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## TITLE

Hydrogen Performance Testing of Swagelok® KPR Regulators with Alloy X-750 Diaphragms, Tested by a Third Party

## PRODUCT TESTED

Three KPR1JTA422A20000 regulators with standard Alloy X-750 diaphragms.

## PURPOSE

This testing was performed to observe the performance of the regulators with Alloy X-750 diaphragms in a hydrogen environment.

## TEST METHODS

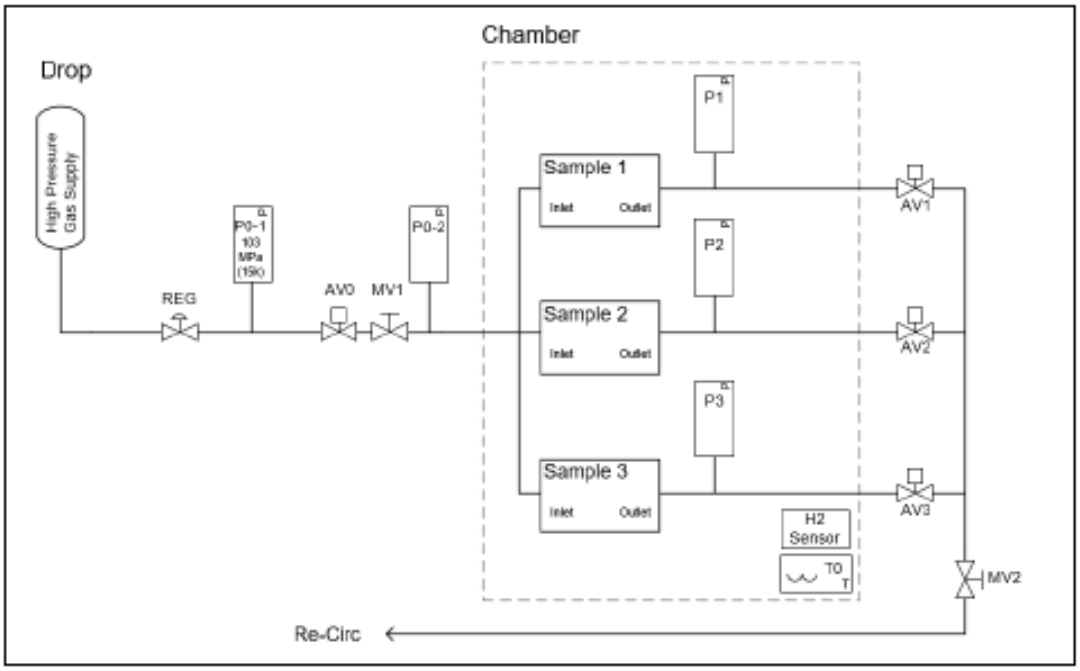
### Endurance Test

All samples were tested under the following controlled laboratory conditions by a third-party laboratory.

### Endurance Test Conditions

Test gas: hydrogen (99.5% minimum purity)
Test inlet pressure: 4351 psig (300 bar) ±5%
Test outlet pressure: 500 psig (34.4 bar) ±5%
Test temperature: 70°F ±18°F (20° ±10°C)
Total cycles: 200 000 non-consecutively (Testing was paused approximately 1/3 of the way through the duration while maintenance was performed on the test equipment.)
Cycle rate: 10 to 15 seconds per cycle
Acceptance criteria: Change in outlet pressure of less than ±5%

**Figure 1: Endurance Test Setup**



## Endurance Testing Procedure

The testing was performed on three KPR1JTA422A20000 assemblies according to the following procedure.

1. The test sample regulators were installed as shown in Figure 1: Endurance Test Set-up. All regulators had a common inlet gas supply, inlet pressure transducers (P01, P02), and upstream control valves (AV0), MV1).
2. The test regulator outlets were connected together after the downstream control valves (AV1, AV2, AV3), to allow the test gas to recirculate. Valve MV2 was set fully open.
3. The ambient temperature was set to 70°F ±18°F (20° ±10°C) and allowed to stabilize.
4. The test regulator inlets were pressurized to the test inlet pressure.
5. With the downstream control valves closed, the test regulators were set to supply the test outlet pressure.
6. All downstream control valves were opened for 1 to 3 seconds to achieve a low flow, then closed via control valve.
7. All outlet pressures were allowed to stabilize.
8. The outlet pressure was compared to the acceptance criterion. Any regulator that exceeded this value was removed from testing.
9. Steps 6 through 8 were completed and repeated for a total of 200 000 cycles.

## Performance Test

After completing endurance testing, two regulators were tested for performance according to the following procedures:

## Performance Test Procedure

### *Seat test*

1. With the regulator handle backed off to the fully-closed position, 4351 psig (300 bar) nitrogen was applied to the inlet port.
2. The regulator outlet port was isolated from exhaust.
3. The outlet pressure was set to 525 to 575 psig (36.1 to 39.6 bar) and allowed to stabilize.
4. The outlet pressure was monitored for 1 minute, with an acceptance criterion of +1/-0 psig (+.0689/-0 bar).

### *Shell Test*

With the inlet pressure set at 4351 psig (300 bar) and the outlet pressure set at 500 psig (34 bar), a liquid leak detector was applied to the leak test holes, sealing faces, and threads. The acceptance criterion was no allowable bubbles over a 10-second test interval.

### *Flow Test*

The regulator was flow-tested with nitrogen at an inlet pressure of 150 to 160 psig (10.3 to 11.0 bar). The acceptance criterion was a flow rate greater than 18 liters per minute.

## TEST RESULTS

| KPR1JTA422A20000 – Hydrogen Performance Testing | |
|---|---|
| Number of Regulators Passing Endurance Testing | Number of Regulators Passing Performance Testing |
| 3/3 | 2/2 |

The above tests were performed to consider a specific set of conditions and should not be considered valid outside of those conditions. Swagelok Company makes no representation or warranties regarding these selected conditions or the results attained. Laboratory tests cannot duplicate the variety of actual operating conditions. Test results are not offered as statistically significant. See the product catalog for technical data.

## SAFE PRODUCT SELECTION

When selecting a product, the total system design must be considered to ensure safe, trouble-free performance. Function, material compatibility, adequate ratings, proper installation, operation, and maintenance are the responsibilities of the system designer and user.