

OWNER

# Meter Verification and Series Comparison

Procedure



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## N O T I C E

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## 1. INTRODUCTION

### 1.1. PURPOSE AND SCOPE

This procedure sets out how the Owner's measurement technicians will verify the two custody ultrasonic meters, FE-111 on meter run MR-110 and FE-121 on meter run MR-120, while the station is in service. It covers the series comparison of the two meters through crossover valve MOV-115, the speed of sound (SOS) check against AGA Report No. 10, the review of meter diagnostics, the zero-flow verification, and the verification of the pressure and temperature measurements that feed flow computer FQI-110.

The procedure applies from first gas. It does not cover flow calibration of a meter at a laboratory, which is governed by MEA-SPC-001, nor the chromatograph, which is covered by MEA-PRC-002.

The series comparison is the main in-service check on the custody meters. With both meters in series, every molecule passes through both, so any difference between their base volumes is a difference between the meters themselves. The check detects divergence between the two meters. It does not detect a shift common to both, which is why the procedure also requires the SOS check and the diagnostic review: those compare each meter with an independent reference.

### 1.2. REFERENCES

1. AGA Report No. 9 (2022), Measurement of Gas by Multipath Ultrasonic Meters.
2. AGA Report No. 10 (2003), Speed of Sound in Natural Gas and Other Related Hydrocarbon Gases.
3. API MPMS Chapter 13, Statistical Aspects of Measuring and Sampling.
4. API MPMS Chapter 21.1, Flow Measurement Using Electronic Metering Systems.
5. 49 CFR 192 Subpart N, Qualification of Pipeline Personnel.
6. GEN-DB-001, Basis of Design.
7. MEA-RPT-001, Measurement System Design Basis and Philosophy.
8. MEA-CAL-001, Ultrasonic Meter Sizing and Meter Run Design.
9. MEA-CAL-002, Measurement Uncertainty Analysis.
10. MEA-CAL-003, AGA 8 Detail and GERG-2008 Comparison and AGA 10 Speed of Sound.
11. MEA-SPC-001, Multipath Ultrasonic Meters, Flow Conditioners and Meter Tube Fabrication.
12. MEA-DS-001, DS-008 and DS-010, datasheets for the meters, flow computer and meter tubes.
13. MEA-PRC-004, Measurement Data, Audit Trail and Event Log Management.

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### **1.3. RESPONSIBILITIES**

The Owner's measurement technician performs the verification and prepares the report. The technician shall be qualified under the Owner's operator qualification program for the covered tasks involved (valve operation, transmitter calibration and flow computer configuration).

The Owner's gas control authorizes every change in valve position, because the series line-up adds pressure loss and changes which meter carries custody.

The receiving pipeline operator is notified before each check and may witness it. Per the Interconnect Agreement (HOLD H-01), notice is 7 days for a scheduled series comparison and 24 hours for a check triggered by a diagnostic alert.



## 2. FREQUENCY AND PREREQUISITES

### 2.1. FREQUENCY

Table 2-1 sets how often each activity is performed and what triggers it outside the schedule. The quarterly series comparison is the minimum; the Interconnect Agreement may require more (HOLD H-01).

**Table 2-1: Verification Activities and Frequency**

| Activity                                                                                                  | Frequency                                                                       | Trigger outside the schedule                                                                                           |
|-----------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------|
| Diagnostic review (SOS against AGA 10, gain, signal-to-noise ratio, profile, turbulence, accepted pulses) | Daily, automatic in FQI-110; weekly review by the technician                    | Any alert                                                                                                              |
| Series comparison                                                                                         | Quarterly minimum (HOLD H-01)                                                   | Diagnostic alert, electronics or transducer change, conditioner inspection, request by the receiving pipeline operator |
| Temperature verification against the reference thermometer in the test well                               | Quarterly                                                                       | Temperature alarm, SOS deviation between 0.25 % and 0.40 %                                                             |
| Pressure transmitter calibration against a deadweight tester                                              | Semi-annual                                                                     | As-found error greater than 0.05 % of reading                                                                          |
| Zero-flow verification                                                                                    | At site acceptance, after a transducer change, and at each removal from service | Suspected path velocity offset                                                                                         |
| Flow conditioner inspection                                                                               | At meter removal                                                                | Profile factor shift beyond the vendor limit                                                                           |
| Flow recalibration at a laboratory                                                                        | Per the Interconnect Agreement (HOLD H-01); recommended at 3 years              | Series disagreement above 0.3 % not resolved in the field                                                              |

### 2.2. SAFETY AND PREREQUISITES

The work is done on live Class 600 gas piping. Valve operation follows the Owner's safe work practices, and no flange, bleed or transmitter manifold is opened on the pressurized run except through its designed bleed or test connection.

