for every inset or offset greater than 18 inches PLUS
4. Add one airmover for every 150 square feet of affected wall and ceiling surface above two feet.

Example: This room is a floor level loss. No walls are wet above two feet. For this example space, 6 to 7 airmovers would be placed to start. One for the room itself, four or five for the floor space, plus one more for the closet. The small inset on the bottom right doesn’t need an airmover because it is smaller than 18 inches.

<table>
<thead>
<tr>
<th>Step</th>
<th>Airmovers</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>This is one room, so we start with one airmover.</td>
</tr>
<tr>
<td>2</td>
<td>4-5</td>
<td>The room has 224 sf of floor area. 15’ x 15’=225 sf – 1 sf= 224 sf 224÷70 = 3.2 which rounds up to 4 224÷50 = 4.5 which rounds up to 5</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>One airmover is needed for the closet. The small inset of 1’ x 1’ doesn’t need an airmover</td>
</tr>
<tr>
<td>4</td>
<td>0</td>
<td>The walls aren’t wet above two feet</td>
</tr>
</tbody>
</table>

Determining How Many Dehumidifiers to Place

The science of drying has advanced to a point where a restorer can apply a few simple factors and know that a balanced drying system is being created. The factors to be applied are:

1. Volume (cubic feet) of air to be dehumidified: can be determined by multiplying length x width x height in the area.
2. Classification of water loss. This will be class 1, 2, 3 or 4.
3. Factor from the dehumidifier factors chart. These factors are based on how many pints need to be removed from each cubic foot of air, or, in the case of desiccants, the number of air exchanges per hour needed.
4. Do the Math! Use the formulas below:

<table>
<thead>
<tr>
<th>Dehumidifier Factors Chart</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td>Conventional Refrigerant</td>
</tr>
<tr>
<td>Low Grain Refrigerant</td>
</tr>
<tr>
<td>Desiccant</td>
</tr>
</tbody>
</table>

For LGRs and Conventional refrigerator dehumidifiers, the math is:

\[
\text{cubic feet} \div \text{factor} = \text{AHAM pints required}
\]

For desiccant dehumidifiers, the math is:

\[
\text{cubic feet} \times \text{factor} \div 60 = \text{CFM required}
\]

Once it is known how many AMAM pints or CFM are required, simply determine the number of dehumidifiers needed to cover the required capacity. For example, if 330 AHAM pints are required, and 100 pint dehumidifiers are available, 4 dehumidifiers would be needed.

Dehumidifier Example Problems

Question 1: When using conventional refrigerant dehumidifiers in a "class 3" water loss containing 15,000 cubic feet, the initial AHAM rated capacity required is about:

Answer:

1. Cubic Footage: 15,000 cubic feet
2. Class: 3 (given in the problem)
3. Factor: 30 (conventional refrigerant and class 3 from the chart)
4. Math:  
   \[
   \text{cubic feet} \div \text{factor} = \text{AHAM capacity required.}
   \]
   
   \[
   15,000 \div 30 = 500 \text{ AHAM pints}
   \]
Question 2: When using low grain refrigerant (LGR) dehumidifiers that remove 80 pints when tested at AHAM conditions, the number installed initially on a class 1 water loss with 16,500 cubic feet is:

Answer:

1. Cubic Footage: 16,500 cubic feet
2. Class: 1 (given in the problem)
3. Factor: 100 (LGR and class 1 from the chart)
4. Math: cubic feet ÷ factor = AHAM capacity required
   
   16,500 ÷ 100 = 165 AHAM pints

   165 AHAM pints are needed. 80 pint LGR dehumidifiers are being used. If two were used, that would only achieve 160 AHAM pints. Therefore, three 80 pint LGRs are needed. Always round up.

