



TECHNOLOGIES

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**MODEL
VMM-400**

**TURBINE
SYSTEM**

INSTRUCTION MANUAL
FOR THE
VMM-400 TURBINE SYSTEM

TURBINE SYSTEM

VMM-400

The VMM-400 Turbine System is a precision volumetric instrument designed specifically for respirometry volume flow measurements. The Turbine System consists of 3 modules: VMM-400 Electronic Module, VMM-PUL Pick-Up Assembly with cable and connector, and of the removable VMM-CTL Turbine Cartridge. Air flowing through the Turbine Cartridge spins an ultra light weight impeller blade supported on sapphire jewel bearings. Infrared light beams, generated by light emitting diodes, are crossing the Turbine Cartridge and the path of the impeller blade. As the impeller rotates, it sequentially interrupts the light beams. These interruptions are detected by phototransistors that produce pulses. By processing these signals the flow rate and volume can be determined.

The VMM-PUL Pick-Up Assembly comprises infrared optoelectronics and cable with connector. It is not immersible.

The VMM-CTL TURBINE CARTRIDGE consists of the transparent turbine assembly, the clear [not tinted] input port and the blue tinted output port. The cartridge is shockproof and immersible for cleaning and sterilization. All cartridges are permanently factory calibrated to be identical and are instantly and easy interchangeable. Moisture, condensed vapor or expelled saliva will not affect the long-term function or accuracy. The cartridges will provide years long and reliable service if properly maintained.

The operation of the transducer is strictly digital. It transmits electrical pulses and the pulses are counted as volume increments or calculated as flow velocity. This is the principle for the 100% drift free operation, long-term stability and consistent accuracy.

It is important that the VMM-CTL TURBINE CARTRIDGE is installed in the proper orientation. The clear [not tinted] end of the VMM-CTL TURBINE CARTRIDGE must be snapped completely into the VMM-PUL Pick-Up Assembly, with the impeller inside the pick-up body. There are three small projections on the circumference of the cartridge collar and all three must snap in. The blue tinted half of the flow cartridge [end away from the cable] is inserted into the breathing valve.

The accuracy of the VMM-400 Turbine System is determined by the mechanical dimensions of the turbine/impeller assembly and by a drag free rotation of the impeller. Because the dimensions are constant and permanent (precision production methods, high quality materials and components), there is no use of any later calibration. A good visual check of the shape of the cartridge (turbine vanes, impeller) and a simple/ flow sensitivity test of the impeller rotation drag will practically guarantee an accurate performance. Malfunction of the optoelectronic system (VMM-PUL) or deteriorated transparency of the cartridge does not affect the accuracy; they result in loss of the electric output signal.

SPECIFICATIONS

VMM-400 Electronic Module

FLOW RANGE: 0.1 - 12 L/sec (6.0 - 720 L/min), see the Turbine Cartridge specifications.

VOLUME RANGE: Unlimited.

ACCURACY: 3% (Typically 1% after Calibration).

STABILITY: Short and long term, 100%.

WARM-UP TIME: None.

DIGITAL OUTPUT: 1: 100 pulses/liter nominal (100 us).

2: 1 pulse/respiration (+5 VDC when flow present, 0 Volt when no flow).

POWER REQUIREMENT: +5 V, 5%, 105 mA with the Pick-Up Assembly plugged in.

VMM-PUL Pick-Up Assembly (shockproof, nonimmersible)

PICK-UP METHOD: Infrared, optically focused.

CABLE: Non-retractable, 10 Ft

CONNECTOR: 6-pin MiniDIN

DIMENSIONS: Outside diameter 1.990. Length 0.800".

VMM-CTL TURBINE CARTRIDGE (shockproof, immersible, sterilizable):

FLOW RANGE: 0.1 to 12.0 Liters/second (6.0 - 720 Liters/minute).

LINEAR RANGE: 0.1 to 12.0 Liters/second.

REPEATIBILITY: 0.3 %

RESISTANCE: 0.45 cm H₂O @ 2 Liters/second.

DEAD SPACE: 38 ml.

CARTRIDGE LENGTH: 3.2".

STERILIZATION: Cold liquid chemical method, Sidex or similar. DO NOT USE ALCOHOL OR SOLVENTS!

CARTRIDGE EXCHANGE: The cartridge is instantly removable for sterilization or replacement without recalibration.

IMPORTANT:

Avoid hair and other particulates from becoming entangled in the Turbine Cartridge! This will cause the impeller to bind and will produce erroneous data.

ELECTRICAL CONNECTORS

Two connectors, a 6-pin MiniDIN and a 6-pin DIN, allow for connections to the VMM-PUL Pick-Up Assembly and to the Electronic Module. They carry only the digital output signals and DC power.

6-pin Mini DIN connector

Pins 1-6: VMM-PUL Pick-Up Assembly

6-pin DIN connector

Pin 2: POWER SUPPLY GROUND, DIGITAL GROUND.

Pin 5: VOLUME OUTPUT, 500 Pulses/Liter.

