

**Document title : Procedure for tank pressure regulator handling**

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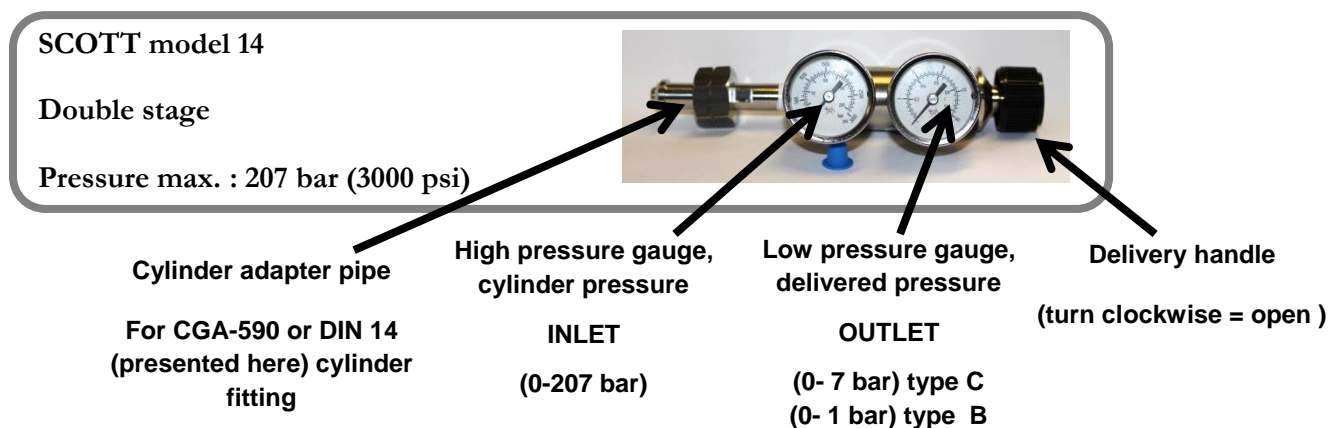
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## Pressure regulator presentation:

The recommended pressure regulators to be used on ICOS Atmospheric site are (see the ICOS Atmospheric Station Specification document for up-to-date information):

- SCOTT MODEL 14 M-14C (or -14B) Nickel-plated brass (see figure 1)
- TESCO Serie 64-3400 Stainless steel electropolish with Teflon PCTFE valve seat And the use of Stainless steel High purity gas pressure gauge (e.g. Bourdon Haenni UPG2).



*Figure 1: SCOTT model 14 pressure regulator*

## 1. Pressure regulator leak test

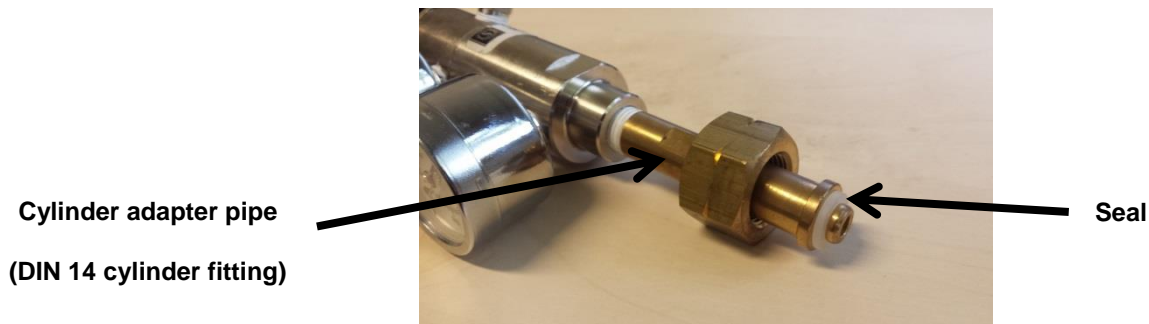
After each installation of a pressure regulator on a cylinder (e.g. cylinder replacement), you must check that there is no leak on the cylinder-regulator connexion. For this we suggest you follow the procedure below:



