

MODULE 01

FOR B1 & B2 CERTIFICATION

MATHEMATICS

Aviation Maintenance Technician Certification Series



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WELCOME

The publishers of this Aviation Maintenance Technician Certification Series welcome you to the world of aviation maintenance. As you move towards EASA certification, you are required to gain suitable knowledge and experience in your chosen area. Qualification on basic subjects for each aircraft maintenance license category or subcategory is accomplished in accordance with the following matrix. Where applicable, subjects are indicated by an "X" in the column below the license heading.

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We wish you good luck and success in your studies and in your aviation career!

REVISION LOG

VERSION	EFFECTIVE DATE	DESCRIPTION OF CHANGE
001	2016 01	Module Creation and Release
002	2017 03	Format Update and Minor Corrections

MATHEMATICS

Welcome	iii
Revision Log.....	iii
Forward.....	iv
Contents	vii

SUB-MODULE 01

ARITHMETIC

Knowledge Requirements	1.1
Arithmetic In Aviation Maintenance	1.2
Arithmetic	1.2
The Integers	1.2
Whole Numbers	1.2
Addition of Whole Numbers	1.2
Subtraction of Whole Numbers	1.3
Multiplication of Whole Numbers	1.3
Division of Whole Numbers	1.4
Factors and Multiples	1.4
Lowest Common Multiple (LCM) and Highest Common Factor (HCF)	1.5
Prime Numbers	1.5
Prime Factors	1.5
Lowest Common Multiple using Prime Factors Method	1.6
Highest Common Factor using Prime Factors Method	1.7
Precedence	1.7
Use of Variables	1.8
Reciprocal	1.8
Positive and Negative Numbers (Signed Numbers).....	1.9
Addition of Positive and Negative Numbers	1.9
Subtraction of Positive and Negative Numbers	1.9
Multiplication of Positive and Negative Numbers ..	1.9
Division of Positive and Negative Numbers	1.9
Fractions	1.9
Finding The Least Common Denominator (LCD)	1.10
Reducing Fractions	1.11
Mixed Numbers.....	1.11
Addition and Subtraction of Fractions	1.11
Multiplication of Fractions	1.12
Division of Fractions	1.13
Addition of Mixed Numbers.....	1.13
Subtraction of Mixed Numbers.....	1.13
The Decimal Number System	1.14
Origin and Definition	1.14
Addition of Decimal Numbers	1.14
Subtraction of Decimal Numbers	1.14

Multiplication of Decimal Numbers.....	1.14
Division of Decimal Numbers.....	1.15
Rounding Off Decimal Numbers	1.16
Converting Decimal Numbers To Fractions	1.16
Decimal Equivalent Chart	1.17
Ratio	1.18
Aviation Applications of Ratios	1.18
Proportion	1.19
Solving Proportions	1.19
Average Value	1.19
Percentage.....	1.20
Expressing a Decimal Number as a Percentage	1.20
Expressing a Percentage as a Decimal Number	1.20
Expressing a Fraction as a Percentage.....	1.20
Finding a Percentage of a Given Number.....	1.20
Finding What Percentage One Number Is of Another	1.20
Finding A Number When A Percentage of It Is Known	1.21
Powers and Indices	1.21
Squares and Cubes.....	1.21
Negative Powers.....	1.21
Law of Exponents	1.22
Powers of Ten.....	1.22
Roots	1.22
Square Roots	1.22
Cube Roots	1.24
Fractional Indices	1.24
Scientific and Engineering Notation	1.24
Converting Numbers From Standard Notation To Scientific Or Engineering Notation	1.24
Converting Numbers From Scientific or Engineering Notation To Standard Notation	1.25
Addition, Subtraction, Multiplication, Division of Scientific and Engineering Numbers	1.25
Denominated Numbers	1.25
Addition of Denominated Numbers	1.25
Subtraction of Denominated Numbers	1.26
Multiplication of Denominated Numbers.....	1.27
Division of Denominated Numbers	1.27
Area and Volume	1.28
Rectangle	1.28
Square	1.28
Triangle	1.29
Parallelogram.....	1.29
Trapezoid	1.29
Circle	1.30
Ellipse	1.30

