

The Cure for The Cure: A Guide to ASTM C511 and Your Curing Facilities

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 Posted: April 2014

Introduction

When I was a Quality Analyst at AASHTO re:source, I encountered countless CCRL report findings regarding curing facilities. Since there seems to be a lot of confusion and misunderstanding regarding curing facilities and their requirements, I decided to write an article about them. The intention of this article is to clarify the specifications listed in ASTM C511, *Standard Specification for Mixing Rooms, Moist Cabinets, Moist Rooms, and Water Storage Tanks Used in the Testing of Hydraulic Cements and Concretes*, and provide tips on achieving conformance to the requirements of the standard. This article is not an exhaustive account for all mix designs, regional specifications, or capabilities of each laboratory. Each laboratory will need to consider the unique requirements of their testing needs when designing and maintaining a curing facility. This article can be utilized as a general guideline for curing materials that include Portland cement concrete, masonry mortar, masonry cement, concrete beams, grout, and hydraulic cement (see Table 1).

	Tanks	Curing Room	Both	Either
Portland Cement Concrete				X
Masonry Mortar		X		
Masonry Cement		X		
Concrete Beams**	Required last 20 hours			X
Grout				X
Hydraulic Cement			X	

Table 1

**Tanks used for the last 20 hours prior to breaking do not need to meet ASTM C511 requirements. The requirements for this soaking period are temperature and the use of calcium hydroxide. No recording thermometer or thermostatic control is required. See ASTM C31 Section 10.1.3.2. for more information. Tanks compliant with C511 will also meet the requirements of C31.

Importance

The importance of having a properly functioning curing facility cannot be overstated. Trying to cut corners on curing can produce erroneous test results. The ability of a lab to properly cure and store specimens is vitally important to achieving accurate results on compression tests. Dry conditions, low temperatures, and abundant fresh water (leaching) can all lead to low strength specimens. High temperatures can lead to falsely high strength.

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In addition to curing being an important practice, the AASHTO Accreditation Program (AAP) considers related test methods when changes to the accreditation status of ASTM C511 occur. That means that deviating from ASTM C511 and not resolving the issue could result in the suspension or revocation of other associated tests, such as ASTM C31, C39, C78, C109, C780, C1077 (Concrete), and E329 (Concrete).

Common Errors

CCRL inspectors write many findings in their reports on curing facilities and associated records. It's understandable, since there is no one correct way to design and build a curing facility, and since there's seemingly an endless pile of records to maintain. Nevertheless, it's important to make sure facilities are up to snuff and that you understand the documentation requirements. Curing facilities, be they tanks or rooms, require lots of documentation.

Some of the most common errors include:

- Failing to evaluate records of weekly temperature data
- Failing to record semi-annual temperature recorder standardizations (every 6 months)
- The inability to control the temperature (lack of heating/cooling mechanisms)
- Incomplete or nonexistent maintenance program

Curing Tanks vs. Moist Rooms

The use of curing facilities is required by several ASTM and AASHTO standards. Depending on the type of material you are working with, you should refer to the applicable specification or standard to determine whether you need to maintain tanks or a curing room, or even a tank within a curing room.

If you've never seen a curing tank, it's basically a large, typically oval tank filled with murky lime-saturated water, and hopefully some concrete samples (See Figure 1). If you've never seen a curing room/moist room (I will be using the terms interchangeably), it looks like a walk-in refrigerator full of fog. It's a sealed, usually metal room full of fog and shelves. Curing rooms range in size, and it is recommended that labs install shelving in a configuration convenient to the size and shape of the room.

Since there is no specific design framework for tanks or a curing room, it's up to the lab to configure their facility based on their resources, preexisting environmental conditions, and the requirements of the materials being cured. Both curing tanks and moist rooms have their benefits and drawbacks. Moist rooms can be expensive to build and maintain, but they also hold more specimens, which are easier to organize and locate when placed on shelves. Curing tanks might be a more cost-effective solution, but temperature control can be difficult, and they take up a lot of floor space. Tanks also require additional documentation.

Whichever option you choose, you must be capable of heating or cooling the system, regardless of your geography, even if the laboratory is located in a region with a fairly consistent climate.

Have you ever wondered which option your competitor is using? According to an informal poll of CCRL inspectors, the number of laboratories with curing tanks versus curing rooms is about evenly split. They both seem to be equally popular.

Requirements for Curing Tanks

If your lab chooses to use curing tanks alone (not inside a curing room), the following information should help clarify some of the requirements. Essentially, your tanks need to be made of a non-corroding material like thick plastic or metal. Fill the tanks with water that has been saturated with lime (calcium hydroxide, a.k.a. high-calcium hydrated lime), and maintain a temperature from 21.0 – 25.0°C (69.8 - 77°F). The temperature of the solution in the tanks must also be monitored.



*Figure 2 -Connected Tanks
Courtesy of Nelson Testing Laboratories in
Elmhurst, IL*

Tanks are available from typical laboratory suppliers, but also from farm supplies, as they can also be used as food and water troughs for animals. If you have more than one tank, you have two options for configuration. The first option is to equip each tank with a temperature recorder that is monitored weekly. If you decide to go this route, you will need to have at least one calibrated chart recorder or digital recorder per tank (see Figure 1). Alternatively, you can connect your tanks with tubing, basically creating one large tank (see Figure 2). If you choose this option, you must make sure that there is a means of evenly circulating the curing solution throughout all of the tanks. Most labs that choose this method use a fish pond circulator. Take extra care to ensure that the flow between the tanks is even. Accidentally draining and overflowing a tank can occur if there is an equipment malfunction. You must also perform a weekly check of the temperature of each bath to ensure that the difference in temperature between the tanks does not exceed 1°C.

