When properly completed the determination of moisture content utilizes advanced technological equipment, laboratory testing and scientific equations. The process has advanced to the point where analysis can be objective and reliable. This phase of the industry has advanced from the days of the ‘educated’ toe and subjective claims of how the system felt as it was walked across.

**Standard Moisture Analysis Procedures**
Proper analysis includes a combination of both non-destructive and destructive methods of testing. Investigations completed using only one of these methods are insufficient and lack creditability. The equipment used to conduct non-destructive tests provides analysis (a snapshot) of the overall roof conditions of large expansive areas in a quick and efficient manner. Destructive testing – coupled with gravimetric tests – are required to verify the conditions observed by the moisture analysis equipment.

There are three types of non-destructive testing equipment:
1. Impedance or Capacitance
2. Infrared
3. Nuclear

Impedance or capacitance moisture testing is conducted using a variety of small hand held meters that – when set over the roof membrane – emit low frequency electronic signals from rubber electrodes located at the base of the instrument. These types of meters typically determine if a specific roof area is either wet or dry. They do not have the capacity to measure the percentage of moisture present. Dry readings are projected at points where the electrodes are insulated from one another and there is not a complete electrical circuit. The electrical conductance is greater at wet areas, which provides a complete electrical circuit.

Impedance testing can be conducted in a pattern or at various points throughout the roof area. A higher number of readings provide more cohesive moisture determination. The testing cannot be completed over wet or ponded areas and modified instruments are typically required for EPDM roof systems.

Infrared themography is conducted with the use of an infrared camera. An infrared camera detects the temperature of the areas within a roof system and identifies temperature differentials throughout the area. Infrared scanning is most effective after sunset because as the air temperature decreases the dry insulation allows the roof to cool quickly. In areas where moisture is present – insulation or membrane – take longer to cool due to a large thermal mass that is developed in these areas.
Thermal mass or ‘hot spots’ are not always an indication of moisture presence. They can be illustrated at under deck heating or cooling vents, venting of hot fumes, moisture on the roof surface (ponded water), or at points of heavy gravel application. Most infrared cameras require clear weather conditions for an external period prior to and during the testing. This typically includes no recent or current precipitation, heavy cloud cover or windy conditions. Any – or all – of these conditions could distort the infrared findings.

Nuclear thermography is conducted using a nuclear scanning meter that emits neutrons from a radiation source from the scanning meter down through the roof assembly. The emitted neutrons that encounter hydrogen atoms in the roof assembly are slowed down and bounced back to the counting detector within the scanning meter. Higher levels of slowed neutrons are recorded at wet areas because water contains a significant amount of hydrogen atoms. The recorded reading is an average of the total roof assembly.

Generally, nuclear scanning can be completed to depths as much as seven inches and testing can be conducted in areas of ponded water. Testing is conducted over the entire roof area by sectioning the roof into grids (5’x 5’ or 10’ x 10’) and recording the readings at each of these locations.

**Moisture Verification**

After visually inspecting all of the roof areas, making notes of all of the conditions, defects and problems it is important to find out the true conditions of the roof system. This is done by extracting a test sample or core cut from the roof area. Core cuts are conducted in a roof analysis because each of the moisture analysis methods has their limitations, and thorough diagnosis of a roof system requires core cuts. Moisture identified by non-destructive moisture testing is relative and must be quantified by a combination of physical core cuts and gravimetric analysis.

The extraction process of core cuts is similar if the sample is to determine construction or condition of the roof system. The differences are in the type of forensic testing that is conducted on the test samples. In the moisture analysis procedure the core cuts are extracted to determine both the construction and condition of the existing roof system. For these purposes, the core cuts can be completed in the following manner for all types of roof systems:
1. Identify the appropriate location of the test cut. The proper area should be representative of the entire roof area construction. Do not take a test cut at a previously repaired area.

2. Take one test cut per moisture representative in each roof area. A test cut should be extracted from those areas determined to be dry, and areas found to have varying levels of moisture presence; low, medium, or high. Facilities with multiple roof areas and/or multiple roof systems require test cuts from each roof area.

3. Identify the location(s) of the test cut(s) on the roof plan.

4. Use a 12” x 12” template and measure the area to be cut at 12” x 12”.

5. Following the established 12” x 12” pattern cut the membrane, any insulation(s) and underlayment(s) to the structural deck. Single ply systems can be cut with scissors. Bituminous roof systems require a box cutter knife or hatchet.

6. Remove all roof system components, (membrane, insulation, and underlayment) from the opening.

7. Photograph the system components and structural deck substrate.

8. Record system construction components identifying the method of attachment of each component, including:

   1. deck type
   2. underlayment (if used)
   3. insulation type, thickness and condition (each layer)
   4. method of insulation attachment (each layer)
   5. membrane type, thickness and condition
   6. method of membrane attachment
   7. type of surfacing and method of attachment

The core samples should be placed in a watertight container and immediately transported to an approved testing facility for gravimetric testing.

Gravimetric testing is conducted by separating each roof assembly component