loggers midway between the floor and top shelf or ceiling, unless you have very tall bays of shelving and stratification is a concern. Avoid placing loggers near outside doors, air vents, radiators, cold walls, fans, and other sources of heated, cooled, dehumidified or humidified air.

It is important to measure temperature and humidity routinely, although in most cases it isn't necessary to download the data daily or even weekly – every few months is usually fine. It is important however to gather data from each location for at least one year so that the data you analyze covers the change of seasons (both heating and cooling seasons). Assign each monitor to a single collection area and leave it in place for a full year. Data collected over a short period of time has limited value for analysis.

3D Additional Considerations when Selecting Environmental Monitoring Devices

Desirable characteristics in an environmental monitoring device include simplicity of use, accuracy, overall expense, and the ease of data transfer to the computer where interpretation and graphing of the data will take place. The overall expense factor includes the cost of associated software, the cost and frequency of recalibration, and the time needed to set up, deploy, and periodically collect data from the loggers.

In June 2008, IPI developed a datalogger comparison table, which is available for review at https://www.imagepermanenceinstitute.org/environmental/datalogger-comparison. In 2011, conservator Rachael Perkins Arenstein researched the most commonly used data management tools and produced a document comparing dataloggers for museum monitoring for the National Park Service which is available at http://www.nps.gov/museum/publications/conserveogram/03-03.pdf.

Finally, consider how you will use and interpret the data you collect. Too often people focus on the price of the monitoring hardware and assume that once they have environmental data, its meaning will magically become clear. The reality is that making sense of data and putting it to practical use has always been the most difficult part of monitoring. See Chapter 6, Analyze Collected Data for more information on getting useful information from the data you have collected.

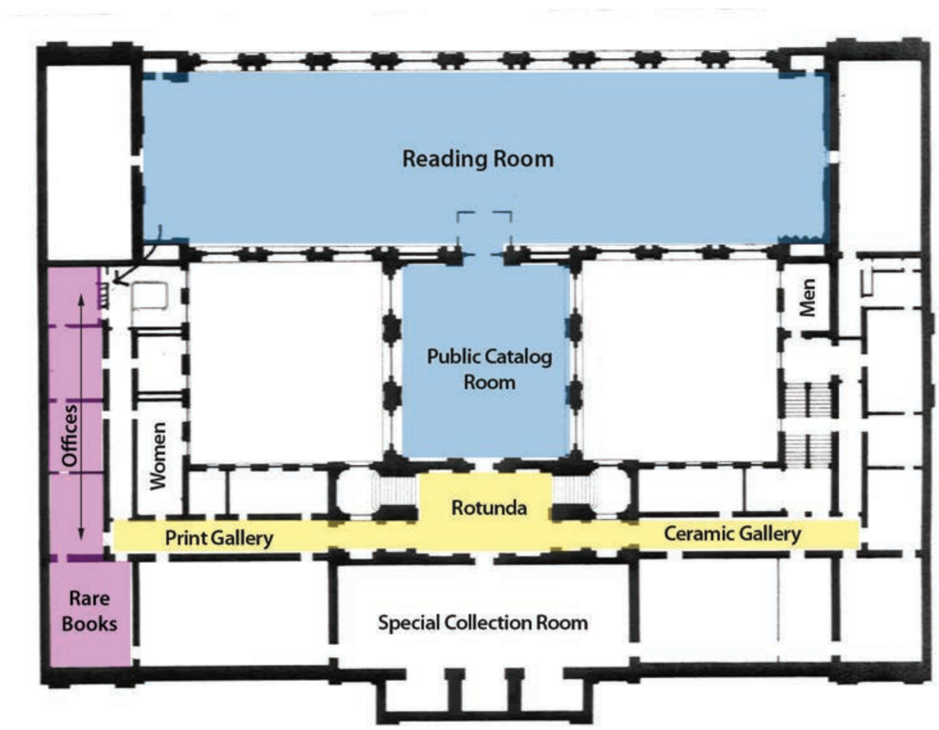
CHAPTER 4: Document Each Storage Facility's Mechanical System

To achieve an optimal and sustainable storage environment it is very important to develop a clear understanding of the HVAC equipment that serves your storage areas. Work with facilities staff to create floor plans identifying the AHU that serves each storage area and an associated list of the areas served by each AHU. It is also instructive to prepare schematic diagrams which follow the air stream loop from the point it leaves the storage space by passing through the return air grills, moves along the return air path to the AHU, and then returns through the supply air ducts to re-enter the storage space via the supply air grills.