CONTENTS

Wing Area	1.30
Volume	1.31
Rectangular Solids.....	1.31
Cube	1.32
Cylinder	1.32
Sphere.....	1.33
Cone	1.33
Weights and Measures	1.34
Questions	1.37
Answers	1.38

SUB-MODULE 02

ALGEBRA

Knowledge Requirements	2.1
Algebra In Aviation Maintenance	2.2
Algebra	2.2
Evaluating Simple Algebraic Expressions	2.3
Addition.....	2.3
Subtraction.....	2.3
Multiplication	2.4
Division	2.4
Retaining The Relationship During Manipulation	2.4
Addition and Subtraction of Expressions With Parentheses/Brackets.....	2.5
Order of Operations	2.5
Simple Algebraic Fractions	2.5
Algebraic Equations	2.6
Linear Equations	2.6
Expanding Brackets.....	2.7
Single Brackets	2.7
Multiplying Two Bracketed Terms.....	2.7
Solving Linear Equations.....	2.8
Quadratic Equations	2.9
Finding Factors	2.9
Method 1: Using Brackets	2.9
Method 2: The 'Box Method'	2.9
Method 3: Factorize out Common Terms	2.10
Method 4: Difference of Two Squares.	2.10
Look at the following quadratic equations:	2.10
Solving Quadratic Equations	2.11
Solving Using Factors	2.11
Using the Quadratic Formula	2.11
Simultaneous Equations	2.12
More Algebraic Fractions.....	2.13
Indices and Powers In Algebra	2.13
Using Rules of Exponents to Solve Equations	2.15
Logarithms	2.15

Transposition of Formulae	2.17
Number Bases.....	2.18
The Binary Number System	2.18
Place Values	2.18
The Octal Number System	2.19
The Hexadecimal Number System	2.20
Number System Conversion.....	2.20
Binary, Octal and Hexadecimal to base10 (Decimal)	2.20
Decimal to either Binary, Octal or Hexadecimal	2.20
Questions	2.23
Answers	2.24

SUB-MODULE 03

GEOMETRY

Knowledge Requirements	3.1
Geometry In Aviation Maintenance	3.2
Simple Geometric Constructions.....	3.2
Angles	3.2
Radians	3.2
Converting Between Degrees and Radians	3.3
Degrees To Radians.....	3.3
Radians To Degrees.....	3.3
Properties of Shapes	3.3
Triangles.....	3.3
Four Sided Figures	3.4
Square	3.4
Rectangle.....	3.4
Rhombus	3.4
Parallelogram	3.4
Trapezium	3.4
Kite	3.4
Graphical Representations	3.4
Interpreting Graphs and Charts	3.4
Graphs With More Than Two Variables.....	3.5
Cartesian Coordinate System	3.7
Graphs of Equations and Functions	3.8
What is a Function?	3.8
Linear Functions and their Graphs	3.8
Slope of a Line	3.9
y-axis Intercept	3.10
Quadratic Functions	3.11
Trigonometric Functions	3.14
Right Triangles, Sides and Angles	3.14
Trigonometric Relationships, Sine, Cosine and Tangent	3.14
Using Sine, Cosine and Tangent Tables	3.14

Trigonometric Ratios for Angles Greater Than 90°	3.16
Inverse Trigonometric Ratios	3.16
Inverse Sine	3.16
Inverse Cosine	3.16
Inverse Tangent	3.16
Pythagoras' Theorem	3.16
Graphs of Trigonometric Functions	3.17
Polar Coordinates	3.18
Questions	3.21
Answers	3.22
Reference	R.1
Glossary	G.1
Index	I.1

GEOMETRY IN AVIATION MAINTENANCE

In this sub-module we will first look at some properties of different shapes e.g. angles, number of sides. We will then consider *functions* and their graphs. Aircraft maintenance data is often presented on a graph. Explanation and examples of how graphs are constructed, used and how to interpret the vital information

conveyed by graphs are given in this sub-module. Since the use of geometry and calculations are important when fabricating parts for structural repair, simple trigonometry and trigonometric relationships are also explored. Trigonometric functions are also important in acoustics, electricity and electronics.