**WARNING: DO NOT OPEN THE CYLINDER VALVE IF THE PRESSURE REGULATOR IS NOT OPEN (DELIVERY HANDLE CLOSED AND/OR OUTLET CLOSED) OR FLUSHED PROPERLY AFTER INSTALLATION TO AVOID ANY CONTAMINATION OF THE CYLINDER AIR MIXTURE.**

**READ THE ENTIRE PROCEDURE BEFORE STARTING**

- Visually inspect the pressure regulator seal or sealing surface (depends to the cylinder fitting type) to detect any scratch, damage or dirtiness.



*Figure 2: Cylinder adapter pipe of the pressure regulator*

- Clean the seal or sealing surface with a soft damp cloth if necessary. Replace the seal if damaged (scratched, flattened...). Use similar seal (dimension and material) for replacement: Ref G29214 PTFCE flat seal.
- Clean the sealing surface of the cylinder fitting.

Sealing surface of the  
cylinder DIN 14 fitting



*Figure 3: Cylinder valve*

- Install the pressure regulator on the cylinder. Overtighten the fitting is not necessary and can damage the seal.
- Open the regulator by turning the pressure handle clockwise. Check the pressure regulator outlet is open (no cap).
- Slowly open the cylinder valve until gas starts to escape at the outlet.

**DO NOT OPEN THE CYLINDER VALVE IF THE PRESSURE REGULATOR OUTLET IS NOT OPEN OR FLUSHED AFTER INSTALLATION**

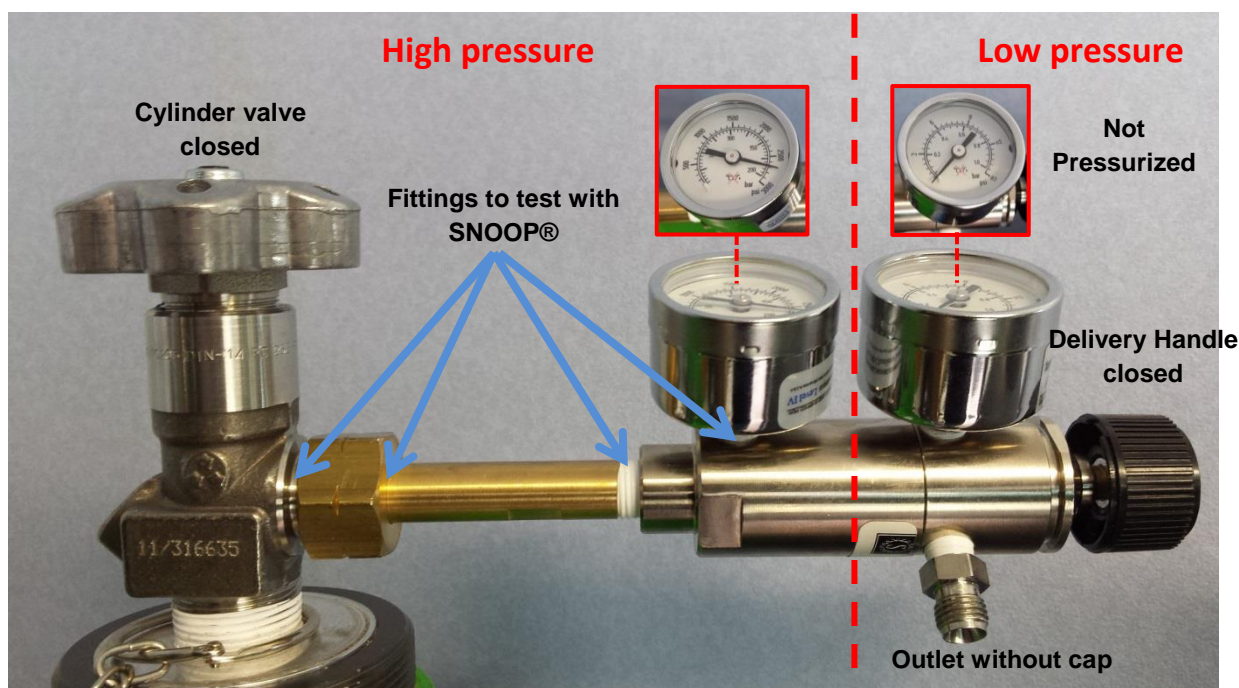
- Keep flushing during 10 seconds.
- Fully open the cylinder valve so that the high pressure gauge jump to maximum value then close the cylinder and the pressure regulator by turning the pressure handle fully counter clockwise in order to keep the first stage of the regulator (high pressure) under the cylinder pressure (see figure 4).
- Look for major leakage on high pressure parts by checking visually any pressure drop on the high pressure gauge. If a pressure drop is observed, the fitting must be retighten on the cylinder adapter pipe (both sides: cylinder and pressure regulator body). However, **NEVER TIGHTEN FITTING UNDER HIGH PRESSURE, IT CAN DAMAGE THE FITTING. THE BEST PRACTICE IS TO RELEASE FIRST THE PRESSURE BY OPENING THE PRESSURE REGULATOR OUTLET, THEN RETIGHTEN THE FITTING.**