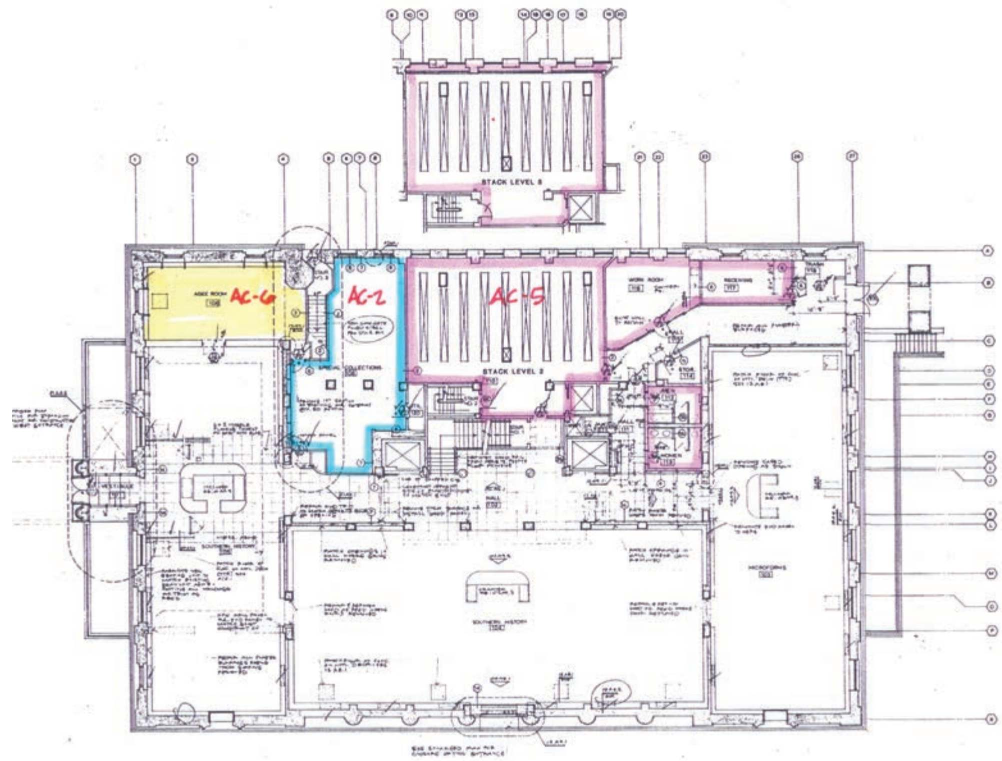
4A Create Floor Plans Indicating Collection Areas and HVAC Zones

We suggest that collection and facilities staff work together to create the mechanical system documentation described in this section. Start with either a basic floor plan of your institution, or a more detailed architectural drawing of each floor that contains storage or exhibition areas. The areas served by each AHU can be determined by studying the duct paths shown on the systems mechanical plans, but to do so requires some experience with reading this type of document. Facilities staff usually know most of the areas served by each AHU and can help determine any unknowns by tracing ducts and/or studying mechanical plans.