SIMPLE GEOMETRIC CONSTRUCTIONS

ANGLES

In *sub-module 01*, in the section on Areas, **Figure 1-15** shows the different types of triangle. We will now look at different types of angles. (**Figure 3-1**)

Angles are measured either in degrees or radians. **Figure 3-2** shows the angle of one radian.

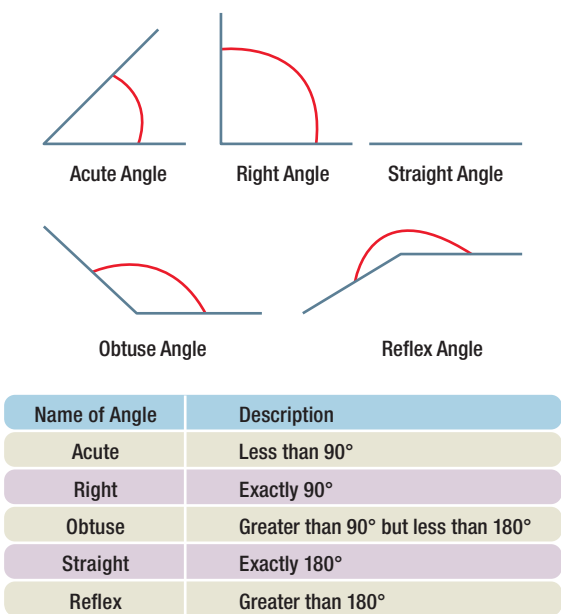


Figure 3-1. Various types of angles.

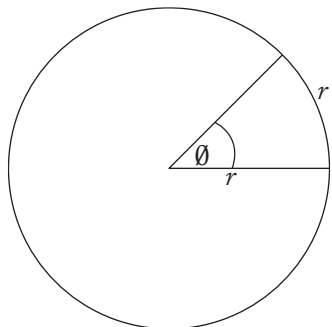


Figure 3-2. Showing an angle of one radian.

Degrees are given the symbol °. A degree is $\frac{1}{360}$ of a full circle. In other words a full circle is divided into 360°. The reason for this type of division is that the ancient Babylonians and Persians believed that there were 360 days in a year! Degrees are further divided in to 60 minutes. Minutes have the symbol '. Each minute is divided into 60 seconds. Seconds are given the symbol ''.

An angle with the measure of 36 degrees, 16 minutes and 34 seconds is therefore written as 36°16' 34''. When using degree measure sometimes decimal points of degrees are used. For example:

$$72^{\circ}30' = 72.5^{\circ}$$

RADIANS

Radians have no symbol, sometimes however, to avoid confusion, they are written with the word 'radians' after the numerical value.

One radian is defined to be equivalent to the angle subtended at the center of a circle by an arc equal in length to the radius, r . There are 2π radians in a full circle. **Figure 3-3** shows a comparison of degree and radian measurement for every quarter circle.

Degrees	Radians
0°	0
90°	$\frac{\pi}{2}$
180°	π
270°	$\frac{3\pi}{2}$
360°	2π

Figure 3-3. Degree and radian measurement for every quarter circle.

CONVERTING BETWEEN DEGREES AND RADIANS

Degrees To Radians

To convert from degrees to radians (and vice versa) we use the fact that:

$$180^\circ = \pi$$

Dividing both sides by 180° gives:

$$1^\circ = \frac{\pi}{180}$$

So, to convert degrees to radians, we multiply by $\frac{\pi}{180}$.

Example:

Convert 27° and 195° to radians

$$27^\circ = 27 \times \frac{\pi}{180} \text{ radians} = \frac{3\pi}{20} \text{ radians}$$

$$195^\circ = 195 \times \frac{\pi}{180} \text{ radians} = \frac{13\pi}{12} \text{ radians}$$

Radians To Degrees

To convert from radians to degrees we also use the fact that:

$$\pi = 180^\circ$$

Dividing each side by π gives:

$$1 = \left(\frac{180}{\pi}\right)^\circ$$

So, to convert radians to degrees we multiply by $\frac{180}{\pi}$.

