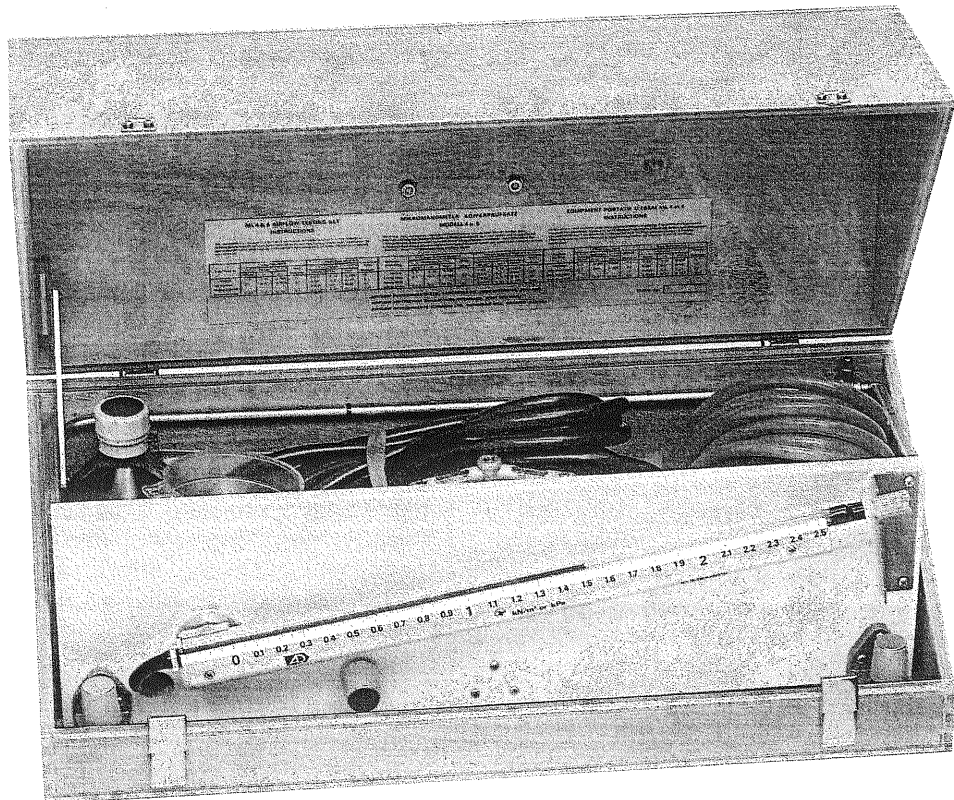


AIRFLOW™

TYPE 5 TEST SET

OPERATING INSTRUCTIONS 9004492/D/02



TYPE 5 TEST SET

General

The Type 5 Test Set incorporates an adjustable-limb manometer mounted on a panel and enclosed in a robust wooden carrying case which has four rubber feet for table or bench mounting. If a flat surface is not available on site, a G-clamp can be supplied which is inserted through a hole in the back of the instrument case and is retained by a screwed Bakelite knob. This clamp can be attached to any convenient hand-rail or similar structure. It is important to make sure that the clamp is absolutely tight and secure before allowing it to take the full weight of the Test Set.

The laboratory version of the Type 5 comprises the main panel of the Portable Test Set mounted on a steel plinth with four rubber feet. This model is supplied without the carrying case.

The manometer will read pressures over the following ranges:

SI	Imperial	Metric
0-125 Pa	0-0.5 in wg	0-12.5 mm wg
0-250 Pa	0-1 in wg	0-25 mm wg
0-500 Pa	0-2 in wg	0-50 mm wg
0-2500 Pa	0-10 in wg	0-250 mm wg

The scales are marked 0-2.5 kPa, 0-10 in wg or 0-250 mm wg and give direct readings when in the vertical position. When using the manometer limb in the inclined positions, it is necessary to multiply the readings by the appropriate factor for the inclination. These factors will be found on the label fixed to the lid of the Portable Test Set or to the plinth of the laboratory model.

Positive, negative and differential pressures can be measured using this manometer – see diagrams 2 – 6.