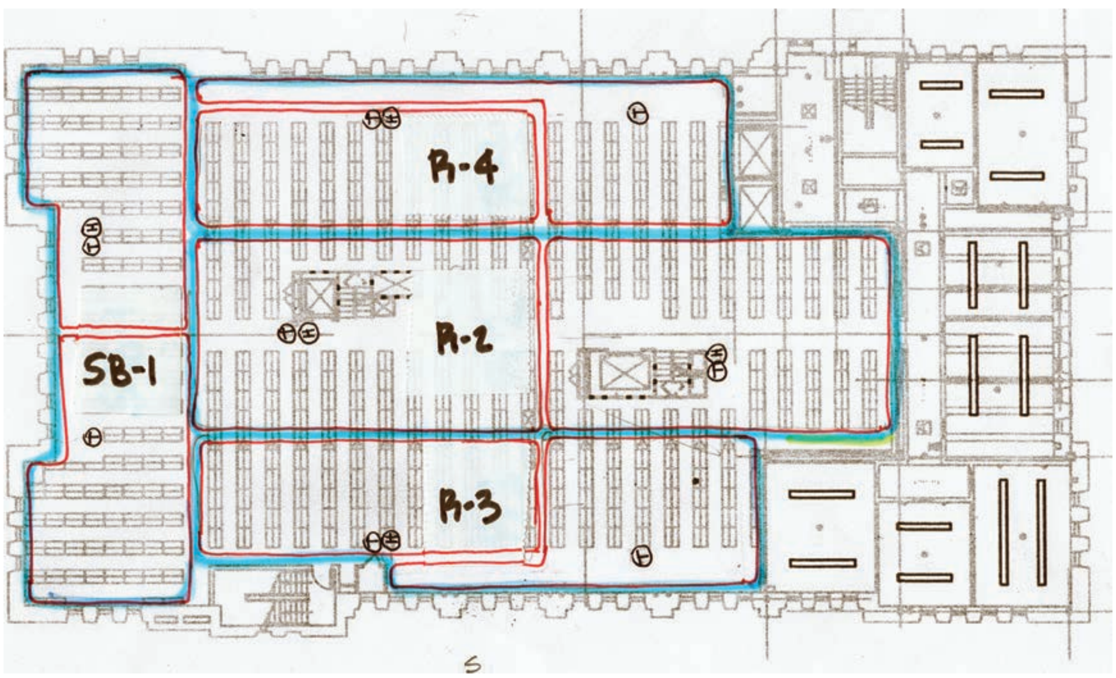
Indicate each HVAC zone on a copy of your floor plans as illustrated in the examples below. This exercise often reveals that some non-storage spaces are also served by the storage area AHU. This is important because adjusting the conditions in one area will effect all areas served by the system. You may want to attach a list of the locations served by the AHU to the documentation you prepare.



Basic floor plan with colors indicating spaces served by separate AHUs



Architectural floor plan indicating spaces served by three separate AHUs



Library floor plan indicating spaces served by four separate AHUs. The T and H notations on the drawing indicate the location of the temperature and humidity control sensors.

In addition to storage areas and work areas, other useful information can be added to architectural drawings. You may want to note the location of the temperature and RH sensors that tell the AHU what to do, and the location of portable dataloggers that monitor space conditions. You can identify outside walls and the location of doors and windows, indicate the lighting layout in the space, or highlight the location of supply air fans.

