ROYAL CANADIAN AIR CADETS

PROFICIENCY LEVEL FOUR

INSTRUCTIONAL GUIDE

SECTION 3

EO M432.03 – DESCRIBE ENGINE INSTRUMENTS

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-804/PG-001, *Proficiency Level Four Qualification Standard and Plan*, 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.

Prepare slides located at Attachment A.

Photocopy the Aero Engines Review Worksheet located at Attachment B for each cadet.

PRE-LESSON ASSIGNMENT

Nil.

APPROACH

An interactive lecture was chosen for TPs 1–4 to clarify, emphasize, and summarize engine instruments.

An in-class activity was chosen for TP 5 as it is an interactive way to reinforce the topic and confirm the cadets' comprehension of aero engine systems.

INTRODUCTION

REVIEW

Nil.

OBJECTIVES

By the end of this lesson the cadet shall have described engine instruments.

IMPORTANCE

It is important for cadets to be able to describe engine instruments as a solid understanding of engine instruments provides knowledge for potential instructional duties and is part of the fundamentals that cadets pursuing future aviation training will require.

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Teaching point 1 **Describe the oil pressure and oil temperature gauges.**

Time: 5 min Method: Interactive Lecture



Show slide of Figure A-1 to the cadets.

One of the principle engine instruments is the oil pressure gauge. It is usually positioned beside the oil temperature and fuel gauges. The instrument is calibrated in pounds per square inch (psi) and indicates the oil pressure supplied by the oil pump to lubricate the engine.

The gauge should be checked immediately after the engine has been started. As the oil warms, the reading should adjust to operational pressure. This may take up to 15 minutes. If the pressure remains high, the engine is not getting proper lubrication. High oil pressure pushes oil into the combustion chamber where it burns causing a smoky exhaust and badly carbonized piston heads, valve seats, cylinder heads and more.

Low oil pressure causes more serious problems as no film of oil goes between the working surfaces of the engine. Metal against metal rubbing causes main bearings to wear out.

The oil temperature gauge records the temperature of the oil in degrees Fahrenheit or Celsius. As the oil warms during start-up, the pressure should read high and the temperature low. Both instruments should approach their normal readings as the oil warms.



An abnormal drop in oil pressure and rise in oil temperature indicates trouble. Also, no change in oil pressure but a change in oil temperature is a warning of excessive friction or overload in the engine.

CONFIRMATION OF TEACHING POINT 1

QUESTIONS:

Q1. Which two gauges measure the properties of the engine oil?

Q2. When should the oil pressure gauge be first checked?

Q3. What changes in oil pressure and temperature indicates trouble?

ANTICIPATED ANSWERS:

A1. Oil pressure and temperature gauges.

A2. Immediately after the engine has been started.

A3. An abnormal drop in oil pressure and rise in oil temperature.

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Teaching point 2 **Describe the cylinder head temperature gauge.**

Time: 5 min Method: Interactive Lecture



Show slide of Figure A-2 to the cadets.

The cylinder head temperature gauge shows the temperature of one or all engine cylinder heads. This reading shows the pilot the effectiveness of the engine cooling system. Extremely high cylinder head temperatures indicate an immediate sign of engine overload which can result in detonation, pre-ignition, and eventual engine failure.

Detonation. Abnormally rapid combustion due to the inability of fuel to burn slowly. Detonation is dangerous and expensive, causing high stress on engine parts and overheating.

Pre-ignition. The premature ignition of the mixture due to glowing carbon particles. It is sometimes confused with detonation. Pre-ignition is often experienced when attempting to start a hot engine and results in a backfire.

CONFIRMATION OF TEACHING POINT 2

QUESTIONS:

Q1. Which gauge measures the effectiveness of the engine cooling system?

Q2. What do extremely high cylinder head temperatures indicate?

Q3. In what can engine overload result?

ANTICIPATED ANSWERS:

A1. The cylinder head temperature gauge.

A2. An immediate engine overload.

A3. Detonation, pre-ignition and eventual engine failure.

Teaching point 3 **Describe the tachometer.**

Time: 5 min Method: Interactive Lecture



Show slide of Figure A-3 to the cadets.

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The tachometer shows the speed at which the engine crankshaft is turning in hundreds of revolutions per minute (rpm). The tachometer records the engine hours of operation. The more common types of tachometer, are mechanical including centrifugal, or magnetic and electrical, which include direct current, or alternating current.

An aircraft with a fixed pitch propeller will only have a tachometer to read the engine power produced. It records the rpm at which the engine cranks and the propeller turns.