The manometer is filled with a dyed blend of technical white oils which has a relative density of 0.784 at 20°C. This should only need to be replenished if accidentally spilt and a bottle of spare fluid and a funnel is provided for this purpose. Before filling, adjust the knob on the front of the panel to bring it to the mid-position of its movement. To avoid an air-lock, it is preferable to fit the funnel to the tube connection, blow some of the fluid from the gauge up into the funnel and add further fluid from the bottle before allowing it to return. Repeat if necessary.

When using the Test Set with the limb in the inclined positions, it is advisable to loop the plastic tubes vertically above the instrument as a precaution against fluid being blown into one of them. Care should be taken when inserting the Pitot tube into the duct to ensure that both the "total" and "static" holes enter quickly to avoid blowing fluid out of the gauge. Alternatively, the plastic tubes may be pinched together whilst the Pitot tube is being inserted or the Manometer Balancing Valve may be used with the knob turned to zero.

Accessories

The Portable version of the Type 5 Manometer is supplied with a comprehensive set of site accessories. These include a Pitot Static Tube, 8 mm diameter x 483 mm long (5/16 in x 19 in); lengths of plastic tubing, colour coded for easy identification; a mercury-in-glass thermometer; a convenient slide-rule type air velocity calculator and a Manometer Balancing Valve.

Accessories for the Laboratory model may be purchased separately as required.

All models are fitted with SI pressure scales with additional Imperial and Metric scales supplied. These scales may be changed by removing the

fixing screws, replacing the scale and refitting the screws, tightening until the scale is evenly clamped.

Additional pressure scales are available calibrated in millibars.

Using the "rest-on" scales supplied the Type 5 manometer will direct-read velocities over the following ranges:

SI	Imperial	
0-14 m/s	0-2800 ft/min	(with limb in bottom inclined position)
0-28 m/s	0-5600 ft/min	(with limb in top inclined position)

These readings are only accurate at 16°C and 1000 mbar atmospheric pressure (68°F and 30 in Hg) which are the conditions for standard air density (1.2 kg/m³). For an on-site test as distinct from an acceptance test, corrections for non-standard air conditions (which are usually quite small) can be ignored if they are unlikely to affect the equivalent velocity pressure value by more than 2 or 3%.

Accuracy

±1% of reading or ±1 Pa whichever is the greater at normal atmospheric pressure and 20°C ambient temperature.

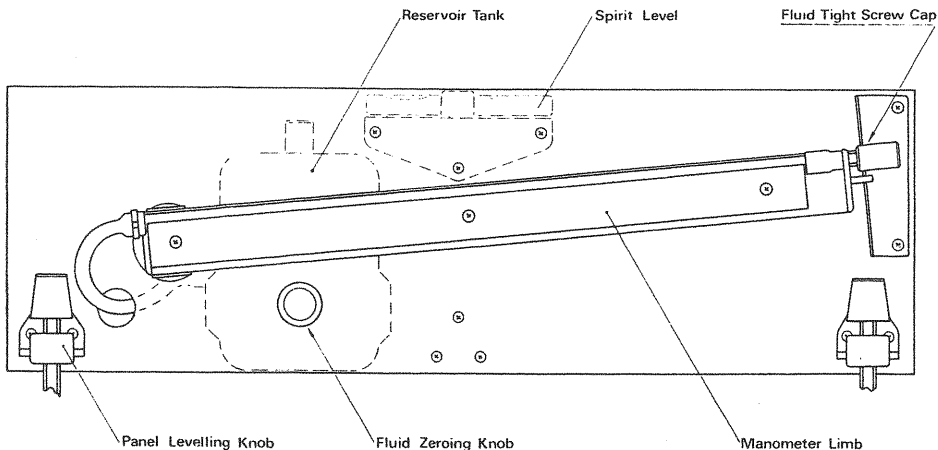
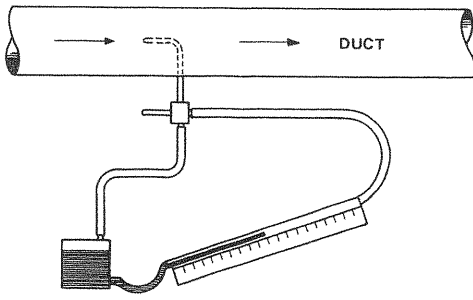