If the leakage is not fixed by tightening fittings, check leakage on fittings on the high pressure parts (including high pressure gauge fitting) with SNOOP<sup>®</sup> as described below.

- Look for medium leakage by checking with SNOOP<sup>®</sup> all fittings of the high pressure parts (regulator – cylinder valve fittings, high pressure gauge fitting) even if any leak has been

observed with the pressure gauge test (step above). Check even micro bubble release at slow rate (once every 5 seconds). Retighten incriminated fitting if micro bubbles are observed.

**Note:** a significant leak can blow out the SNOOP<sup>®</sup> and make the leak detection impossible (no bubbles observed). That's why major leak must be detected first with the pressure gauge mintoring.



*Figure 4: leak test on the high pressure parts of the pressure regulator*

- If no leak is detected using SNOOP<sup>®</sup>, write down in the logbook the cylinder pressure read on the high pressure gauge and leave the system in current state during at least 12 hours (ideally 24 hours).  
**(Optional if done in the global check, see Chapter 3).**
- Read the pressure on the high pressure gauge and compare with the pressure previously reported in the logbook in order to detect any pressure drop over the test period. In case of pressure drop, check carefully with SNOOP<sup>®</sup> the fittings on the high pressure parts (including high pressure gauge fitting) as described previously above and retighten them if necessary.  
**(Optional if done in the global check, see Chapter 3).**

**Important:** following this procedure (above) allows you to detect leakage only on the high pressure parts: fitting of the adapter pipe on the cylinder, fitting of the adapter pipe on the regulator body, high pressure gauge fitting. However the low pressure parts must be also tested for leakage. This test can be done with a global check (see Chapter 3) or here by performing similar leak test (SNOOP<sup>®</sup> and pressure gauge monitoring) than the one detailed above but using a Swagelok<sup>®</sup> cap on the pressure regulator outlet fitting to pressurize the low pressure part of the regulator. The leak test by monitoring the low pressure gauge requires isolating it from high pressure part by closing the delivery handle.