Example:

Convert 5 and $\frac{2\pi}{3}$ radians to degrees.

$$5 \text{ radians} = 5 \times \left(\frac{180}{\pi}\right)^\circ = \frac{900}{\pi}^\circ$$

$$\frac{2\pi}{3} \text{ radians} = \frac{2\pi}{3} \times \left(\frac{180}{\pi}\right)^\circ = \frac{360}{3} = 120^\circ$$

PROPERTIES OF SHAPES

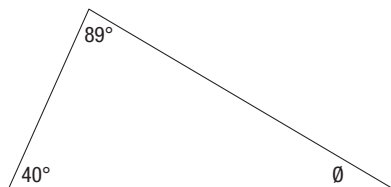
In *sub-module 01* we showed how to calculate the areas and volumes of different shapes. In this sections we will look at the properties of shapes e.g. number of sides, angles etc.

TRIANGLES

All triangles have three sides and the sum of the angles in any triangle is 180° . There are five types of triangle, as described in **Figure 3-4**. A diagram of these triangles is given in *sub-module 01*.

Example:

For the triangle shown below, what is the measure of the angle θ ?



Since the sum of the angles in a triangle is 180° ,

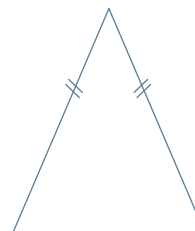
$$\theta = 180^\circ - (89^\circ + 40^\circ) = 51^\circ$$

Five Types of Triangles	
Right Angle	Has one 90° angle.
Equilateral	All angles 60° . All sides equal length.
Isosceles	Has two angles the same and two sides the same.
Scalene	Has all three angles and all three sides different.
Obtuse	Has one obtuse angle.

Figure 3-4. A description of the five types of triangles.

Example:

State the type of triangle shown below and give a reason for your answer.



This is an Isosceles triangle, it has two sides the same length.

FOUR SIDED FIGURES

There are six types of four sided shapes. (*Figure 3-5*)

SQUARE

The square has four sides of equal length. Each of the interior angles is 90° . The diagonals are equal and bisect each other. This means they divide each other equally.

RECTANGLE

The rectangle has two pairs of opposite and equal sides. Each of the interior angles is 90° . The diagonals are equal and bisect each other.

RHOMBUS

The rhombus has four sides of equal length. The diagonals are not equal in length. The diagonals bisect each other.

PARALLELOGRAM

The parallelogram has two pairs of opposite, equal and parallel sides. The diagonals are not equal in length. The diagonals bisect each other.

TRAPEZIUM

This shape has one pair of opposite sides that are parallel to each other.

KITE

A kite has two pairs of sides of equal length.