DIAGRAM 1

Setting-up Procedure

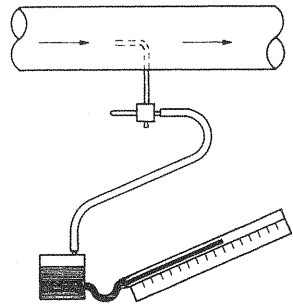
1. Remove the fluid-tight caps. It is safer to remove the cap from the tank first to release any slight pressure set up by a change in atmospheric conditions.
2. Using the plastic tubing, connect the manometer as required (see diagrams 2-6).
3. Level the instrument by adjusting the two knobs on the front of the panel. The two sensitive spirit-levels are set substantially parallel to lines between a flexible mounting at the rear and the two levelling screws at the front. Therefore each spirit-level is affected by only one adjusting screw and complete levelling in all directions is carried out quickly and accurately.
4. Bring the fluid to zero by rotating the knob below the manometer limb (anti-clockwise to increase pressure). Do not operate this adjustment before removing the fluid-tight caps from the manometer connections, otherwise pressure may be set up in the reservoir tank resulting in possible loss of fluid when one of the caps is removed. It is important to remember that when the inclination of the manometer has been altered it is essential to re-zero the fluid. If this is not carried out a false reading will be obtained. Do not operate this knob to its extreme limits to overcome low fluid level.
5. After using, always replace fluid-tight caps to prevent accidental spillage of the manometer fluid.



VELOCITY PRESSURE

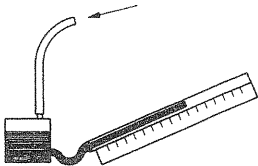
DIAGRAM 2

This diagram is correct for positive and negative systems.



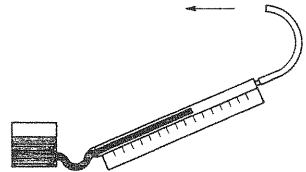
STATIC PRESSURE

DIAGRAM 3



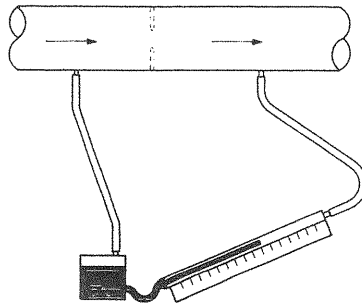
POSITIVE PRESSURE

DIAGRAM 4



NEGATIVE PRESSURE

DIAGRAM 5



DIFFERENTIAL PRESSURE
(ORIFICE PLATE)

DIAGRAM 6

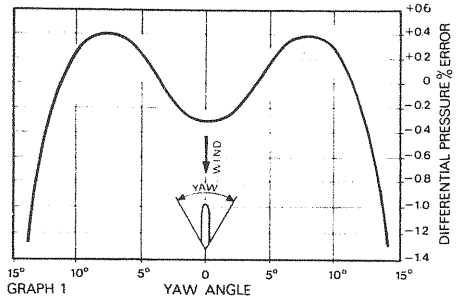
Measurement

To determine the flow of air in a ducted system it is necessary to carry out what is called a "Traverse" with the Pitot Static tube at a plane in a section of the duct, and at right angles to its walls. If possible the section should be chosen to be at least 6 duct diameters or widths downstream of any bend or obstruction in the system. Holes are drilled at appropriate points in the wall of the duct to enable the Pitot Static tube to be inserted and moved successively to the various positions shown in diagram 7 for circular airways and diagram 8 for rectangular airways. Sliding spring clip markers are fitted to the stem of the Pitot Static tube to indicate depth of insertion.

Care must always be taken to ensure that the head of the Pitot Static tube is held parallel to the walls of the duct. This can be checked by reference to the direction pointer on the tail of the Pitot tube.

Reliable results will only be obtained if the bulk of the flow in the duct is substantially parallel to its walls. If swirl or cross-flow is suspected this can be checked by inserting the Pitot Static tube in several positions and turning the head in both pitch and yaw to find the angle at which maximum Velocity Pressure reading is obtained. If this is not more than about 15° from the position parallel to the duct walls no great error will occur in the results. Pronounced swirl is often present in circular ducts, particularly downstream of such items as cyclone dust separators, axial fans, etc.