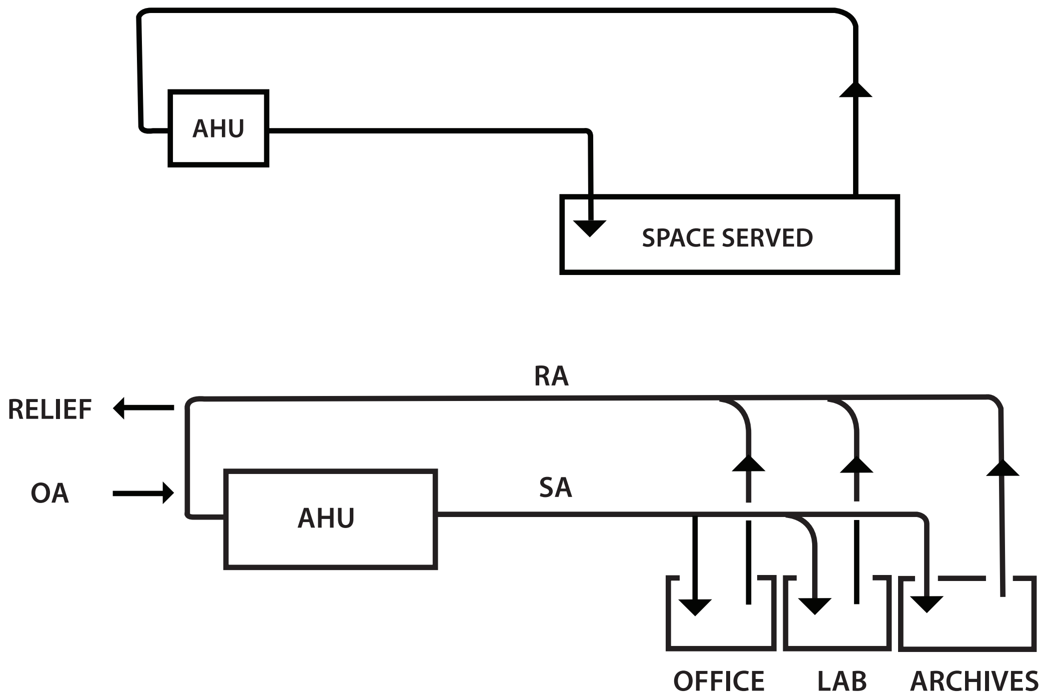
Architectural floor plan Indicating HVAC zones, logger locations, and other information

4B Create Schematic Diagrams to Document the Mechanical System

Most Class Four and Class Five buildings employ a moving stream of air to control the climate of storage spaces (see Section 2C). To fully understand how the storage climate is created it is important to develop a schematic understanding of the entire mechanical system, and this can be achieved by following the air stream loop from the point it leaves the storage space through the return air grills, along the return air path to the AHU, through the AHU, and returning through the supply air ducts to re-enter the storage space via the supply air grills.

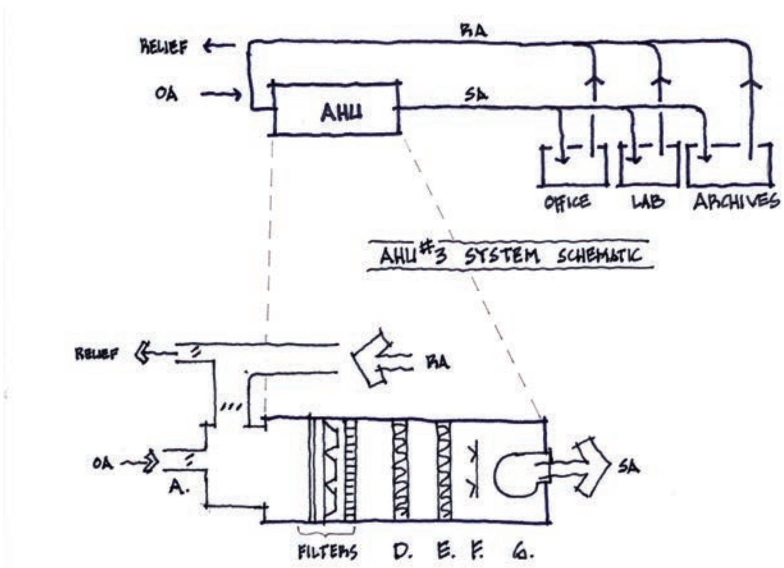
To begin, simply draw a square representing the spaces served, and a square representing the AHU with lines representing the supply and return ducts to complete the loop. This is illustrated in the drawing on the top right.

When the details of the exact spaces served by the AHU are known, the schematic can be refined as shown in the schematic image on the lower right. This drawing shows the return air (RA), the place where relief air leaves, the place where outside air (OA) enters, and the supply air (SA) path to three locations (office, lab, and archives).



