
Constant Pressure Inlet (CPI) for the CCN

Operator Manual DOC-0125 Revision L



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Introduction

The supersaturation in the thermal gradient CCN counter can be disturbed by changes in pressure in the column. There is a slight influence of the column internal pressure on the supersaturation under stable conditions (Roberts and Nenes, *Aerosol Science and Technology*, **39**, 206-221, 2005). With rapid changes in pressure, when an aircraft ascends or descends, the supersaturation in the column will drop and the CCN measurements will not be reliable until the pressure has stabilized. The CCN constant pressure inlet (CPI) accessory provides constant pressure at the inlet of the CCN when the CCN is operated from an aircraft platform. A hose clamp pinching the inlet conductive tubing is used to provide a pressure drop, and the CPI provides a variable vacuum to maintain a constant pressure in the CCN instrument.

The following details the specifications of the constant pressure inlet system:

Power:	28 VDC, 2 A
Size:	30 cm long, 12 cm high, 20 cm wide
Weight:	2.3 kg
External Signals:	Valve voltage, system pressure

Theory of Operation

The CPI accessory for operating the CCN on an aircraft has been designed to reduce the pressure in the inlet manifold and operate the CCN at a constant reduced pressure. Figure 1 shows the schematic diagram CPI installed in an aircraft environment in conjunction with a CCN counter. An Orifice on the conductive tubing at the inlet serves to reduce the pressure. The CPI also provides a vacuum in addition to that provided by the CCN counter. An analog feedback loop is used between the set point given by the potentiometer on the front of the control box and the pressure transducer.

Appendix B shows the suggested orifice to use for a particular altitude. For instance, if 14,000' is the maximum expected altitude, the 0.20 orifice should be used. If flying at 15,000' or higher, the 0.017" diameter orifice should be used.

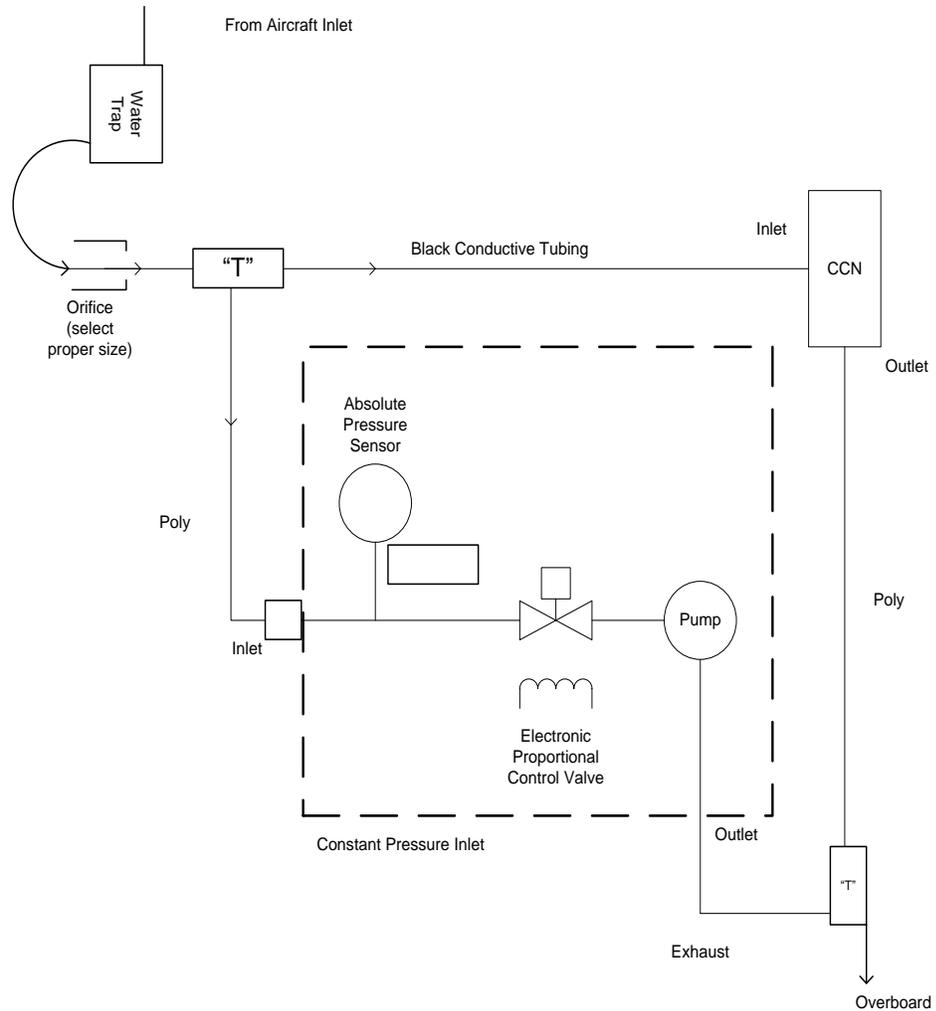


Figure 1: Block Diagram of the CPI Flow System

Figure 2 shows the control panel on the front of the CPI. A two-position switch controls the readout of the panel meter. In the down position, the meter will read the control voltage to the proportional valve. In the up position, the panel meter readout will give the manifold pressure set-point in mb. The back panel of the CPI has BNC jacks for connection of the pressure readout and the valve voltage to an auxiliary data system, if desired. This connection is not part of the DMT standard PADS data system package.



