ROYAL CANADIAN AIR CADETS

PROFICIENCY LEVEL THREE

INSTRUCTIONAL GUIDE

SECTION 1

EO M370.01 – IDENTIFY COMPONENTS OF THE PITOT STATIC SYSTEM

Total Time:	30 min

PREPARATION

PRE-LESSON INSTRUCTIONS

Resources needed for the delivery of this lesson are listed in the lesson specification located in A-CR-CCP-803/PG-001, Chapter 4. Specific uses for said resources are identified throughout the instructional guide within the TP for which they are required.

Review the lesson content and become familiar with the material prior to delivering the lesson.

Create slides of Annexes A and B.

PRE-LESSON ASSIGNMENT

N/A.

APPROACH

An interactive lecture was chosen for this lesson to review, clarify, emphasize, and summarize the pitot static system.

INTRODUCTION

REVIEW

N/A.

OBJECTIVES

By the end of this lesson the cadet shall have identified components of the pitot static system used in aircraft.

IMPORTANCE

It is important for cadets to identify components of the pitot static system because it is an important part of most aircraft. Familiarity with this system will allow cadets to gain an understanding of this common aircraft feature as it applies to both manufacturing and maintenance of aircraft.

Teaching Point 1	**Explain the Pitot Static System**
Time: 10 min	Method: Interactive Lecture

Flight instruments enable an aircraft to be operated with maximum performance and safety. One set of flight instruments, those of the pitot static system, measure and utilize air pressure.

Show the cadets Figure 17A-1.

There are two major parts of the pitot static system:

- the static pressure vent and lines, and
- the pitot pressure, also called impact pressure, chamber and lines.

The static pressure line provides the source of ambient (normal outside) air pressure for the operation of the altimeter, vertical speed indicator, and airspeed indicator, while the pitot pressure, or impact pressure line provides impact pressure to the airspeed indicator. The airspeed indicator is the only instrument that requires both air pressures.

STATIC VENT

The static vent is located where the air flowing past the aircraft will not disturb air pressure. This will vary with each model of aircraft. The static vent provides undisturbed air pressure for the static line.

The openings of the static vent must be checked during the pre-flight inspection to ensure that they are free from obstructions. Blocked or partially blocked openings should be cleaned by a certified mechanic. Blowing into these openings is not recommended because this could damage the instruments.

STATIC LINE

The static line is a hollow tube. Since the static line is vented to the free undisturbed air by the static vent, air pressure in the static line will change as the air pressure around the aircraft changes. As the aircraft gains altitude, air pressure in the static line will drop. This pressure change is transmitted through the static line to the instruments which utilize static air pressure. These instruments include the:

- altimeter,
- vertical speed indicator, and
- airspeed indicator.

PITOT PRESSURE CHAMBER

In the pitot static system, the impact air pressure (air striking the airplane because of its forward motion) is taken from a pitot tube. It is mounted in a location that provides minimum disturbance or turbulence caused by the motion of the aircraft through the air. Often, a pitot tube cover is placed over the pitot tube when the aircraft is parked to prevent foreign objects, such as insects, from entering the pitot static system. It is important that the pitot tube cover, if used, is removed prior to takeoff.

As the aircraft moves through the air, the impact pressure on the open pitot tube affects the pressure in the pitot pressure chamber. Any change of pitot (impact) pressure in the pitot pressure chamber is transmitted through a line connected to the airspeed indicator, which uses impact pressure for its operation.

In some aircraft, the static pressure is obtained at the same location as the pitot pressure. This is done by using a hybrid pitot-static tube. In a pitot-static tube, the static vent is combined with the impact tube. The effects are the same.

Show the cadets Figure 17A-2.

The opening of the pitot tube must be checked during the pre-flight inspection to assure that it is free from obstructions. Blocked or partially blocked openings should be cleaned by a certified mechanic. Blowing into these openings is not recommended because this could damage the instruments.

PITOT LINE

Any change of pressure in the pitot chamber is transmitted through a pitot line (a hollow tube) to the airspeed indicator, which uses impact pressure as well as static pressure for its operation.

OPERATION OF THE PITOT STATIC SYSTEM

As described above, the pitot static system of chambers and lines delivers two types of air pressure to flight instruments:

- static pressure, and
- pitot pressure.

When flight instruments are calibrated correctly, they will measure the air pressure that is delivered to them, relative to air pressure at sea level as well as impact pressure relative to static pressure. By measuring the air pressures in the static pressure and impact pressure lines, the calibrated instruments will present useful information about the aircraft’s position to the pilot.

Pitot static instrument error will almost always indicate blockage of the pitot tube, the static port, or both.

CONFIRMATION OF TEACHING POINT 1

QUESTIONS

Q1. What is the pitot static system used for?

Q2. How is static pressure change delivered to the instruments?

Q3. Which instrument measures pitot (impact) pressure?

ANTICIPATED ANSWERS

A1. For operating instruments that measure and use air pressure.

A2. It is delivered through lines.

A3. The airspeed indicator.

Teaching Point 2	**Explain Instruments of the Pitot Static System**
Time: 15 min	Method: Interactive Lecture

AIRSPEED INDICATOR

> Show the cadets Figures 17B-1 and 17B-2.