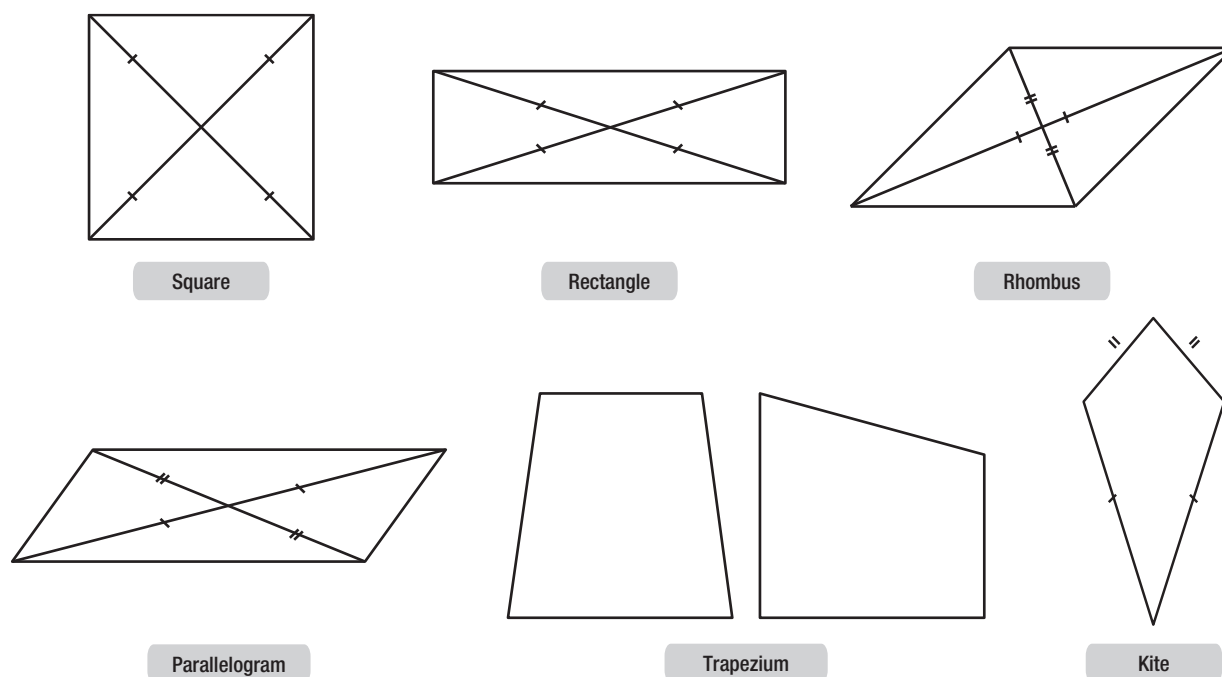


Figure 3-5. Six types of four sided shapes.

GRAPHICAL REPRESENTATIONS

Graphs and charts are pictorial presentations of data, equations and formulas. Through their use, the relationship between two or more quantities may be more clearly understood. *Graphs* show certain conditions or relationships at a glance that might require considerable time to ascertain from the same information in a written description or table.

INTERPRETING GRAPHS AND CHARTS

The words graph and chart are synonymous. Aviation maintenance technicians are more concerned with reading and interpreting the information presented on graphs and charts than they are in actually constructing them. The type of graph in *Figure 3-6* is commonly used. It presents two different but related variables to be considered by the user.

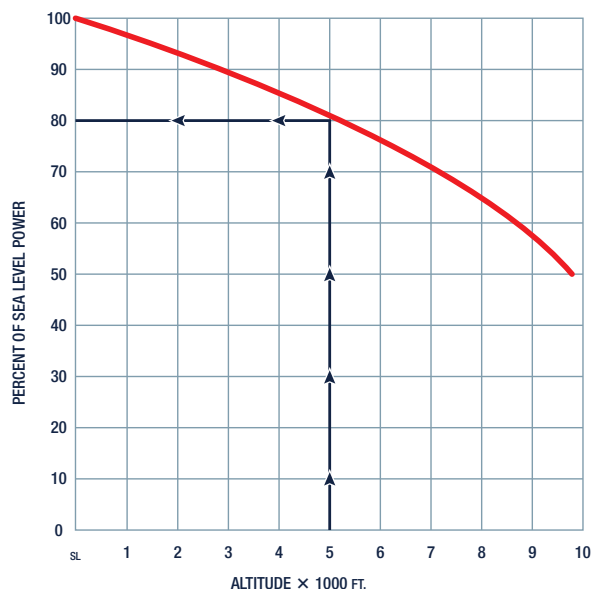


Figure 3-6. Engine horsepower versus altitude.

This particular graph is useful in analyzing the decrease in engine power as altitude increases.

One variable, altitude, is presented on the horizontal axis. It increases as one moves to the right. The other variable, the percent of sea level power, is presented on the vertical axis. It increases as one moves up the axis. The line is drawn on the graph in the precise position that shows the relationship between these two variables. When one of the variables is known, the other can be determined. This is done by moving vertically or horizontally from where the curved line and the known quantity intersect, to the axis of the unknown variable. Read the scale on the axis to obtain the unknown value.

An example comparison of altitude and percent of sea level power is indicated in *Figure 3-6* by the arrows. The chart is being used to find the available power when flying at 5 000 feet. At 5 000 feet altitude (read off of the scale on the horizontal axis), the user moves directly up until the 5 000 foot line intersects the curved line. From this point, the user moves directly left to the vertical axis where the percent of power value can be read off the vertical scale. The arrows show that 80 percent of sea level power is available.

There is virtually no limit to the number of two variable relationships that can be depicted with a graph or chart in this manner.