EFFECT OF YAW ANGLE ON PRESSURE OUTPUT OF MODIFIED ELLIPSOIDAL NOSE PITOT TUBE



With the combination of Airflow Precision Manometer, Pitot Static Tube and flexible tubing, a dwell of between 10 and 20 seconds at each test point will usually be sufficient to obtain a reading. Where fairly wide velocity variations are present between individual readings, it may take somewhat longer for the manometer to steady in a mean position.

The duct area in the test plane must be measured with care and the volume flow rate is determined by calculating the average velocity in the manner which follows and multiplying it by the measured duct area.

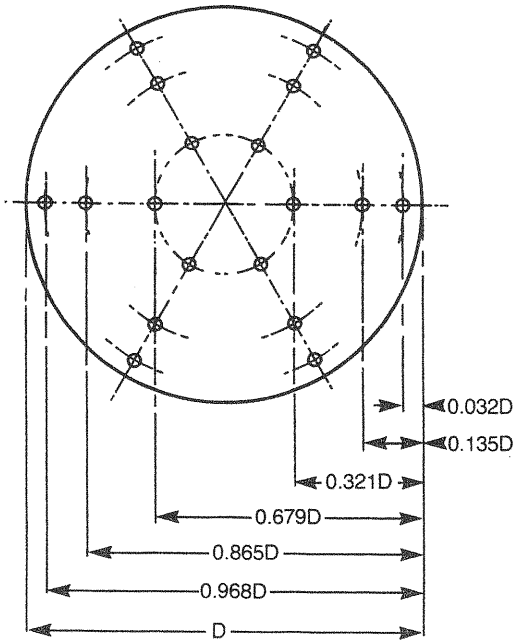


DIAGRAM 7

Note: Should difficulty in access make it impossible to traverse on more than two diameters; these should be mutually at right angles and the number of points on each line must be increased to 10.

The spacing should be as follows:
 0.019D 0.077D 0.153D 0.217D 0.361D
 0.639D 0.783D 0.847D 0.923D 0.981D

Log Linear rule for traverse points on 3 diameters in a circular duct

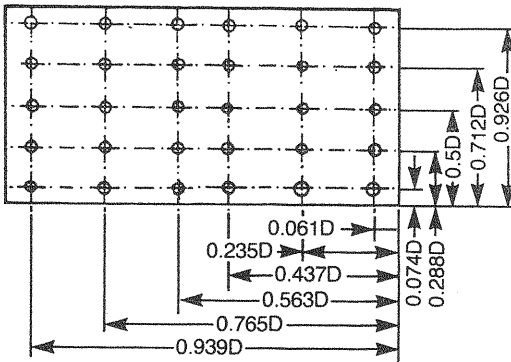


DIAGRAM 8

Position of alternative measuring points and traverse lines relative to side lengths for rectangular ducts

No. of points or traverse lines	Position relative to inner wall
5	0.074, 0.288, 0.5, 0.712, 0.926,
6	0.061, 0.235, 0.437, 0.563, 0.765, 0.939,
7	0.053, 0.203, 0.366, 0.5, 0.634, 0.797, 0.949, .

Log Tchebycheff Rule for Rectangular Ducts

AIR VELOCITY CALCULATIONS USING S.I. SCALES

The Standard formula for calculating velocity from velocity pressure is $V = 1.291 \sqrt{P_v}$. This is only correct for standard air density at 16°C and 1000 mbar atmospheric pressure.

For non-standard air conditions this equation becomes:

$$V = 1.291 \sqrt{\frac{1000 \times T}{B \times 289 \times 100000 + P_s}} \times P_v$$

- V = velocity m/s
- B = barometric pressure mbar
- T = absolute temperature °K
(=t°C+273 where t is
airstream temperature)
- Ps = static pressure Pa
- Pv = velocity pressure Pa

The expression $\frac{100000}{100000 + P_s}$

is a correction for the static pressure in the duct and may normally be ignored if Ps is less than 2500 Pa.

When calculating average velocity in a duct, the square roots of the velocities should be averaged. In practice however, no great error will be introduced by taking the square root of the average of velocity heads when the majority of the readings do not vary by more than about ± 25% from a mean figure.

AIR VELOCITY CALCULATIONS USING IMPERIAL SCALES

The standard formula for calculating velocity from velocity pressure is $V = 4000 \sqrt{P_v}$. This is only correct for standard air density at 68°F and 30 ins Hg atmospheric pressure.