The airspeed indicator is a sensitive, differential pressure gauge, which measures and shows the difference between pitot, or impact, pressure and static pressure. These two pressures will be equal when the airplane is parked on the ground in calm air. When the aircraft moves through the air, the pressure in the pitot line becomes greater than the pressure in the static line. This difference in pressure is registered by the airspeed pointer on the face of the instrument, which is calibrated in miles per hour, knots, or both.

As the pressure in the pitot tube and pitot line increases, the diaphragm in the airspeed indicator expands. The diaphragm will then maintain its size while the impact pressure is stable. As the impact pressure decreases, the diaphragm contracts accordingly. This expansion and contraction of the diaphragm is reflected in the readout of the airspeed indicator via a system of gears and shafts.

Prior to takeoff, the airspeed indicator should read zero unless there is a strong wind blowing directly into the pitot tube.

VERTICAL SPEED INDICATOR

> Show the cadets Figures 17B-3 and 17B-4.

The vertical speed indicator (VSI), sometimes called a vertical velocity indicator (VVI), indicates whether the airplane is climbing, descending, or in level flight. The rate of climb or descent is indicated in thousands of feet per minute. If properly calibrated, the VSI indicates zero in level flight.

Although the VSI operates solely from static pressure, it measures pressure difference; the pressure now relative to the pressure a moment ago. It contains a diaphragm with connecting linkage and gearing to the indicator pointer inside an airtight case. The inside of the diaphragm is connected directly to the static line of the pitot static system. The area outside the diaphragm, which is inside the instrument case, is also connected to the static line, but through a restricted orifice (calibrated leak).

Both the diaphragm and the case receive air from the static line at existing atmospheric pressure. When the airplane is on the ground or in level flight, the pressures inside the diaphragm and the instrument case remain the same and the pointer indicates zero.

However, when the aircraft climbs or descends, the pressure inside the diaphragm changes immediately, but due to the metering action of the restricted passage, the case pressure remains higher or lower for a short time, causing the diaphragm to contract or expand. This causes a pressure difference that is relative to climb rate and is indicated on the instrument needle as a climb or descent.

ALTIMETER

Show the cadets Figures 17B-5 and 17B-6.

The altimeter measures the height of the aircraft above sea level. Since it is the only instrument that gives altitude information, the altimeter is one of the most vital instruments in the aircraft. However, the altimeter is calibrated with respect to standard atmospheric conditions, while air will actually seldom meet those standard conditions. Variations in atmospheric pressure and temperature will introduce errors into the altimeter's measurements. To use the altimeter effectively, its operation and how atmospheric pressure and temperature affect it must be thoroughly understood.

A stack of sealed aneroid wafers comprises the main component of the altimeter. Aneroid wafers expand and contract with changes in atmospheric pressure, in this case, pressure from the static source. The mechanical linkage translates these changes into pointer movements on the indicator.

The pressure altimeter is an adaptation of an aneroid barometer that measures the pressure of the atmosphere at the level where the altimeter is located and presents it as an altitude indication in feet instead of simple air pressure, as a barometer would. The altimeter uses static pressure as its source of operation. Air is denser at sea level than aloft, so as altitude increases, atmospheric pressure decreases. This difference in pressure at various levels causes the altimeter to indicate changes in altitude.

Since altimeters are calibrated with respect to standard atmospheric conditions as described above, it is necessary to adjust altimeters to non-standard static pressures that result from weather fronts. For example, if flying from a high-pressure area to a low-pressure area without adjusting the altimeter, the actual altitude of the aircraft would be LOWER than the indicated altitude because the altimeter was originally set to compensate for a non-standard high air pressure. Arriving in the low-pressure area, it must be reset to compensate for a non-standard low air pressure.

An old saying, "High to low, look out below" is a way of remembering which condition is most dangerous. When flying from a low-pressure area to a high-pressure area without adjusting the altimeter, the actual altitude of the airplane is HIGHER than the indicated altitude because the altimeter was originally set to compensate for a non-standard low air pressure. Arriving in the high-pressure area, it must be reset to compensate for a non-standard high air pressure.

CONFIRMATION OF TEACHING POINT 2

QUESTIONS

Q1. What does an airspeed indicator measure?

Q2. What does a vertical speed indicator measure?

Q3. What does an altimeter measure?

ANTICIPATED ANSWERS

A1. The difference between static pressure and pitot, or impact, pressure.

A2. The difference between static air pressure now and static air pressure a moment ago.

A3. The difference between static air pressure and a standard air pressure, usually at sea level.

END OF LESSON CONFIRMATION

QUESTIONS

Q1. Which flight instrument measures pitot, or impact pressure?

Q2. Why are pitot tube covers used?

Q3. What is the difference between a pitot tube and a pitot-static tube?

ANTICIPATED ANSWERS

A1. The airspeed indicator.

A2. To prevent blockage of the pitot tube when the aircraft is parked.

A3. A pitot-static tube is a combination of a pitot tube with a static vent.

CONCLUSION

HOMEWORK/READING/PRACTICE

N/A.

METHOD OF EVALUATION

N/A.

CLOSING STATEMENT

The pitot static system, which is based on different air pressures, is found on most aircraft. Understanding how the system works allows a pilot or mechanic to use instruments correctly and to diagnose problems that are encountered with pitot static systems.

INSTRUCTOR NOTES/REMARKS

N/A.

REFERENCES

C3-116 (ISBN 0-9680390-5-7) MacDonald, A. F., & Peppler, I. L. (2000). *From the Ground Up: Millennium Edition*. Ottawa, ON: Aviation Publishers Co. Limited.