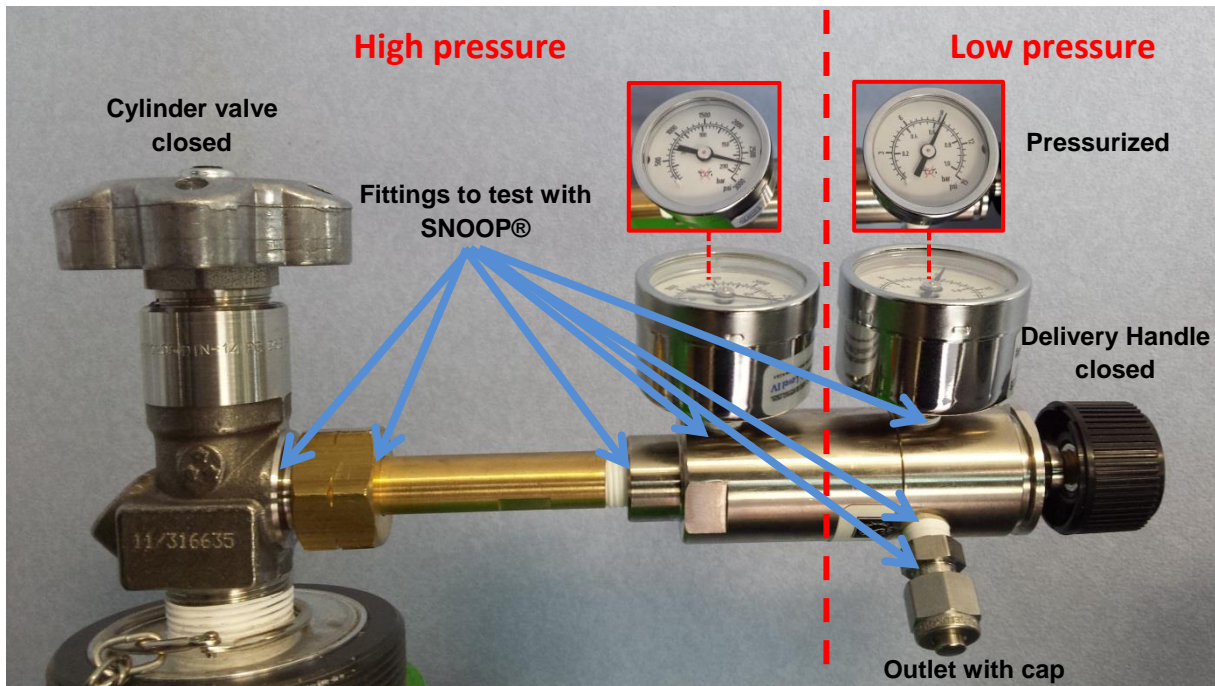


Figure 5: leak test on the high and low pressure parts of the pressure regulator

## 2. Pressure regulator flushing procedure

Once installed on a cylinder, the pressure regulator must be properly flushed before starting any measurements. This must be done after checking leaks on the regulator (see Chapter 1 above). For this purpose we suggest you follow the procedure below:

**WARNING:** DO NOT OPEN THE CYLINDER VALVE IF THE PRESSURE REGULATOR OUTLET IS NOT OPEN (DELIVERY HANDLE CLOSED AND/OR OUTLET CLOSED WITH CAP) OR ALREADY FLUSHED PROPERLY AFTER INSTALLATION TO AVOID ANY CONTAMINATION OF THE CYLINDER AIR MIXTURE.


### READ THE ENTIRE PROCEDURE BEFORE STARTING

- Close the cylinder valve
- Open the pressure regulator outlet by turning the delivery handle clockwise... first third of the maximum aperture.
- Fully open the cylinder valve so that the high pressure gauge jumps to high value (cylinder pressure) then close immediately the cylinder. let the gas flowing through the regulator until the high pressure gauge decreases down to 10-20 bar but "NOT down to zero" (to avoid back contamination in the pressure regulator) and open the cylinder valve again shortly to reload the pressure regulator with gas as before.

Note: adjust the delivery pressure if the pressure drop is too fast (less than 5 seconds) or too slow (more than 30 seconds).

- Repeat 4 times the previous step and **leave the regulator over pressure at the end of the last repetition** by closing the delivery handle (high pressure gauge showing high value).



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### 3. Global flush and leak test

Once the pressure regulator has been installed and flushed properly (see Chapter 2 above), you need to connect your pressure regulator to the sample distribution system (e.g. Valco valve) and check there is no leak before starting using your cylinder for measurements. For this we suggest you follow the procedure below:

#### Global flush:

- Connect with a dedicated line the cylinder pressure regulator outlet to the sample distribution system (e.g. Valco valve).
- Open the cylinder valve (make sure your pressure regulator has been flushed after installation).
- Select on the sample distribution system (e.g. Valco valve) the port on which you connected the cylinder. The analyser starts to sample the air from this port.
- Open and adjust the outlet pressure on the regulator at 0.5 barg (or even more if there is a significant pressure drop downstream: for instance, 6m of 1/16" OD tubing).
- Keep the analyser flushing the line during at least 30 seconds.