Question 3: When using desiccant dehumidification in a class 4 water loss with low permeance/porosity materials (plywood, concrete, no wet carpet/pad) in a 3,000-square-foot restaurant with 10-foot ceiling height, the initial CFM required is:

Answer:

1. Cubic Footage: 30,000 cubic feet (3000 x 10)
2. Class: 1 (“low permeance/porosity…no wet carpet/pad”)
3. Factor: 1 (desiccant and class 1 from the chart)
4. Math: cubic feet x factor ÷ 60 = CFM required

   30,000 x 3 ÷ 60 = 1,500 CFM
### Determining Electrical Cost per Day
In order to know how much electricity is costing the customer, use the following formula:

\[
\text{amps} \times \text{volts} \times 24 \div 1000 \times \text{cost per kWh} = \text{cost per day}
\]

The factors of the electrical usage formula are:

- “24” converts hours into days
- “1000” converts watts into kilowatts
- “cost per kwh” is the local electrical cost per kWh

**Question:** Six 2 amp airmovers and one 7 amp dehumidifier at 115 volts are used in a city where each kWh of electricity costs $.08. What is the cost per day for this equipment per day?

**Answer:** The equipment all together uses 19 amps of electricity at 115 volts. Plug all the factors in the formula:

\[
19 \text{ amps} \times 115 \text{ volts} \times 24 \div 1000 \times 0.08 = 4.20
\]

### Determining How Much Heat Equipment Produces
All electrical devices produce heat as a by-product of using electricity. The amount of heat produced is measured in British Thermal Units (BTUs). A BTU is a specific unit of heat. If BTUs are added to the environment, the temperature will rise. If BTUs are removed, the temperature will fall. 12,000 BTUs is called a “ton” of heating or air conditioning.

Determining the number of BTUs produced by restoration equipment is easy. The simple formula is

\[
\text{amps} \times \text{volts} \times 3.4 = \text{BTUs per hour}
\]

**Question:** Fifteen 3 amp airmovers and two 8 amp dehumidifiers at 115 volts are used on a restorative drying job. How many BTUs are produced by this equipment? How many tons of air conditioning would be needed to offset the heat from this equipment?

**Answer:** A total of 61 amps are being used and inserting the factors into the formula:

\[
61 \text{ amps} \times 115 \text{ volts} \times 3.4 = 23,851 \text{ BTUs per hour}
\]

Each ton of air conditioning offsets 12,000 BTUs of heat, therefore 2 tons of air conditioning are needed to offset 23,851 BTUs of heat.
Our Industry Needs Documentation
Are you certain that every water damage restoration job you’ve handled was left completely dry? Of those you’re not absolutely certain of, how many have the potential to return as a mold remediation job? Even if you are positive, what happens if mold occurs in a building for reasons unrelated to the water damage you handled? Do you have the documentation to clearly show that your firm is not at fault?

Change in our industry has become a runaway train. Driven by a need for more information and fueled by the importance of indoor air quality, new research facilities are producing ideas never before available. The equipment we use is constantly evolving as we learn more about the science of restoring a water-damaged building. Because it is running on the hardened tracks of past mistakes in our field, this locomotive will either carry you to the next stop or leave you behind at the station.

Knowledge has never been so vital to restorative drying. Our drying decisions must be made on a case-by-case basis, founded on a proper diagnosis for each structure, water loss and claim. The good news is that we now have the ability to make those decisions. The information is here! However, in order to understand the decisions we need to make we must clearly define what we are trying to accomplish.

The Goals of Restorative Drying
As restorative drying contractors, our goal is to return the structure to equilibrium with the environment as quickly as possible without causing any additional damage. Throughout this process we must continually evaluate the cost of restoration versus the cost of replacement on each component within the building—from carpet and pad to drywall, baseboards, furnishings and other contents.

The keyword is “restorative.” Restoration of carpet, pad, drywall and baseboard is one of the fastest changing areas in our industry. The evolution of less disruptive drying methods have enabled us to do more restoring and less reconstruction and replacement. The more we learn about the various materials in the homes we dry, the more we are able to prevent secondary damage from water contact. Instead of automatically replacing materials, we can cost-effectively dry them.