Pin 6: RESPIRATION/ACTIVE FLOW OUTPUT. +5 Volt @ flow, 0 Volt @ no flow / low flow.

Pin 7: +5 VDC/105 mA POWER INPUT LINE, used when powered from Interface Box or a regulated 5V Power Supply.

ACCURACY TEST

The only reliable accuracy test, closest to real conditions and within a practical reach, is by the use of a good calibration syringe. It can simulate a single inhalation or exhalation, as well as repetitive breathing within the range of human respiration. We recommend this classic method using a hand-operated syringe. We do not recommend the use of step-motor driven cylinders/syringes, because they deliver a flow with higher frequency pulsing components and may cause errors under some conditions. They simply do not deliver the type of flow comparable to real breathing.

NOTE: The syringe must come with a certified measurement of the actual syringe volume accurate to better than 1.0cc. Use this certified volume provided by the manufacturer for calibration; do not use the generic volume of the syringe.

- A. **SYRINGE - FLOW TRANSDUCER ARRANGEMENT.** The flow transducer should never be attached directly to the output nozzle of the syringe. Many syringes have tapered nozzles and eject a choked, narrow, high velocity stream of air (compare with water stream at the garden-hose nozzle). When it reaches the flow transducer input port without having a chance to expand properly, it will cause erroneous, usually higher readings. Therefore use a non-rebreathing valve, or provide a straight smoothbore tube, at least 25 cm (10 inches) long, between the syringe nozzle and the flow transducer input port. Standard spiral plastic tubing with 30 mm inside diameter will do the job.
- B. With the VMM-400 in ready condition and with the flow transducer connected to the syringe as described above, pull the syringe piston to the rear stop. Reset your counter or computer and check if it reads zero; Start pumping the syringe, make 5 full continuous onward strokes and stop. Avoid hard-hitting the end stops, because it causes air bouncing in and out and increases the readings. The display reading should be within the specified syringe volume. The readings will be generally much better.

CLEANING

The cartridge must be removed from the transducer body for inspection. To remove it, hold firmly the transducer body and apply a moderate axial pressure with your palm to the clear [not tinted] part of the cartridge. It will pop out easily. While doing this, secure the tinted end of the cartridge with the other hand to prevent the cartridge from dropping to the floor when it pops out.

a. **CLEANING THE VMM-PUL Pick-Up Assembly BODY.** Use a lint free, soft dry cloth and do not apply any pressure to the optical lenses inside the body. Keep it always dry.

b. **CLEANING THE VMM-CTL Turbine Cartridge.** Clean the cartridge by rinsing it in water after each use to prevent deposits caused by dried-out saliva or use sterilizing solution. Otherwise a continuous build-up of deposits will slowly deteriorate the transparency of the inner center part of the cartridge and cause malfunction of the infrared beam, passing through this part of the cartridge. The infrared beam is not affected by fogged cartridge, water vapor or condensed water inside the cartridge. **NEVER** clean the cartridge by using a Qtip or similar cleaning probe inserted inside the cartridge, because this will damage the turbine blade and/or the pivot assembly.

c. **STERILIZING THE VMM-CTL Turbine Cartridge.** Use only cold liquid chemical method: Sidex, *Control III* by Sterilaire Medical of Tustin, California, Tel. (714) 544-7711, or *WAVICIDE-01* by Wave Energy Systems, Inc, 25 Mansard Court, Wayne, NJ 07450, tel. (800) 252-1125.

Follow manufacturer's directions for use of the product. Approximately 10 minute immersion time is required for disinfection, 10 hours for sterilization. After disinfection, rinse thoroughly in water that meets Federal Drinking Water Standards, then shake out droplets of water and let dry.

NOTE: DO NOT USE ALCOHOL, SOLVENTS, abrasive cleaners, or strong detergents! Hot air may cause a permanent damage to the cartridge.

CARTRIDGE FLOW SENSITIVITY TEST

Hold the cartridge aside your body so that you can see its profile and the impeller inside the transparent part of the cartridge. The clear [not tinted] input port must be facing the front. Do not obstruct the ports with your fingers. Start walking slowly, watching for rotations of the impeller. If the impeller does not rotate freely, it indicates a malfunction of the jewel bearing suspension system, likely caused by some deposit around the bearing/pivot area. It may be a hair, which is clearly visible through the window and may be easily, but very carefully removed with a tiny long nose tweezers. Or it may be a gradual deposit built-up, caused by insufficient maintenance cleaning. In such a case, the cartridge should be immersed for few hours in water and than rinsed to remove the dissolved deposits. The most efficient and quick cleaning method is to apply a moderate stream of water from the water faucet directly into the clear [not tinted] input port. If any malfunction persists, the cartridge should be sent to the factory for inspection or be replaced.

Visually examine the walls of the cartridge in the vicinity of the impeller. The plastic walls should be reasonably transparent. Heavy scratches or contamination could interfere with the optical pick-up. Worn and heavily scratched cartridge should be replaced.



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