Before the valve line-up begins, the technician shall confirm the following:

1. FQI-110, both meters and both pressure and temperature loops are healthy, with no active meter alarm.
2. The last calibration dates of PT-111, PT-121, TT-111 and TT-121 are recorded, and none is overdue.

3. Station flow can be held steady at or below 90 MMSCFD, the case C2 rate. The series line-up adds 1.97 psi of pressure loss at 90 MMSCFD and 4.07 psi at 120 MMSCFD ([REDACTED] MEA-CAL-001). Series verification shall not start above the C2 rate, because at full flow the added loss reduces the station's delivery capability at minimum inlet pressure. Gas control confirms the inlet pressure margin.
4. The double block and bleed body cavity of MOV-115 shows no pressure, which confirms that its seats are holding while it is closed.
5. FQI-110 is set to verification mode, so that both runs are recorded at 1 s intervals and an event marks the start of the test.

### 3. PROCEDURE

#### 3.1. VALVE LINE-UP FOR SERIES OPERATION

In normal operation the standby run is kept pressurized with its outlet valve open and only its inlet valve closed. A gas-filled run closed at both ends and left in the sun can exceed the 1,440 psig design pressure, so no run is ever blocked in at both ends unless it has been depressured for maintenance. The line-up below starts from run 1 on duty and run 2 on standby.

1. Confirm the starting position: MOV-111 and MOV-112 open, MOV-121 closed, MOV-122 open, MOV-115 closed and locked. Flow registers on FE-111 only, and run 2 is at outlet header pressure.
2. Confirm that FE-121 reads zero flow within its low-flow cutoff. A reading above the cutoff means MOV-121 is passing; stop and report.
3. **HOLD POINT.** Gas control authorizes the series line-up.
4. Remove the MOV-115 lock with the authorized key and open MOV-115 slowly from local control. Run 2 is now connected to the discharge of run 1.
5. Close MOV-112. All gas now passes FE-111, the crossover 10"-G-1015-A6 and FE-121 in turn, and both meters read the same flow.
6. Confirm that MOV-121 is closed and its body bleed shows no leakage, so that no gas bypasses FE-111.
7. Allow 30 minutes for stabilization. The flow shall be steady within 2 % and the TT-111 and TT-121 trends parallel within 0.2 °F.
8. **WITNESS POINT.** Start data collection with the receiving pipeline operator's witness present or notified.

To return to normal, open MOV-112, then close MOV-115 and relock it. For the new duty assignment, close only the inlet valve of the run going to standby (MOV-111 if run 2 becomes duty); both outlet valves stay open. The duty run is rotated at each quarterly check so that both meters accumulate comparable service.

#### 3.2. DATA COLLECTION

At least three consecutive one-hour periods are collected after stabilization. For each period FQI-110 reports, for each meter, the volume at base conditions calculated with that meter's own pressure, temperature and compressibility, the average velocity, the average SOS, the AGA 10 SOS and the path diagnostics.

The deviation for each period is the difference between the two base volumes:

$$Dev_k = \frac{V_{b,121,k} - V_{b,111,k}}{V_{b,111,k}} \times 100$$

The mean deviation and its standard deviation over the  $n$  periods follow API MPMS Chapter 13:

$$\overline{Dev} = \frac{1}{n} \sum Dev_k, \quad s = \sqrt{\frac{\sum (Dev_k - \overline{Dev})^2}{n - 1}}, \quad U = t_{0.975, n-1} \frac{s}{\sqrt{n}}$$

The pressure loss between the two meters (run 1 plus the crossover) is 1.97 psi at 90 MMSCFD and 4.07 psi at 120 MMSCFD, with a Joule-Thomson temperature drop of 0.11 °F and 0.25 °F (MEACAL-001). Each meter uses its own pressure and temperature, so no correction is applied beyond the normal flowing-to-base conversion.