AHU System Basic Schematic

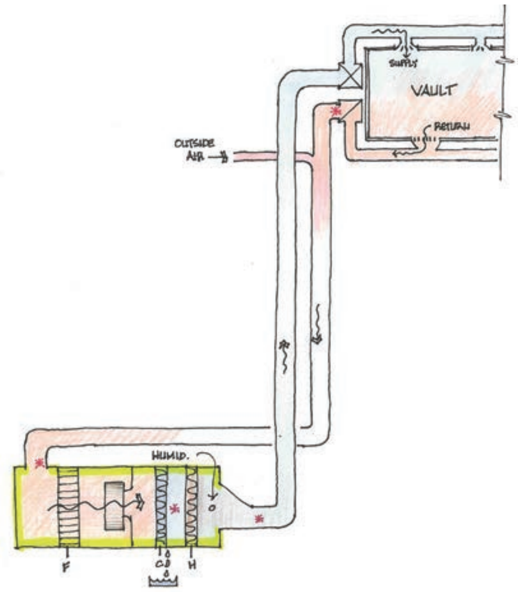
Finally, the components of the AHU itself can be inventoried and shown schematically in their appropriate location. The AHU detail in the schematic illustrated below shows what might be encountered while following an air path through an AHU. The outside air enters (A), passes through filters, a cooling coil (D), a heating coil (E), a humidifier (F) and a fan (G), and then leaves the AHU as supply air to the spaces. Many building management systems have graphics similar to this for each AHU. In such cases all that remains to be done is to create a graphic that shows all the spaces served by each AHU.



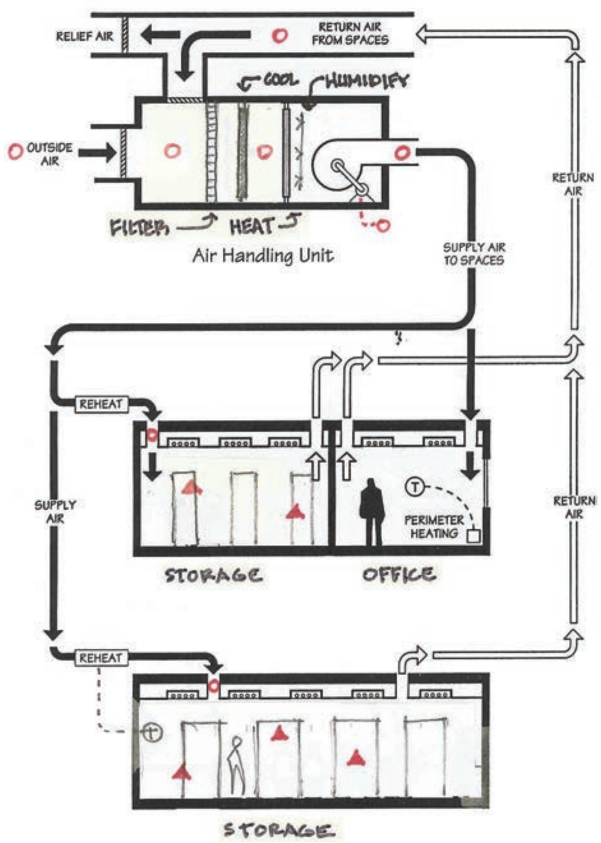
AHU System Schematic with Detail

Be forewarned that no two systems are exactly alike. The schematic shown at right, for example, appears similar to the system on the previous page. However, it differs in that the outside air enters in a location remote to the AHU, the supply fan is before the cooling and heating coils, and there is no provision for relief air.

System schematics are extremely useful tools. Developing these diagrams as a team is a great learning experience. Using the documents as a point of discussion allows all participants in environmental management (facilities management and operators, collections care staff, and administrators) to reach a shared understanding of how the climate is created, and promotes a fuller understanding of the system's overall capabilities.



See Section 4 for HVAC System Documentation Worksheets including a checklist of system components. These worksheets can be very helpful when documenting your mechanical system.



Later on additional information can be added to the storage area schematic, such as the location of the sensors that control the cooling coil and humidifiers, and information on how the quantity of outside air is controlled. The drawings can indicate which walls abut interior spaces and which are exterior and exposed to weather. All relevant documentation should be centralized into a file for each mechanical system and made available to the Environmental Management Team.