Figure 2: Control Panel on CPI

The pressure drop to the inlet of the CCN is accomplished with an orifice on the black conductive tubing that is supplied with the CPI.

Connecting the CPI to the CCN

Figure 3 shows the standard mounting of the CPI on the CCN. (Mounting hardware for this configuration is provided.) Figure 4 shows a typical inlet assembly connected to a CCN instrument.



Figure 3: Standard Mounting Configuration

CCN-100 INLET

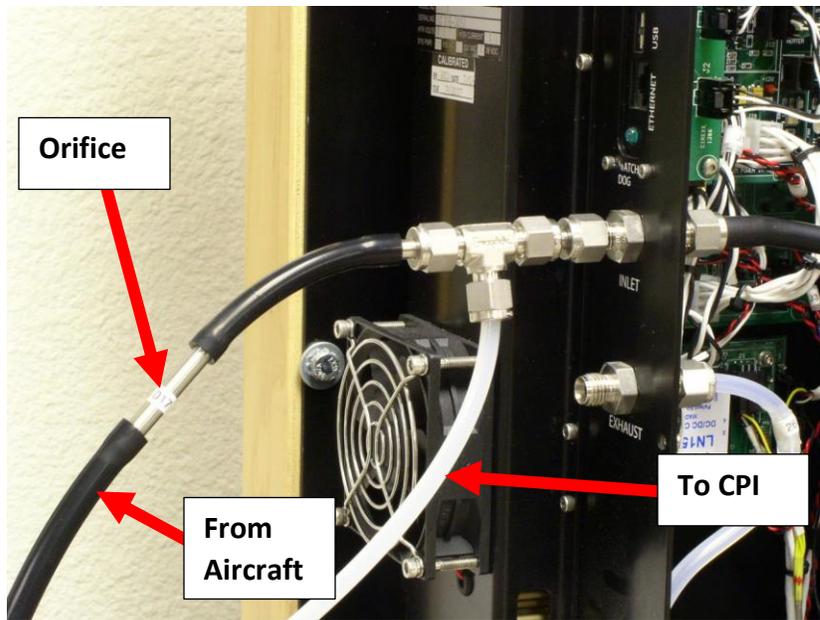


Figure 4: Inlet Tubing and "T" Attached to **CCN-100** Inlet

CCN-200 INLET

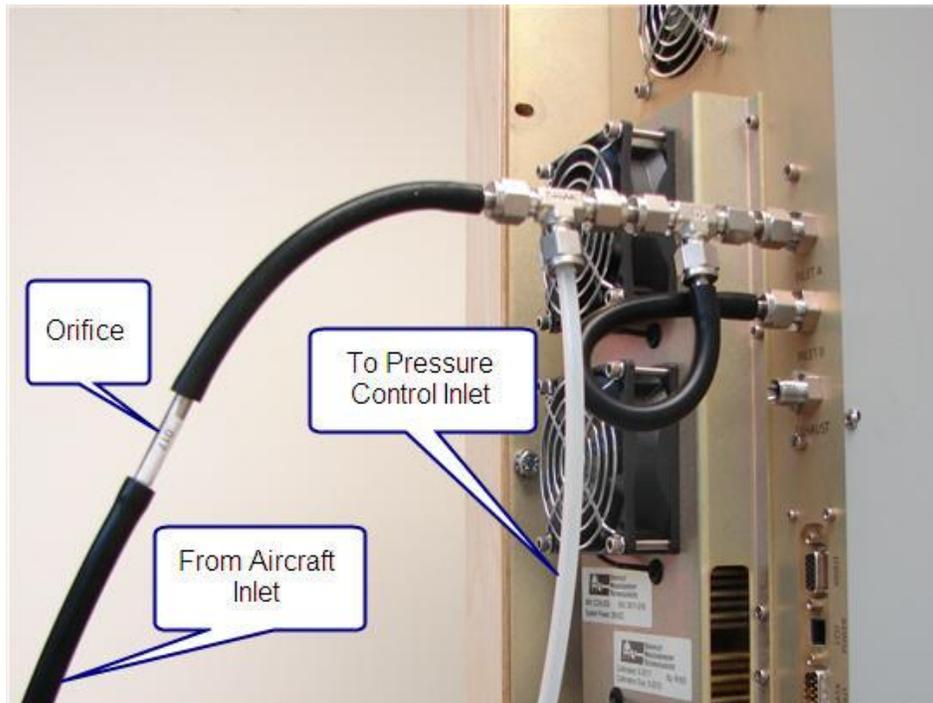


Figure 5: Inlet Tubing and "T" Attached to **CCN-200** Inlet

Pre-Flight Set-up

Setting the inlet manifold set-point involves selecting the correct orifice size. .017 and .020 are provided. The minimum pressure in the inlet should correspond very closely to the maximum altitude expected for the aircraft. Appendix B gives a table of altitude (in feet) and standard atmospheric pressure. The true atmospheric pressure at any altitude will vary according to meteorological conditions and a pressure slightly lower than the lowest expected pressure should be chosen.

1. Install the CPI as shown in Figures 1, 3 and 4 on the CCN. (Consult Figure 5 instead of Figure 4 for a CCN-200.)
2. Select the control pressure for the maximum altitude that measurements will be made from Appendix B.
3. Install .020 orifice into ¼" conductive tubing
4. Start the CCN counter
5. Turn on the PUMP POWER and the SYSTEM POWER switches on the CPI.
6. Perform leak check of entire CCN/Constant pressure inlet plumbing
 - a. Install Plug on inlet from aircraft, gently pinch the black conductive tubing or disconnect it from fitting to outside air and install plug
 - b. Monitor inlet pressure, it should drop quickly and go below 400mb
 - c. Turn off Pumps on CCN and Constant pressure inlet.
 - d. Wait 30 seconds and verify leak rate is less than 5mb per second.
 - e. If leak rate is more than 5mb sec, leak must be located and fixed before valid data will be attained.
7. Set the PRESSURE SET potentiometer on the front of the CPI box to the pressure as determined in step 2.
8. Select Manifold pressure with the switch on the front panel
9. Verify that the manifold pressure can reach the desired pressure set by potentiometer in step 6.
10. If manifold pressure cannot reach set point, install the smaller size orifice and repeat steps.
11. If during flight the manifold pressure is not stable, a different orifice size may be needed. Contact DMT for further assistance

It may be necessary to reset the sheath/sample flow ratio at the reduced pressure for the CCN.