In *Figure 3-7*, Boeing Aircraft Company compares two variables that are used by the technician to properly service the main landing gear strut with nitrogen. Included in the diagram with the chart are the servicing instructions and procedures to guide the technician when interpreting the data on the chart. A drawing of where dimension "x" should be measured is also included. Dimension "x" is one of the variables on this two-variable chart. The other variable is the inflation pressure to which the strut should be serviced.

A unique feature on this chart is that there are two curved lines. They are to be used as the instructions indicate. Also, one of the lines is thick. This presents a range of intersecting values rather than a single point. However, the basic procedure for using the chart remains as presented in the previous example. Always follow the manufacturer's instructions when further instructions on using a graph or chart are presented.

GRAPHS WITH MORE THAN TWO VARIABLES

A graph or chart with more than two variables may be encountered. This type of graph is shown in *Figure 3-8* and is called a *nomogram*. When interpreting this type of graph, start with the known variables and move horizontal or vertically until all the known variables have been included in the movements. The value of the unknown variable should be able to be read off of one of the scales at the edge of the graph.

Follow the example below to learn how this is done. Also, always be sure to read and follow any manufacturer's instructions that accompany any graph or chart.

Example:

An aircraft reciprocating engine has a 1 830 cubic inch displacement and develops 1 250 brake-horsepower at 2 500 rpm.

What is the brake mean effective pressure?

Explanation:

Use the following steps:

1. Find the 1 250 brake-horsepower vertical line at the top of the chart, and follow this line down until it intersects the diagonal line for the 1 830 cubic inch displacement engine.