### 3.3. ZERO-FLOW VERIFICATION

The run is isolated at line pressure with its inlet and outlet valves closed and the bleeds verified. This is the one condition in which a run is closed at both ends while pressurized, and it lasts only for the test: the outlet valve is reopened as soon as the readings are taken. After 30 minutes for thermal stability, each path velocity is recorded for 5 minutes.

### 3.4. TEMPERATURE VERIFICATION

The reference thermometer, calibrated annually with an expanded uncertainty of 0.10 °F ( $k = 2$ ), is inserted with heat transfer fluid into test well TW-112 (run 1) or TW-122 (run 2). After 15 minutes, 10 paired readings of the reference and the custody transmitter are taken over 10 minutes. Adjustment is made only with the receiving pipeline operator's witness where the Interconnect Agreement requires it.

## 4. ACCEPTANCE AND FOLLOW-UP

### 4.1. ACCEPTANCE CRITERIA

Table 4-1 gives the acceptance limits. The 0.3 % series agreement is the basis limit; the tighter 0.20 % level is a warning that starts trend review before the limit is reached. The SOS limits come from the uncertainty of the SOS comparison, 0.22 % at 95 % confidence ( MEA-CAL-003).

**Table 4-1: Acceptance Criteria**

| Check                                                         | Accept                                                                       | Action level                                                                                                      |
|---------------------------------------------------------------|------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------|
| Series agreement, mean of periods                             | Within $\pm 0.20$ %                                                          | 0.20 % to 0.30 %: record, review diagnostic trends, repeat within 30 days. Above 0.30 %: investigate both meters  |
| Repeatability of period deviations                            | $s$ no more than 0.05 %                                                      | Extend the test to 6 periods                                                                                      |
| SOS of each meter against AGA 10                              | Within $\pm 0.25$ %                                                          | $\pm 0.25$ % to $\pm 0.40$ %: alert, check temperature and chromatograph. Beyond $\pm 0.40$ %: alarm, investigate |
| SOS of FE-111 against FE-121, same gas                        | Within 0.20 %                                                                | Investigate the meter with the larger AGA 10 deviation                                                            |
| Path diagnostics (profile factor, symmetry, turbulence, gain) | Within vendor limits and the as-left calibration baseline                    | Compare with the baseline file                                                                                    |
| TT-111 against TT-121 in series                               | Within 0.3 °F after allowing for the 0.11 °F Joule-Thomson drop at 90 MMSCFD | Verify both against the test wells                                                                                |
| Zero-flow reading                                             | Each path within 0.04 ft/s; mean of all paths within 0.02 ft/s               | Investigate transducer delay settings                                                                             |
| Temperature verification                                      | Mean difference no more than 0.2 °F                                          | Recalibrate the loop                                                                                              |

### 4.2. INVESTIGATION OF A FAILED CHECK

When a meter fails a criterion, the technician works from the simplest cause to the most costly remedy:

1. Verify pressure and temperature on both runs against the deadweight tester and the reference thermometer. At case C5, an error of 1 °F moves the base volume by 0.34 % and an error of 1 psi by 0.13 % ( MEA-CAL-002), so a transmitter fault can mimic a meter fault.
2. Verify the chromatograph ( MEA-PRC-002) if both meters show the same SOS deviation from AGA 10.

3. Review the path-level data. A single path with low gain or a changed SOS points to transducer fouling or failure. A changed profile factor points to a fouled or blocked flow conditioner.
4. Isolate and depressure the suspect run under the Owner's procedure, remove the conditioner, photograph it and record its condition before cleaning.
5. If the cause is not found in the field, remove the meter tube assembly and have it recalibrated as-found and as-left ( MEA-SPC-001).
6. **HOLD POINT.** Any volume correction for the period since the last good verification is agreed with the receiving pipeline operator under the Interconnect Agreement (HOLD H-01) and processed under MEA-PRC-004.

#### 4.3. RECORDS

Each verification is recorded on a report form that carries the date, the personnel and witnesses, the valve line-up checklist, the flow and pressure, the base volumes and deviation for each period, the statistics, a snapshot of the SOS and diagnostics, the temperature and pressure verification results, the conclusions, and the signatures of the Owner and the receiving pipeline operator. The FQI-110 event log for the test is exported and attached. Records are retained under MEA-PRC-004.