DIMENSIONING AND TOLERANCING GUIDELINES

EXACT NUMBERS

Exact numbers are those that have defined values or are integers that result from counting numbers of objects. An exact number has absolutely no uncertainty in it. Exact numbers cannot be simplified and have infinite precision. In this document exact numbers between zero and ten are shown in written form, while exact numbers of 11 and greater are written without any decimal places.

- Exact number examples: Four bolts, 12 sets of tires

MEASURED NUMBERS

Measured numbers are those that are an estimated amount measured to a certain level of precision and with an allowable tolerance to account for measurement error. Measured numbers have a limited number of significant figures.

- Measured number example: A width of 2.25 (+/- 0.25) inches

NOMINAL DIMENSION

A nominal dimension is a dimension used as a name, or to identify something. The nominal dimension does not carry a tolerance, nor does it have the ability to be rounded. A nominal dimension may describe something that has a set of standards governing its basic dimensions, precision, and tolerances.

- Nominal dimension example: A nominal 1 inch x 1 inch square tube

FRACTIONAL DIMENSION

A fractional dimension shown in this document is similar to a nominal dimension and is used as a name, or to identify something. The fractional dimension does not carry a tolerance, nor does it have the ability to be rounded. A fractional dimension may describe something that has a set of standards governing its basic dimensions, precision, and tolerances.

In this document fractional dimensions are reserved for fastener hardware and other standard raw materials.

- Fractional dimension examples: 1/4 inch diameter bolts or 1/2 inch round tubing

DATUMS

Each drawing coordinate system has three datum axes labeled with a “0” indicating the origin of the respective axes. The origin of each axes is considered to have infinite precision. Tolerances should not be applied to axes origins.

MAX OR MAXIMUM DIMENSION

In this document, if a dimension is noted as a MAX or maximum dimension, the upper limit of the dimension is considered to have infinite precision. For example, 10.00 MAX shown on a drawing has a tolerance of (+0.00000000……).

- MAX or maximum dimension example: If the rule states a maximum of 1.000 inch and the measurement device yields a value greater than 1.000000000…. , it does not meet the specification. A 1.00000001 measured number would be considered out of spec.

MIN OR MINIMUM DIMENSION

In this document, if a dimension is noted as a MIN or minimum dimension, the lower limit of the dimension is considered to have infinite precision. For example, 10.00 MIN shown on a drawing has a tolerance of (-0.00000000……).

- MIN or minimum dimension example: If the rule states a minimum of 1.000 inch and the measurement device yields a value less than 1.000000000…. , it does not meet the specification. A 0.99999999 inch measured number would be considered out of spec.

PRECISION

The precision of a measured number is the total number of significant decimal digits recorded.

ACCURACY

The accuracy of a measured number is the degree to which a measured number is correct and free from error. Accuracy is conveyed by a basic dimension and a tolerance.

DIMENSION

A dimension is a numerical value that defines the physical quantity of a feature.

BASIC DIMENSION

The basic dimension is the value that defines the theoretically exact size of a feature.

TOLERANCE

A tolerance is an allowable amount of variation of a specified quantity from a specification or standard. The tolerance should have the same precision as the specification it is associated with.

SIGNIFICANT DIGITS (OR FIGURES)

The significant digits of a measured number are those digits that carry meaning contributing to its measurement resolution. The number of significant digits sets the precision of a measured number.

ROUNDING

Rounding is a process used to reduce the number of significant digits to a predetermined size in a systematic method. The rules of rounding used in this document are shown below:

1. In rounding off numbers, the last figure kept should be unchanged if the first figure dropped is less than 5.

- For example, if only one significant digit to the right of the decimal is to be kept, then 6.42850 rounds to 6.4.

2. In rounding off numbers, the last figure kept should be increased by 1 if the first figure dropped is greater than 5.
   - For example, if only two significant digits to the right of the decimal are to be kept, then 6.42850 becomes 6.43.
3. In rounding off numbers, if the first figure dropped is 5, and all the figures following the five are zero or if there are no figures after the 5, then the last figure kept should be increased by 1.
   - For example, if only three significant digits to the right of the decimal are to be kept, then 6.42850 becomes 6.429.