An aircraft with a controllable pitch or a constant speed propeller uses two gauges. The tachometer shows the rpm settings as controlled by the propeller control. The manifold pressure gauge shows the power produced by the engine.

The tachometer is marked with colour-coded arcs to indicate the proper range of engine operation, including:

- green indicating normal range of operation;
- yellow indicating the caution range and possible problems; and
- red indicating the maximum limit.

CONFIRMATION OF TEACHING POINT 3

QUESTIONS:

Q1. What does the tachometer show?

Q2. How is the tachometer marked?

Q3. Which colours are used to indicate the proper range of engine operation?

ANTICIPATED ANSWERS:

A1. The speed at which the engine crankshaft is turning.

A2. With colour-coded arcs.

A3. Green (normal range), yellow (caution range), and red (maximum limit).

Teaching point 4 **Describe the manifold pressure gauge.**

Time: 5 min Method: Interactive Lecture



Show slide of Figure A-4 to the cadets.

The manifold pressure gauge also has colour-coded arcs displayed on the gauge to indicate the normal operating range and operation limits. The gauge indicates in inches of mercury the fuel / air pressure in the engine intake manifold at the point between the carburetor and the cylinders.

With an aircraft fitted with a constant speed propeller, the rpm setting will remain constant. The manifold pressure gauge is the only instrument to show any fluctuations in the engine power output. A reduction in manifold pressure can indicate carburetor icing.

When the engine is not running, the reading on the manifold pressure gauge will be of the existing atmospheric pressure.

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Excessive manifold pressure raises the compression pressure causing high stress on the pistons and cylinder assemblies. It also produces excessive temperature which may cause scoring on the pistons, sticking rings, and burned out valves.



When increasing power, increase the rpm first and then the manifold pressure.

When decreasing power, decrease the manifold pressure first and then the rpm.

CONFIRMATION OF TEACHING POINT 4

QUESTIONS:

Q1. What does the manifold pressure gauge indicate?

Q2. What can a reduction in manifold pressure indicate?

Q3. What will the reading on the manifold pressure gauge be when the engine is not running?

ANTICIPATED ANSWERS:

A1. The gauge indicates in inches of mercury the fuel / air pressure in the engine intake manifold at the point between the carburetor and the cylinders.

A2. Carburetor icing.

A3. The existing atmospheric pressure.

Teaching point 5 **Conduct an in-class activity to review aero engines.**

Time: 5 min Method: In-Class Activity

OBJECTIVE

The objective of this activity is to have the cadets review aero engine systems.

RESOURCES

- Pen / pencil,
- Aero Engines Review Worksheet located at Attachment B, and
- Aero Engines Review Worksheet Answer Key located at Attachment C.

ACTIVITY LAYOUT

Nil.

ACTIVITY INSTRUCTIONS

1. Distribute a worksheet to each cadet.

2. Have the cadets complete the worksheet.

3. When the cadets have completed their worksheet, have them review their answers using the answer key located at Attachment C.

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SAFETY

Nil.

CONFIRMATION OF TEACHING POINT 5

The cadets' participation in the activity will serve as the confirmation of this TP.

END OF LESSON CONFIRMATION

The cadets' completion of the Aero Engines Review Worksheet will serve as the confirmation of this lesson.

CONCLUSION

HOMEWORK / READING / PRACTICE

Additional time may be required for the cadets to complete the worksheet.

METHOD OF EVALUATION

This EO is assessed IAW A-CR-CCP-804/PG-001, *Proficiency Level Four Qualification Standard and Plan*, Chapter 3, Annex B, Aviation Subjects–Combined Assessment PC.

CLOSING STATEMENT

Being able to describe engine instruments is important for understanding more complex material. A solid understanding of engine instruments is required to pursue future aviation training.

INSTRUCTOR NOTES / REMARKS

Nil.

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.

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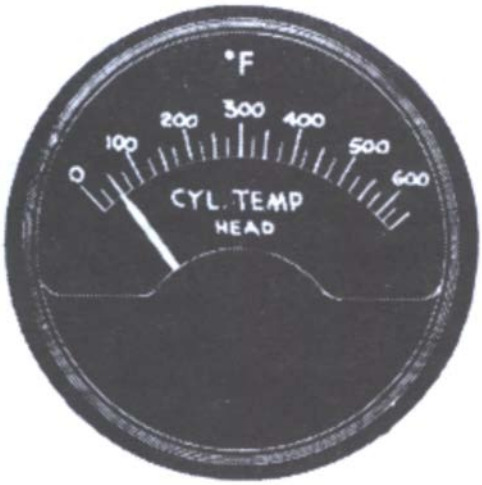
Oil Pressure Gauge



Oil Temperature Gauge

Note. From From the Ground Up (p. 133), by A. F. MacDonald and I. L. Pepper, 2000, Ottawa, ON: Aviation Publishers Co. Limited. Copyright 2000 by Aviation Publishers Co. Limited.