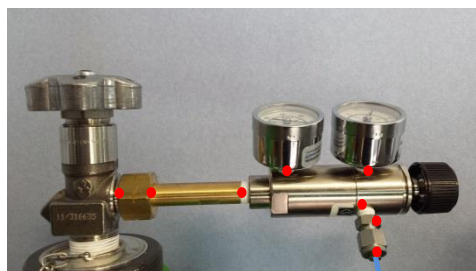
#### Global leak test:

- Select another port (e.g. ambient air) on the sample distribution system. This will stop the flow within the line and the pressure regulator. All the line from the pressure regulator to inlet port of sample distribution system is slightly over-pressurized.
- Close the cylinder valve.
- Close the pressure regulator outlet by turning the delivery handle in counter clockwise. By closing the delivery handle, we isolate the low pressure from the high pressure. Thus high pressure does not feed the low pressure anymore which allows distinguishing a leakage on low pressure parts from a leakage on high pressure parts by checking pressure drop on respective pressure gauges.
- Look for major leakage on high pressure parts by checking visually any pressure drop on the high pressure gauge. If a pressure drop is observed, the fitting must be retighten on the cylinder adapter pipe (both sides: cylinder and pressure regulator body). However, **NEVER TIGHTEN FITTING UNDER HIGH PRESSURE, IT CAN DAMAGE THE FITTING. THE BEST PRACTICE IS TO RELEASE FIRST THE PRESSURE BY OPENING THE PRESSURE REGULATOR OUTLET, THEN RETIGHTEN THE FITTING.**

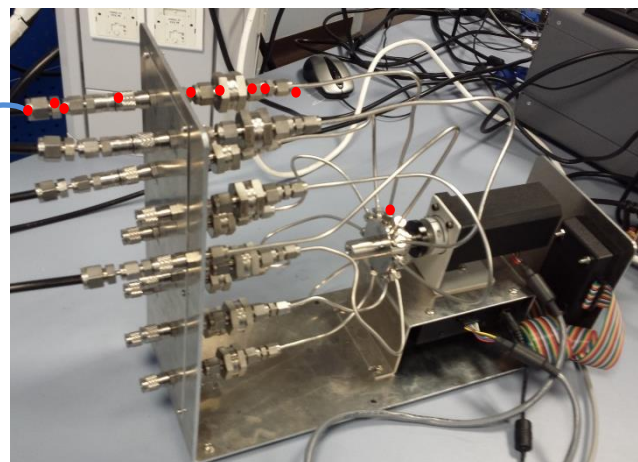
If the leakage is not fixed by tightening fittings, check leakage on fittings on the high pressure parts (including high pressure gauge fitting) with SNOOP<sup>®</sup> as described below.

- Look for major leakage on low pressure parts by checking visually any pressure drop on the low pressure gauge. Retighten fittings (after releasing the pressure) if a pressure drop is observed. If the leakage is not fixed by tightening fittings, check leakage on fittings on the low pressure parts (including low pressure gauge fitting) with SNOOP<sup>®</sup> as described below.

- Look for medium leakage by checking with SNOOP<sup>®</sup> all fittings from cylinder fitting to the end of the line in test (e.g. Valco valve head) even if any leak has been observed with the pressure gauge test (steps above). Check even micro bubble release at slow rate (once every 5 seconds). Retighten incriminated fitting (after releasing the pressure) if micro bubbles are observed.



Tubing



- Point to check for leakage with SNOOP<sup>®</sup>

*Figure 6: Global leak test*


**Note:** a significant leak can blow out the SNOOP<sup>®</sup> and make the leak detection impossible (no bubbles observed).