NOTE: This setup may not be able to keep the inlet pressure constant when flying at high altitudes. An orifice for low altitude and one for high altitude may be required to get the dynamic range. Contact DMT for further assistance.

Concentration and Supersaturation Corrections

Operating the CCN at constant pressure will affect the particle concentration. If the CCN pressure is reading 500 mb, and the ambient pressure is 500 mb, no correction to the CCN concentration is needed. If the pressure in the manifold is 500 mb, the aircraft is flying at a pressure altitude of 750 mb, and the CCN concentration is reading at 1000 particles/cc, the true concentration needs to be corrected by 750/500, or a factor of 1.5. The true particle concentration is then 1500 particles/cc. Using the constant pressure inlet system will require external recording of the ambient static pressure and post processing correction of the CCN concentration. There may be slight differences between the pressure measured using the pressure transducer in the CCN instrument and that measured by the CPI. The most accurate data will be obtained by using the pressure ratio based on the measurement in the CCN counter.

The CCN is calibrated at ambient pressure in Longmont, Colorado, nominally 830 mb. DMT tests in our laboratory showed that the supersaturation will drop approximately 0.035% for each 100 mb change in pressure. You may want to adjust your SS% appropriately to get your desired SS%. The CCN instrument does not automatically adjust for pressure.

Appendix A: Revisions to Manual

Rev. Date	Rev No.	Summary	Section
3-11-10	H	Reformatted manual	All sections
		Changed supersaturation drop relative to pressure change from 0.07 to 0.035% for each 100 mb	4.0
9-7-10	I	Corrected example showing maximum expected altitude and corresponding orifice size	2.0
5-18-11	J	Added photo of Constant Pressure Inlet attached to CCN-200	2.0
6-26-13	K	Updated Figure 2, Inserted Figure 3	2.0 and 3.0
2/12/18	L	Updated various Appendix D Current Revision/ artwork.	All sections

Appendix B: Suggested Orifice Size for Specific Altitudes

Altitude (ft)	Meter	Standard Pressure (mb)	Orifice Size for maximum altitude
0000	0000	1013	.020
1000	305	977	.020
2000	610	942	.020
3000	915	908	.020
4000	1219	875	.020
5000	1524	843	.020
6000	1829	812	.020
7000	2134	782	.020
8000	2438	753	.020
9000	2743	724	.020
10000	3048	697	.020
11000	3353	670	.020
12000	3658	644	.020
13000	3962	619	.020
14000	4267	595	.020
15000	4572	572	.017
16000	4877	549	.017
17000	5182	527	.017
18000	5486	506	.017
19000	5791	485	.017
20000	6096	466	.017

Appendix C: CCN Aircraft Inlet