For non-standard air conditions this equation becomes:

$$V = 4000 \sqrt{\frac{30 \times T}{B \times 528 \times 408 + P_s}} \times P_v$$

- V = velocity ft/min
- B = barometric pressure ins Hg
- T = absolute temperature °R
(=t°F+460 where t is
airstream temperature)
- Ps = static pressure ins wg
- Pv = velocity pressure ins wg

The expression $\frac{408}{408 + P_s}$

is a correction for the static pressure in the duct and may normally be ignored if Ps is less than 10 ins wg.

When calculating average velocity in a duct, the square roots of the velocities should be averaged. In practice however, no great error will be introduced by taking the square root of the average of velocity heads when the majority of the readings do not vary by more than about ± 25% from a mean figure.

AIR VELOCITY CALCULATIONS USING METRIC SCALES

The standard formula for calculating velocity from velocity pressure is $V = 4.05 \sqrt{P_v}$. This is only correct for standard air density at 20°C and 760 mm Hg atmospheric pressure.

For non-standard air conditions this equation becomes:

$$V = 4.05 \sqrt{\frac{760}{B} \times \frac{T}{293} \times \frac{10350}{10350 + P_s} \times P_v}$$

- V = velocity m/s
- B = barometric pressure mm Hg
- T = absolute temperature °K
(=t°C+273 where t is
airstream temperature)
- P_s = Static pressure H₂O
- P_v = velocity pressure mm H₂O

The expression $\frac{10350}{10350 + P_s}$ is a correction for the static pressure in the duct and may normally be ignored if P_s is less than 250 mm H₂O.

When calculating average velocity in a duct, the square roots of the velocities should be averaged. In practice however, no great error will be introduced by taking the square root of the average of velocity heads when the majority of the readings do not vary by more than about ± 25% from a mean figure.

PITOT STATIC TUBES

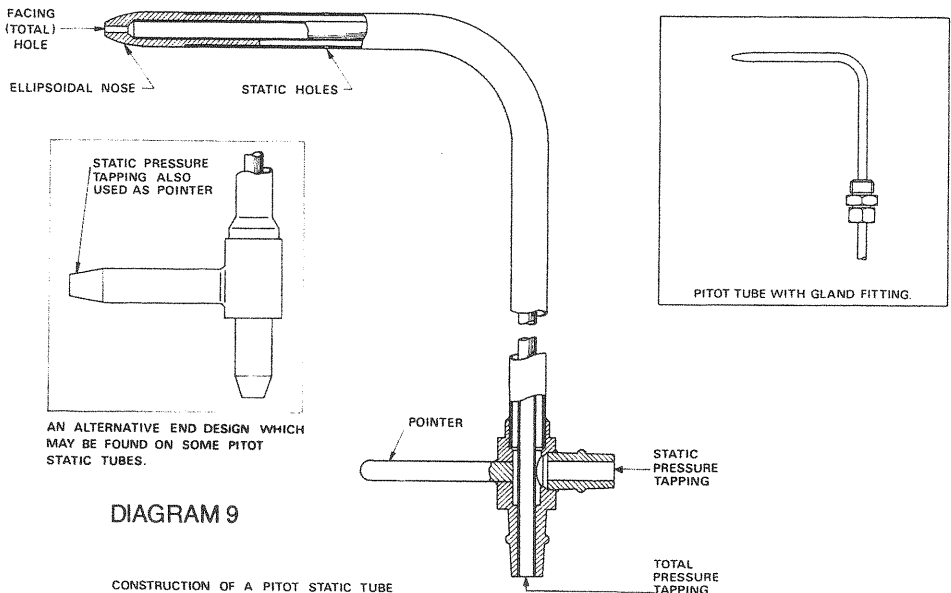
Developed between 1952 and 1954 by the National Physical Laboratory and manufactured since 1955 by Airflow Developments Limited, the modified ellipsoidal nose Pitot Static tube is now the only form of Pitot tube recommended in BS1042 (Part 2A) for measuring the flow of air in ducts by the traverse method. A range of sizes is available from Airflow.

When inserted into a duct with the tip facing directly into the flow it will enable air velocity at that point to be determined by connecting the Static Pressure and Total Pressure tapings (see diagram 9) to opposite sides of a sensitive manometer. The manometer will show the difference between the two pressures. This is the Velocity Pressure, from which the air velocity can be calculated.