Figure A-1 Oil Pressure and Temperature Gauges



Note. From From the Ground Up (p. 133), by A. F. MacDonald and I. L. Pepper, 2000, Ottawa, ON: Aviation Publishers Co. Limited. Copyright 2000 by Aviation Publishers Co. Limited.

Figure A-2 Cylinder Head Temperature Gauge

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Figure A-3 Tachometer



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Figure A-4 Manifold Pressure Gauge

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AERO ENGINES REVIEW WORKSHEET

1. Where should the fuel tank be positioned in a gravity feed system?

   _____.

2. What system do low-wing configured aircraft and large aircraft with a large volume of fuel use?

   _____.

3. What does the fuel selector valve, used by the pilot, do?

   _____.

4. A rich mixture is used for:

   _____.

5. How are the fuel / air proportions calculated?

   _____.

6. Which propeller would not be good for taking off and climbing?

   _____.

7. What is maintained throughout most of the diameter of the propeller by means of the variation in airfoil sections and the angle of attack?

   _____.

8. What is the distance a propeller travels forward in one revolution?

   _____.

9. What colour-coded arcs are found on the tachometer?

   _____.

10. What reading will register on the manifold pressure gauge when the engine is not running?

    _____.

11. What occurs to an engine as the altitude increases and the air becomes less?

    _____.

12. A feathered propeller is in:

    _____.

13. In what units is the oil pressure gauge calibrated?

    _____.

14. What does the tachometer show?

    _____.

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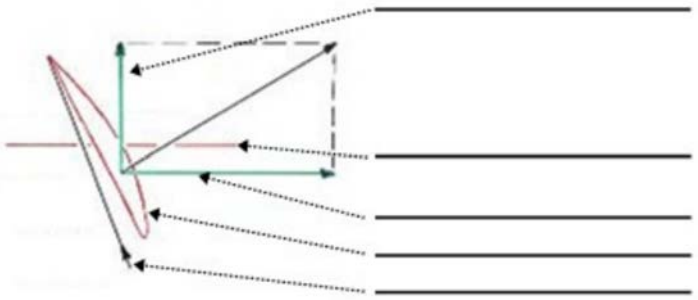
15. Label the following parts on the diagram below.

    1. Thrust
    2. Relative airflow
    3. Propeller
    4. Axis of rotation
    5. Propeller torque force



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AERO ENGINES REVIEW WORKSHEET ANSWER KEY

1. Where should the fuel tank be positioned in a gravity feed system?

   Above the carburetor.

2. What system do low-wing configured aircraft and large aircraft with a large volume of fuel use?

   Pressure-feed system.

3. What does the fuel selector valve, used by the pilot, do?

   Select desired fuel tank to draw fuel and shut off the flow of fuel from the tanks.

4. A rich mixture is used for:

   high power settings.

5. How are the fuel / air proportions calculated?

   By volume.

6. Which propeller would not be good for taking off and climbing?

   Coarse pitch.

7. What is maintained throughout most of the diameter of the propeller by means of the variation in airfoil sections and the angle of attack?

   Thrust.

8. What is the distance a propeller travels forward in one revolution?

   Pitch.

9. What colour-coded arcs are found on the tachometer?

   Green, yellow, red.

10. What reading will register on the manifold pressure gauge when the engine is not running?

    Atmospheric pressure.

11. What occurs to an engine as the altitude increases and the air becomes less dense?

    Power decreases.

12. A feathered propeller is in:

    extreme coarse pitch position and stops turning.

13. In what units is the oil pressure gauge calibrated?

    Pounds per square inch.

14. What does the tachometer show?

    The speed at which the engine crankshaft is turning.

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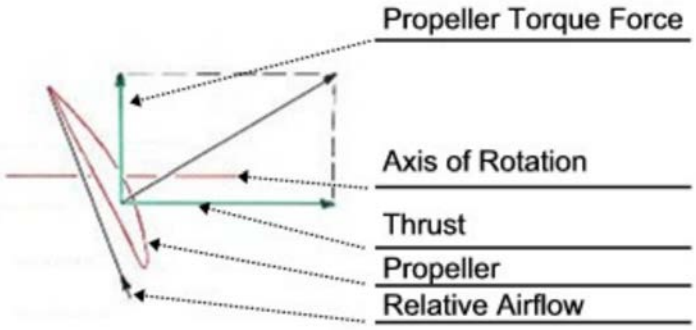

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