The schematic on the left includes a diagram of the AHU and follows the return air and supply air paths to office and storage spaces connected to that particular mechanical system. The room drawings include heat loads from both lighting and perimeter heating.

4C Identify Heat Loads and Sources of Moisture

Several factors unrelated to the climate control settings can influence the temperature and humidity in a given space. These are defined as heat loads and sources of moisture. It is important to identify the source and impact of these factors in collection storage and exhibition spaces.

Ernest Conrad, P.E., President, Landmark Facilities Group, Inc., has identified six sources of heat load. Review each of these and try to understand how they affect the environment in your building—particularly in areas that house and display collections.

Solar

Heat energy from the sun, which enters the building through windows, doors and skylights.

Transmission

Heat energy that moves through a wall or roof caused by a temperature difference on either side. This is most significant in the winter when the difference between the inside and outside temperature is greatest.

Lights

Lights and other electric devices (computers, copiers, etc.) which contribute heat energy when they are running.

People

People produce a heat load which is about half water vapor and half warmth. This can vary with the temperature of the room (hotter room – more water output). Unless the room is crowded with people, the influence is small.

Infiltration

The movement of moisture laden air from one space to another, such as air moving through an opening or through porous materials.

Minimum Outdoor Air

The outdoor air mandated by building codes which must be introduced into all occupied spaces for indoor air quality purposes.

Excess moisture has a major impact on collection preservation. Building-related problems that can raise the level of relative humidity within a structure include:

- roof, ceiling, or window leaks
- gaps in walls, floors, or foundation vapor barriers
- leaking plumbing
- damaged gutters and downspouts
- trees and shrubs close to the building which retain moisture
- wet walls and foundations from poor drainage
- deteriorated brick or masonry
- open water sources such as sinks or toilets
- high levels of ground water, underground streams, nearby ponds

Incorporate notes about these problems into your floor plans and related documentation for easy reference during analysis.

Stefan Michalski, Senior Conservation Scientist with the Canadian Conservation Institute (CCI), created the drawing on the right to help historic house staff identify sources of incorrect RH around their sites and buildings (left half of drawing) and their control (right half, with an asterisk).

A. surface moisture - *improve drainage above ground

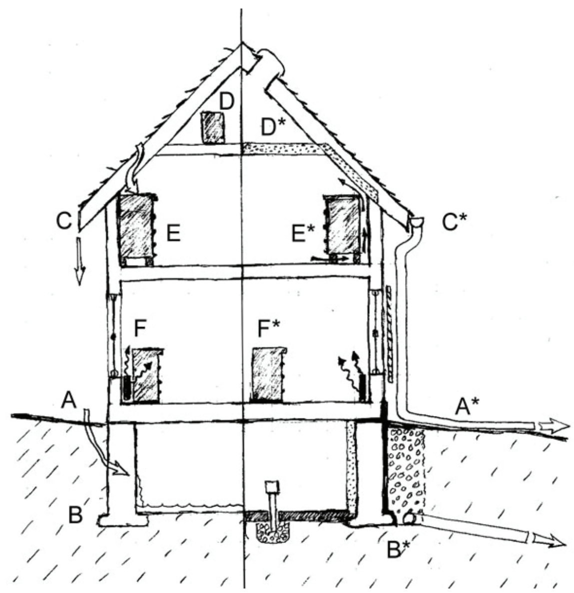
B. moisture in soil - *improve drainage below ground

C. rainwater - *add gutters, downspouts

D. hot attics - *add roof ventilation, floor insulation

E. exterior walls - *keep collections away, add insulation

F. heating systems - *don't block vents and returns



Source: Incorrect Relative Humidity
URL: http://www.cci-icc.gc.ca/caringfor-prendresoindes/articles/10agents/chap10-eng.aspx, Department of Canadian Conservation Institute, 2011. Reproduced with the permission of the Minister of Public Works and Government Services Canada, 2012.