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Subject	Method change for calibrating flow rate transfer standards
Sites	All
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Recommendation	N/A
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Supporting Information

In 2014, it was noted that external flow rate audits predominately measured low nominal flow rates at the IMPROVE sites. This led to a thorough examination of the calibration procedure, including the procedure for calibrating the flow rate transfer standard kit, which we concluded was creating a bias in the sampler flow rate calibrations.

The transfer standard calibration kit consists of a machined restriction placed at the sampler inlet and a Magnahelic® gauge which measures the pressure drop across the restriction. The transfer standard is calibrated against a primary standard at UC Davis and is then brought to the field to calibrate the sampler flow rates. The transfer standard has historically been calibrated against a graphite piston-based primary flow standard, such as a BIOS definer, with the two devices placed in series. Air entered through the restriction holes in the transfer standard, passed through the primary standard, and then was drawn through an adjustable needle valve and vacuum pump. This configuration resulted in pressures slightly below atmospheric at the primary standard inlet, since the transfer standard and connecting tubing were upstream of it and acted as restrictions. This produced a slightly lower air density at the primary standard inlet, which then measured an erroneously high volume flow rate. The result was a slight error between volume flow measured by the transfer standard and volume flow measured by the primary standard, effectively calibrating the transfer standard low when compared to correct volume flow rate at ambient conditions. This effect was verified by placing two primary standards in series with one another, resulting in the downstream device reading 0.7%-2% higher than the upstream device. The effect of the change in calibration procedure is expected to be of similar magnitude (i.e., sampler flow rates will be set 2-3% higher on 2015 maintenance visits than they have been set in the past).

In November 2014 the method for calibrating each transfer standard against a primary standard was adjusted to avoid placing the two devices in series. A range of flowrates are now generated using a standard IMPROVE controller with a calibration cartridge which includes four different flow restrictions and measured with 1) only the primary standard placed at the inlet to establish the reference flow rates and 2) only the transfer standard at the inlet. The calibration is now performed with three different calibration cartridges for a 12-point calibration, whereas the old calibration was only performed at four flow rates set using a needle valve. Evaluation of system pressure at the ORI pressure tap indicated a negligible change in flow when switching between the two configurations. A comparison of transfer standard calibrations using the new method to previous calibrations of the same devices using the old method of devices in series shows that the new method results in a transfer standard calibration that is typically 2-3% lower on average at nominal sampler flow. The direction of this shift is consistent with expectations from the change in calibration method.