Whether you have multiple tanks or just one tank, you must perform routine maintenance. For tank maintenance, you are required to thoroughly stir each tank at least monthly to replace depleted calcium ions. At least every 24 months, you must clean and refill each tank with calcium hydroxide to saturation. You must keep records of these activities, including the date (month/day/year), name of person responsible, and a record of the action taken.

Requirements for Moist Rooms

If your lab tests a lot of samples or tests a variety of materials, a curing room might be the best choice for you. There is also the option of using a smaller moist cabinet for specialized projects rather than building an entire room. Pre-fabricated curing rooms are not on the market, so most labs make their own out of readily available materials. The size of your room will depend on how much space is available in your lab and how many samples you plan to store. Moist rooms are made from walk-in refrigerators, insulated shipping containers, or scratch built rooms. In both moist cabinets and rooms, care must be taken to ensure air-tight seals on doors and walls. This will significantly help maintain the temperature and humidity requirements. In both cases, extreme care must be taken to prevent water from dripping onto the stored specimens, since lime can leach out and lower the strength.

In order to maintain an extremely humid environment, you must have a good water supply and humidifying equipment, and the temperature must be maintained at 21.0 – 25.0°C (69.8 - 77°F), aside from brief departures from opening the door. After installing the main room and insulating it, labs need to install misters onto water lines spaced throughout the room. A common problem with misters is that they tend to clog. Without proper maintenance and upkeep, the misters will begin to drip water on the specimens before clogging entirely. The system used in most grocery store produce sections works very well for this purpose. It is highly recommended that laboratories institute a program in which the spray nozzles are switched out with a second set that has been soaking in a mild acid such as vinegar to slow the clogging process.



*Figure 1- 3 Separate Tanks
Courtesy of Pennoni Associates Inc. in King of*



Figure 3 – Overhead Mister
Courtesy of CCRL

Maintaining two sets of working spray nozzles will be less time consuming than continuously repairing dripping nozzles, or suffering the consequences of improperly cured materials.

Digital vs Chart Recorder

One of the requirements of ASTM C511 is that your curing facility must be monitored by a temperature recorder. The temperature recorder must be accurate and readable to 1°C and shall be capable of recording the temperature at least once every 15 minutes. There are two options to fulfill this requirement. You may use either a chart recorder or a digital recorder.

More labs currently use chart recorders. Some of the drawbacks include the pen drying out and having to be replaced often, and the temperature not reading correctly. The benefit of a chart recorder is that the information is readily available and in full view at all times, and labs that use these tend not to get written up for not evaluating the weekly temperature data. It is important to choose temperature charts that are easily read and do not have a scale so

small that the pen or marker line width exceeds the scale lines.

Digital temperature recorders (or data loggers) are gaining popularity. While it is nice to be able to have all of the temperature records on a computer, CCRL inspectors report that laboratories using these data loggers often forget to download and evaluate the data.

So How Can I Avoid All of These Issues?

Unless you are a new lab, thinking of rebuilding, or moving to a new building, you probably already have a curing facility set up. The best way to make sure that you have a well-circulated, temperature-controlled facility that meets all of the requirements is to take the time and money to get it right the first time. First, heavily consider the placement of your moist room or tanks. It is best to have them inside and against an interior wall. If you have to install a moist room against an exterior wall, try to give at least 6 inches of dead air space. Imagine Arizona's 110°F heat or Minnesota's -20°F right up against the wall. It's going to make your heating/cooling equipment work extra hard and increase the likelihood of going out of tolerance. Tanks near drafty bay doors will also wreak havoc on any kind of temperature control you think you have. To help reduce exposed surface area, try covering the tanks with large pieces of Styrofoam insulation. Take the time to install insulation, piping, replaceable misters, heating and cooling units, circulators, and temperature recording devices as applicable. Just like with the very construction projects you are working on, it's always more cost-effective to get the job done right the first time, rather than having to tear it up and redo it. Also consider all the man hours lost to constant maintenance and quick-fixes, not to mention having to spend time writing corrective action reports for your AASHTO re:source Quality Analyst to review.

When it comes to keeping records, try adding them in to your regular routines and setting Microsoft Outlook® or scheduling reminders like you would normally do for other mandatory calibration, standardization, and maintenance activities.

In the end, remember that no matter how much precision is used to mix your ingredients, your curing methods will impact the strength of the material you are testing. It's not just your laboratory that might be impacted by the results of out-of-spec curing, but the people who drive on the roads and bridges, and work or learn in the buildings that these materials are used to build.



Figure 4 - Moist Room on Interior Wall
Courtesy of CCRL

Special thanks to Jan Prowell and the other employees of CCRL who shared their experiences evaluating curing facilities and records.

Other Resources

- [To Cure or Not to Cure?](#)
- [Tests Requiring ASTM C511 Curing Facilities Table](#)
- [The Manual of Aggregate and Concrete Testing](#)

References

- ASTM International, "ASTM C31, Standard Practice for Making and Curing Concrete Test Specimens in the Field," *Book of Standards*, Volume 04.02, 2012
- ASTM International, "ASTM C511, Standard Specification for Mixing Rooms, Moist Cabinets, Moist Rooms, and Water Storage Tanks Used in the Testing of Hydraulic Cements and Concretes," *Book of Standards*, Volume 04.01, 2013

<http://aashtoresource.org/university/newsletters/newsletters/2016/08/04/the-cure-for-the-cure-a-guide-to-astm-c511-and-your-curing-facilities>