Several benefits result from using less disruptive drying methods. Insurance adjusters spend less time and money replacing components and contents so their claims can close much faster than previously possible. Homeowners return to their normal lives faster with fewer disruptions added to an already traumatic experience. Restoration companies generate more rental revenue from their drying equipment and increase overall profit margins.
With the heightened awareness of mold growth associated with water damage, however, the innovation of less disruptive drying can be hard to sell. And if not executed properly, it will likely cause problems. A thorough understanding of the science and principles of restorative drying is absolutely critical, as is complete and proper documentation.

**Four Knows of Drying**

What you know limits what you can do. The decisions you make about the equipment you place, the materials you remove and those you dry starts with knowing what is wet, how wet, and how well it will dry.

As with a medical exam, proper restoration begins and ends with knowing what is happening on the jobsite. A doctor first looks at all the signals and symptoms before he or she gives a diagnosis. Once diagnosed, careful attention is given to the prescription or treatment to ensure that the patient responds well. Doctors always look for the treatment option that is least disruptive to each patient with the least possibility of “secondary damage.” Once treatment is prescribed, it is clearly documented. The treatment is administered, and then a follow up is scheduled. The physician ensures that the treatment has been effective, and again it is documented.

Medicine is a very mature industry with an abundance of research, trial and error, development and history to back it up. By comparison, water damage restoration is a young industry. But it is beginning to mature, and we need to be able to provide a clear, understandable and necessary service. Our decisions must show sound reasoning and the results must be clearly documented.

Your documentation and decision process boils down to four simple “knows” of drying:

**First, “What is wet?”**

As simple as it sounds, this is where many of us get off track. Is the sill wet? Is the insulation wet? Is there moisture in the subfloor beneath the cabinets? Is the exterior sheathing wet? Is it wet beneath the bathtub?

Proper training and professional meters are necessary to locate every area of the structure that the water has migrated to. If one area remains undiscovered, you leave the potential for microbial activity and other secondary damage.
Second, "How wet is it?"
It is never enough to know just what parts of the structure are wet. Without quantification, you cannot make proper decisions or check your progress. Moisture in the structure should be documented in a way that shows “how wet,” rather than simply “wet” or “dry.” As with the physician’s diagnosis, just plain “sick” is never good enough.

Third, “Is it drying?”
This is where most of the decisions start rolling in. Progress is the key. As long as you can document and follow up on your progress, you know that you prescribed the correct treatment. If you don’t see any progress, you have two choices. Either apply a more aggressive drying method (providing that material value supports it) or get more disruptive to the structure itself by making holes, removing materials, perforating, etc. (providing that repair costs are less than aggressive drying techniques).

Fourth, “Is it done?”
Again, this step sounds deceptively simple. But if it’s not thoroughly dry and properly documented, you leave yourself open to expensive lawsuits in the future. Million dollar lawsuits have been successfully brought against restoration contractors who skipped this last step. The moisture levels upon completion of every water damage job should be documented as "within 4 percentage points of dry standard" according to the latest IICRC S500 Standard and Reference Guide for Professional Water Damage Restoration. Every area you marked as "wet" in step one should clearly indicate acceptable moisture levels when you finish.

Most other service providers include clear documentation showing the result of the work completed. The same is now being expected of us. The demand for proof will only get stronger with each incomplete water damage job and related lawsuit.

Progressive change is an opportunity to set your organization apart from the competition. You have the opportunity to take your business to the next level and stay in control of the locomotive, not left in the tracks behind it. Use the “Four Knows of Drying” to clearly document each restoration claim you handle. You will not only be able to make more effective, confident decisions, but will also have the security of defense just in case mold is ever found in a home that your firm handled. If you can show that you left it dry, you can avoid a costly finding against you. Without clear documentation you have no defense.