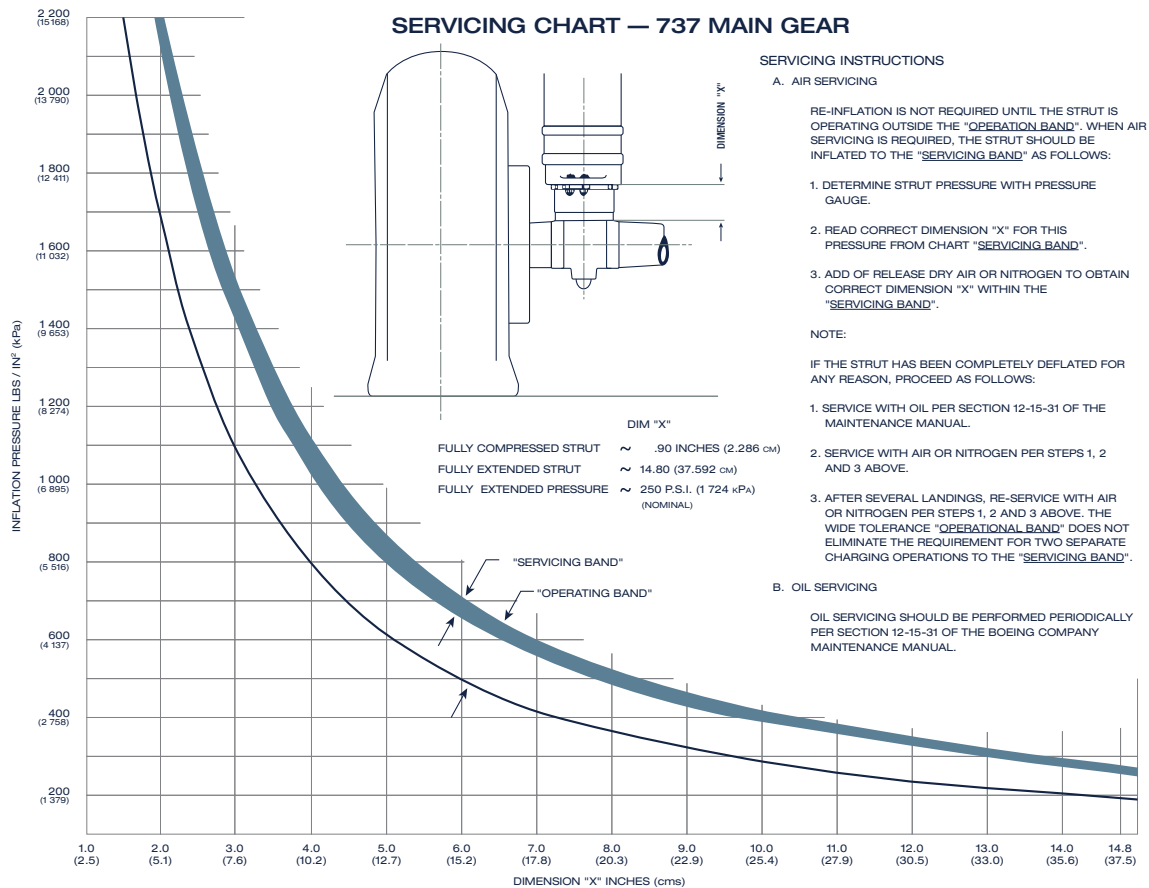


Figure 3-7. A Boeing Aircraft Company main landing gear servicing chart.

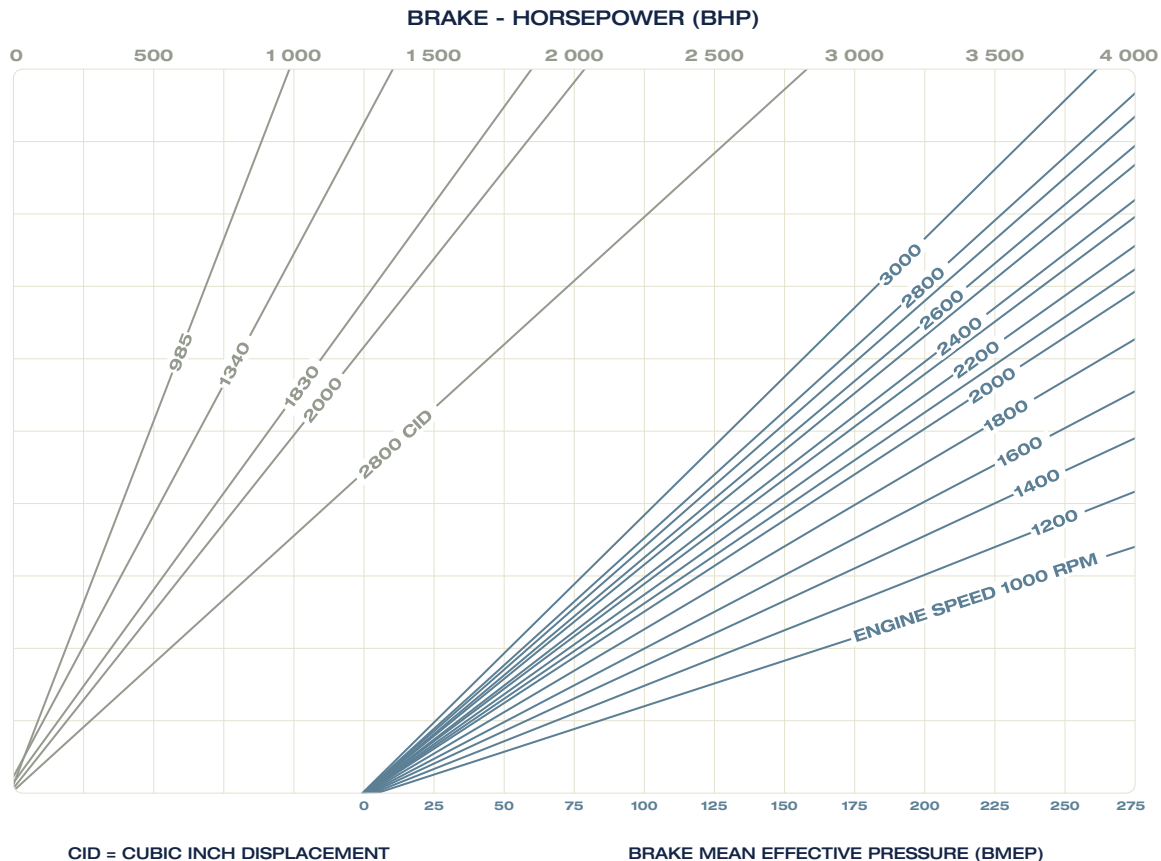


Figure 3-8. A brake horsepower nomogram for 5 engines with 3 variables on the same graph.