At its head the Pitot tube features a modified ellipsoidal nose with a single forward facing hole for sensing Total Pressure, and a ring of side holes for

sensing Static Pressure. Both these inlets are individually connected by concentric tubes leading to tapping outlets at the tail of the tube (see diagram). The heel of the Tube is rounded to facilitate entry through the duct wall and the tail fitting is provided with a direction pointer so that the Pitot tube can be aligned accurately within the duct.

Constructed entirely in stainless steel to BS3605-321S18 with welded joints, the tube can be safely exposed to temperatures up to 680°C (1256°F) and for short periods up to 800°C (1472°F). Exceptions to this are the 2.3 mm and 4 mm diameter tubes which have silver brazed joints. These are suitable only for temperatures up to 550°C (1022°F). Sliding spring clip markers are fitted to the 4 mm, 8 mm and 9.5 mm diameter Pitot tube stems (not on glanded Pitots) to indicate depth of insertion and can be used at temperatures up to 276°C (529°F).



JOINTED PITOT TUBES

Pitot tubes are available for larger ducts, in sizes up to 4.26m (14ft). These larger tubes are manufactured in jointed form consisting of two parts, a Nose assembly and a Tail assembly,

each being enclosed in a tubular casing. The Tail and casing slides over a spigot on the Nose casing and is secured by a countersunk screw.

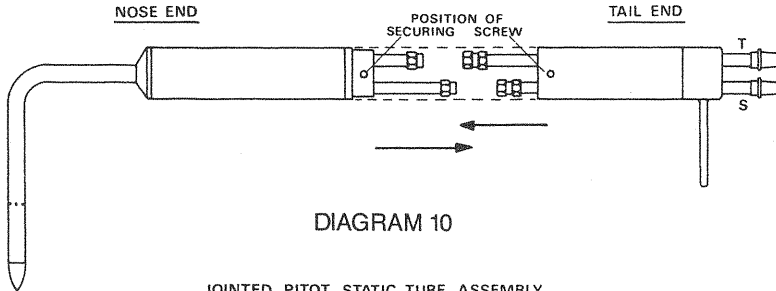


DIAGRAM 10

JOINTED PITOT STATIC TUBE ASSEMBLY

The Static and Total pressure tubes within the Nose and casing pass through the spigot to protrude 19 mm (3/4 in) (Total) and 70 mm 2 3/4 in) (Static), each tube end being fitted with pipe couplings. These couplings are marked "T" and "S" for easy

identification, and the Tail end pressure tubes are similarly marked. The Tail end outer casing slides freely over the pressure tubes.

The method of assembly is clearly shown in diagram 10.

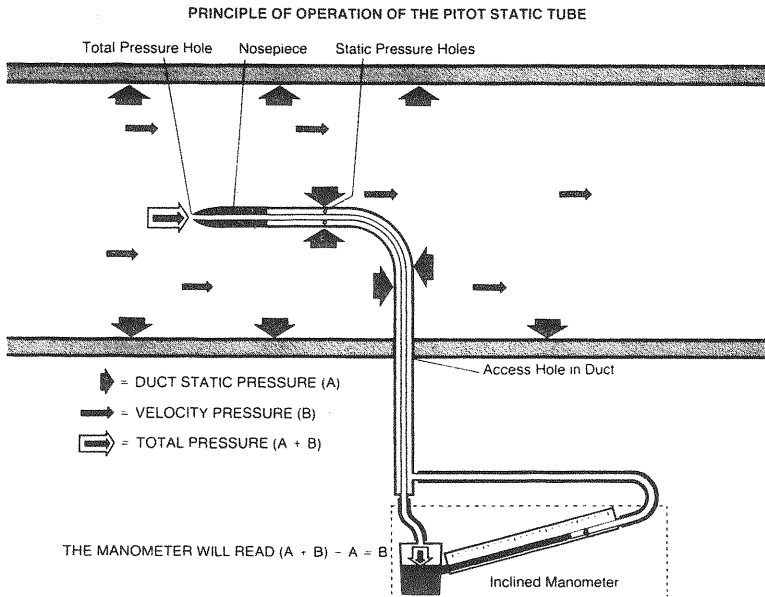


DIAGRAM 11

AIRFLOW™

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