Background
The accurate measurement of steam generator moisture carryover plays an important role in assuring that reactor thermal power remains within licensed limits while maximizing electrical output is achieved. When calculations fail to account for moisture carryover in the secondary heat balance, the thermal and hence the electrical output of the plant can be reduced by 0.9 percent for every 1.0 percent of carryover. Furthermore, if carryover increases significantly, long-term operation under these conditions can lead to excessive erosion of the turbine blade and housing.

Westinghouse offers a solution: measurement of moisture carryover using the nonradioactive chemical tracer lithium, in the form of either lithium hydroxide or lithium nitrate. This approach allows the utility to successfully verify the warranted separator performance on replacement steam generators, to evaluate separator performance following extended power uprates and to diagnose potential carryover problems in units that have experienced a decrease in cycle performance.

This service employs sampling and analysis techniques that not only determine the overall carryover of the steam generators, but also isolate a problem to a particular generator, thus reducing the outage inspection time.

Description
The accuracy of Westinghouse’s moisture carryover measurements is ±0.1 percent of actual moisture carryover, with a 95-percent confidence level. For example, if the measured amount of moisture were 0.25 percent, there would be a 95-percent probability that the actual steam quality would be between 99.65 percent and 99.85 percent. The accuracy of moisture carryover measurements is dependent on the stability of reactor power, steam generator water level and pressure during the test plus the magnitude of the amount of moisture being carried over with the steam. It should be noted that in practice the uncertainty of most moisture carryover measurements is on the order of a couple of hundredths of a percent or less.

Westinghouse measures the moisture levels while the plant is operating under full-power conditions. The amount of moisture being carried over from each generator is determined by taking samples from the main feedwater line and from the blowdown and main steam lines of each steam generator.

During the test, the concentration of tracer within the steam generators is continually monitored so that the
Electric Power Research Institute’s Level 2 guidelines for salts are not exceeded, though sufficient tracer must remain to allow for the detection of as little as 0.01 percent of moisture carryover.

**Deliverables**
When performing a moisture carryover test, Westinghouse provides virtually everything that is needed:

- Draft of the test procedure
- Chemical tracer
- Sample bottles
- Chemical analysis
- Quality-assured calculation to support the results
- Test report documenting the results

The utility is responsible for adjusting the draft test procedure to comply with the plant’s format and for providing two days of operational support for on-site setup and testing.

**Benefits**
Benefits of performing a moisture carryover test include:

- Increased electrical output by incorporating results into the plant’s secondary heat balance
- Verification that the moisture separation systems in replacement steam generators meet warranted performance
- Ability to quantify moisture separation performance following a power uprate
- Avoidance of costly blade and housing repairs through early detection of excessive moisture carryover and erosion

The use of a chemical rather than a radioactive tracer has several advantages:

- Allows for compliance with as-low-as-reasonably-achievable (ALARA) initiatives, since the use of a nonradioactive tracer reduces the potential for personnel exposure to radiation.
- Provides additional flexibility in scheduling testing, since there are no tracer half-life issues.
- Keeps plant operational support to a minimum, since all on-site testing can be completed in two days (for setup and testing)

**Experience**
Westinghouse has performed numerous moisture carryover tests globally since 1984. A list of plants where testing has been performed can be provided upon request.