**Warning:** over-tightening fittings, especially on 1/16" tubing, may result to leakage and fitting damage.

- If no leak is detected with SNOOP<sup>®</sup>, write down in the logbook the initial pressure from each gauge (high and low pressure).
- Let the system in current state for at least 12 hours (ideally 24 hours) in order to perform a global tiny leak detection. Make sure the sample distribution system will not select the port on which the cylinder is connected during the test period.

**Note:** for system using Valco valve: if you leave a Valco valve controller system (e.g. Sequencer on Picarro) running with a sequence selecting alternatively 2 or more ports (e.g. ambient air and target gas), it might induce a pressure drop on the line in test even if the corresponding port is never selected by the system (in the sequence). Indeed, alternating between 2 or more ports might result in passing briefly over the port in test which might induce a small pressure drop at each rotation. So the best practice is to stop the Valco controller during the test period.

- Read the pressure on both pressure gauges and compare with the pressures previously reported in the logbook in order to detect any pressure drop over the test period. In case of pressure drop is observed on the high pressure gauge, check carefully with SNOOP<sup>®</sup> the

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fittings on the high pressure parts (including high pressure gauge fitting) as described previously above and retighten them if necessary (after releasing the pressure). In case of pressure drop observed on the low pressure gauge, check carefully with SNOOP<sup>®</sup> the fittings on the low pressure parts as described previously above and retighten them if necessary.

If the leaking fitting is not identified, the best practice to find the leak consists in testing (by monitoring the pressure gauge over long period as explained above) first the pressure regulator with a cap on the regulator outlet and then progressively adding one by one (once validated) the different elements of the line (tubing, filter, union fitting) with a Swagelok<sup>®</sup> cap at the ending. The alternative is to replace the doubtful parts.

**Warning:** over-tightening fittings, especially on 1/16" tubing, may result to leakage and fitting damage.

## 4. Pressure adjustment

Once the pressure regulator has been installed and flushed properly (see Chapters 1, 2 and 3 above), the delivery pressure must be adjusted to avoid critical pressure at the instrument inlet which might induce artefacts. This appropriate inlet pressure range is instrument specific. It is reported in the ATC test report of each individual analyser. Moreover, in order to avoid/limit bias in case of tiny leak, it is recommended to adjust the pressure at the instrument inlet slightly above the atmospheric pressure.

**Important:** the pressure range specified in the ATC report is given for the instrument inlet, NOT for the outlet pressure of the cylinder pressure regulator. The regulator outlet pressure is higher than the instrument inlet pressure due to the pressure drop along the line (tubing, filter, Valco...) between the Picarro and the cylinder pressure regulator outlet. Moreover the outlet pressure gauge of the cylinder pressure regulator might be inaccurate. A dedicated pressure sensor installed temporary at the instrument inlet is recommended for the cylinder pressure regulator adjustment.


However, for Picarro analyzer, the pressure regulator can be adjusted without pressure sensor at the Picarro inlet by using the internal instrument parameter: the outletvalve (or inletvalve for mobile/flight analyser) opening value (without unit: 0=closed; 65000=open) which is an image of the pressure at the instrument inlet (i.e. instrument reacts to any pressure change at its inlet with its "outlet proportional valve" to regulate the cavity pressure).

For that purpose, the ATC test report specifies also in term of outletvalve opening value the recommended pressure range and the atmospheric pressure (nominal outletvalve value) at the instrument inlet.

So the outlet pressure of the cylinder pressure regulator can be adjusted by using the Picarro outletvalve value as follows: above the atmospheric nominal value and below the upper limit of the recommended range specified in ATC specific instrument test report.

**Important:** if there is other instrument(s) sharing the same cylinder (or Valco), it is important to adjust the cylinder pressure regulator while other instrument(s) is sampling also this cylinder.



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In case the ATC test report is not available, a good approximate of the appropriate outletvalve opening value for the cylinder measurement is to add 1000-2000 to the outletvalve value observed while the Picarro is sampling room air without any tubing or filter at its inlet.