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IN-PLACE CALIBRATION OF
MOISTURE MONITORS

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U. S. DEPARTMENT OF ENERGY
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IN-PLACE CALIBRATION OF MOISTURE MONITORS

R. L. Thompson and D. M. Griffin

ABSTRACT

An inexpensive, relatively quick calibration technique, used to calibrate moisture measuring instruments in Rocky Flats process lines is described. The new method decreases the required down time of the measuring instrument from days to hours.

INTRODUCTION

Calibration of moisture monitors in Buildings 707 and 777 has historically been accomplished in two parts.

1. An in-place, electrical calibration of the meter movement.
2. An out-of-place moisture calibration of the electrolytic cell.

Down time of the associated system was up to one week. This resulted from the shipping of the electrolytic cell to and from Building 125, and allowing the cell to dry down after exposure to ambient moisture levels. Approximately 10,000 parts per million by volume (ppm) is the ambient moisture level, while 2 ppm is the approximate normal operating level. The cells were capped and hand-carried between buildings to minimize shock and exposure to ambient moisture levels.

This calibration technique had two major drawbacks.

1. Poor utilization of personnel.
2. Extensive down time of user equipment.

A decision was made to develop a new calibration concept that would solve the two problems.

CALIBRATION THEORY

A necessary requirement for any calibration is that sufficient points must be checked to ensure agreement of the test instrument with the standard, within a specified tolerance. Three potential problem areas must be investigated and checked for this type of moisture monitor.

1. **Electrolytic Cell Depletion:** Caused by the physical depletion of phosphorous pentoxide, and would be indicated by lower than true moisture level at high moisture levels. Therefore, a calibration point of higher moisture level than will normally be measured must be obtained.
2. **Electrolytic Cell Leakage:** Caused by an electrical short within the cell, and would be indicated by a higher than true moisture level at low moisture levels. Therefore, a calibration point of lower moisture level than will normally be of concern must be obtained.
3. **Meter Attenuation Errors:** Caused by changes in resistance of one or more of the attenuator circuits. Therefore, at least one point on each range certified must be obtained.

THE NEW CONCEPT

Moisture monitors are now checked electrically first. Two standard moisture gas mixes are then introduced with the moisture monitors in-place (see Appendix A - Procedure 14007). This provides an end-to-end system calibration and reduces down time to approximately six hours.

This concept has the advantages of minimal production down time, negligible moisture shock

TABLE 1.

Calibration Date	Indicated Flow Rate (cc/min)	Observed Value (ppm)	Standard Value (ppm)	Error (ppm)	Stabilization Time (hr)
11-81	≅ 120	88.0	87.0	1.0	1.0
11-81	≅ 120	11.0	7.5	3.5	4.5
4-82	≅ 120	91.2	91.5	0.3	0.75
4-82	≅ 120	9.4	7.9	1.5	4.0

and provides a calibration representative of actual conditions of use.

SUMMARY

Calibration of the moisture monitors was performed twice at 6 month intervals, using the new concept. Individual data was collected and recorded. Moisture contents of the gas standards

were determined by the Reference Standards Laboratory prior to usage for each interval.

Table 1 represents average values obtained during the two different series of calibrations, using the new concept.

It is strongly believed that significant reductions in stabilization times can be realized with a minor revision in the calibration procedure used.

APPENDIX A
PROCEDURE NO. 14007
MOISTURE MONITOR
CEC MODEL 26-303
IN-PLACE CALIBRATION
700 COMPLEX

PREPARED BY: J. C. Bergen / R. M. Hyppin DATE: 12-8-81

R. M. Hyppin R. M. Hyppin

APPROVED BY: R. M. Hyppin DATE: 12-8-81

INTRODUCTION

The subject moisture monitors are located in various areas to continuously monitor the moisture content of argon supply gases.

The monitors utilize electrolytic cells which convert water-content of the sample gas to an electrical current. The cell determines moisture by absorbing the gaseous water on a thin film of phosphorous pentoxide deposited between two electrodes. A dc voltage on the electrodes electrolyzes the absorbed water and produces a current proportional to moisture and flow. For this reason, the proper indicated flowrate must be determined to produce accurate results (100 cc/m nominal).

A great deal of care and patience is required during this calibration as response time is rather slow. Care must be exercised to prevent leaks and external moisture influence.

EQUIPMENT REQUIRED

Argon gas standard with low moisture content (less than 10 PPM desired), pressure regulated, i.e., RF 76358.

Argon gas standard with higher moisture content (50-100 PPM desired), pressure regulated, i.e., RF 76359.

Tubing with fittings approved for moisture measurements to connect the standards to the test instrument (approximately 8' of tubing for each bottle).

Moisture monitor electrical calibrator with moisture cell adapter, i.e., RF 31099.

SAFETY CONCERNS

1. Standard company safety policies regarding the protection of personnel in a potentially radioactive environment shall be observed during the calibration. Direct any safety questions to your immediate supervisor.
2. The standard gas bottles are under pressure. The bottle valve should be closed and pressure bled off, when not in use.

PRELIMINARY NOTES

1. Observe and record the regulator pressure, flowrate, and moisture readings of the test instrument.
2. Valve off the gas supply to the test instrument.
3. Set the test instrument range control to X100.
4. Carefully remove the moisture cell from the test instrument, and cap the end immediately to prevent damage and moisture accumulation. Record the cell serial number.

5. Adjust the calibrator output to minimum and carefully insert the moisture cell adapter into the test instrument receptacle (ensure good contact).
6. Apply power to the test instrument if required (normally powered continuously).
7. Set the test instrument and the calibrator controls to the X10 range.

CALIBRATION PROCEDURE

Electrical Measurements

1. Adjust the calibrator output to indicate 2 on its meter. This corresponds to moisture cell output current for $2 \times 10 = 20$ ppm moisture.
2. The test instrument shall indicate 2 ± 0.5 . Record results on the calibration data sheet.
3. Adjust the calibrator output to indicate 5 on its meter.
4. The test instrument shall indicate 5 ± 0.5 . Record results on the calibration data sheet.
5. Adjust the calibrator to indicate 8 on its meter.
6. The test instrument shall indicate 8 ± 0.5 . Record results on the calibration data sheet.
7. Set the test instrument and the calibrator controls to the X3 range.
8. Repeat steps 1-6 for the X3 and X1 ranges.

NOTE

Discuss with area engineer if tolerances are not met.

9. Reduce the calibrator output to minimum and remove the adapter from the test instrument.
10. Carefully replace the test instrument moisture cell and ensure good contact is made.

Moisture Measurements

1. Disconnect a test instrument fitting that will allow connection of the standard gas (include the bypass capability if applicable).

NOTE

Standard gas bottles and accessories should remain together and be capped when not in use. Fittings should remain leak-tight and not be disturbed. Do not interchange parts from one bottle to the other as the moisture content is difficult to stabilize.

2. Slowly open the bottle valve to pressurize the regulator.
3. Slowly adjust the regulator and output valve for an indication of 5 psig pressure to purge lines.
4. Connect the standard gas (higher moisture content) to the test instrument as shown in Figure A-1.

FIGURE A-1.

5. Open the test instrument bypass flowmeter valve (if applicable). Adjust the sample flowmeter valve for zero flow if bypass is utilized (low flow if bypass is not available).

NOTE

Some additional regulator adjustment may be required.

6. Allow a few minutes purge time to help acclimate the system.
7. Close the bypass valve and adjust for 20 psig pressure at 100 cc/m sample flowrate (initial calibration only).

NOTE

For subsequent calibrations, the indicated flowrate is adjusted to the value previously established.

8. Allow the flow to continue until stabilized readings are obtained.
9. At this point, some observations and conclusions must be made as follows:
 - a. The objective is to establish the indicated flowrate to obtain agreement with the certified moisture content of the standard gas used. Once this is achieved, the calibration with this gas is completed.
 - b. The indicated moisture increases with flowrate. Adjust the flowrate to a different flow as required and allow time for stabilization.
 - c. Continue with flow changes as required until stabilized moisture readings are obtained that agree with the certified gas standard.

10. Record the final values obtained (moisture reading and flowrate).
11. Close the standard bottle valve and slowly bleed all pressure from the regulator.
12. Disconnect the supply from the test instrument and immediately cap the standard supply line to prevent moisture accumulation.

NOTE

Ensure that all pressure has been removed from the standard regulator and that all valves are closed.

13. Repeat steps 2-8 for the lower moisture gas. Use the same final flowrate established in the higher moisture gas.
14. The test instrument shall agree with the certified moisture content of the standard gas used (within the certified tolerance stated on the calibration data sheet).

NOTE

If agreement is not obtained, a new flowrate must be established that will produce agreement with both standard gases. The moisture cell must be replaced and the moisture measurements repeated if the agreement between the standard gases is not possible.

15. Record the final values obtained (moisture reading and flowrate).
16. Close the standard bottle valve and bleed all pressure from the regulator.
17. Disconnect the supply from the test instrument and immediately cap the standard supply line to prevent moisture accumulation.

NOTE

Ensure that all pressure has been removed from the standard regulator and that all valves are closed.

18. Reconnect the user supply to the test instrument.
19. Return the system to its normal operating condition, except that the indicated sample flowrate must be set to the final value determined at the end of the calibration.

DOCUMENTATION

1. Complete the test and calibration sheet, recording all calibration data as required. Affix the proper seals/decals after calibration has been completed. The blue calibration decal shall state the limited conditions of certification.
2. Submit the completed data sheet to the area engineer for approval and update of the recall system.

MOISTURE MONITOR DATA SHEET (PROC. NO. 14007)

RF _____ DATE _____ MAN NUMBER(S) _____

AS FOUND: REG PRESS _____ FLOWRATE _____

PPM _____ CELL S/N _____

ELECTRICAL MEASUREMENTS

SV-PPM	OV-PPM	ERROR-PPM	RANGE	LOW LIMIT	HIGH LIMIT
2			X10	1.5	2.5
5			X10	4.5	5.5
8			X10	7.5	8.5

2			X3	1.5	2.5
5			X3	4.5	5.5
8			X3	7.5	8.5

2			X1	1.5	2.5
5			X1	4.5	5.5
8			X1	7.5	8.5