TRUNCATION

Truncation is limiting the number of significant digits right of the decimal point. Truncation sets the level of precision by discarding extra digits to the right. Truncation is not rounding.

- Truncation example: The compression ratio is called out as truncated value of 12.0 or less. A calculated value of 12.09999 truncates to 12.0 (legal) and a calculated value of 12.10001 truncates to 12.1 (out of spec).

STANDARDS

A standard is an established norm or requirement in regard to a material, process, or system. It is usually a formal document that establishes uniform engineering or technical criteria, methods, processes, practices, specifications, and tolerances. A standard is something considered by an industry accepted authority (i.e. ASTM, SAE, etc.) as a reasonable level of precision and accuracy for a basis of comparison.

DIMENSION AND TOLERANCE PRECEDENCE

Within this document, dimensions and tolerances can occur in Rule Book text only, drawings only, or both Rule Book text and drawings concurrently. Every attempt has been made to keep these dimensions and tolerances consistent. However, in the event that there is a discrepancy between the dimension and tolerance shown in the Rule Book text and the drawing, the dimension and tolerance shown in the drawing takes precedence.

TOLERANCE ASSIGNMENT PROTOCOL

The tolerance for a dimension referenced within this document can be determined by several different methods. The tolerance assignment protocol establishes the priority for the assignment of tolerances used in this document.

When a parameter appears on a Rule Book drawing only, the tolerance associated with the parameter will be based on the following:

- If the tolerance is explicitly stated, the tolerance is that which is stated in parentheses next to the base dimension. For example, 10.000 (+0.100, -0.050) inches.

- If a dimension is noted as a MAX or MIN dimension, the dimension is considered to have infinite precision. For example 10.00 MAX shown on a drawing has a tolerance of (+0.00000000……), while 10.00 MIN has a tolerance of (-0.000000000…….).
- If a dimension is noted by a standard, then the precision and tolerance of the dimension are those set forth in the standard. For example, box tubing with a minimum wall thickness of 0.075 inch, meeting the ASTM A500 specification.
- If a dimension is noted as nominal, there is no associated tolerance. This type of dimension denotes a recognized industry standard size or quantity. For example, a nominal 14 inch air filter element.
- If a dimension is shown as a fractional number, there is no associated tolerance. Fractional dimensions are reserved for fastener hardware and other standard raw materials and represent nominal industry accepted standards. For example, 1/4 inch diameter bolts or 1/2 inch round tubing.
- If the tolerance is not explicitly stated and is not a MAX or MIN, but is defined in the tolerance block, the tolerance is the tolerance stated in the tolerance block. For example, 10.00 shown on a drawing has a tolerance of (+/- 0.01) in the tolerance block.
- If the tolerance is not explicitly stated, is not a MAX or MIN, and is not defined in the tolerance block, the tolerance is implied from standard rounding procedure. For example, 10.0 shown on a drawing has a tolerance of (+0.0499……/-0.0500……).

When a parameter appears in the Rule Book text only, the tolerance associated with the parameter will be based on the following:

- If the tolerance is explicitly stated, the tolerance is that which is stated in parentheses next to the base dimension. For example, 10.000 (+0.100, -0.050).
- If a dimension is noted as a maximum or minimum dimension, the dimension is considered to have infinite precision. For example a maximum of 10.00 written in the text has a tolerance of (+0.00000000……), while a minimum of 10.00 has a tolerance of (-0.000000000…….).
- If a dimension is noted by a standard, then the precision and tolerance of the dimension are those set forth in the standard. For example, box tubing with a minimum wall thickness of 0.075 inch, meeting the ASTM A500 specification.
- If a dimension is noted as nominal, there is no associated tolerance. This type of dimension denotes a recognized industry standard size or quantity. For example, a nominal 14 inch air filter element.
- If a dimension is shown as a fractional number, there is no associated tolerance. Fractional dimensions are reserved for fastener hardware and other standard raw materials and represent nominal industry accepted standards. For example, 1/4 inch diameter bolts or 1/2 inch round tubing.
- If the tolerance is not explicitly stated and the words maximum or minimum are not used, the tolerance is implied from standard rounding procedure. For example, 10.0 written in the text has a tolerance of (+0.0499……/-0.0500….).

Special Circumstances

- In the event that the procedure used to determine a tolerance, limit, or range does not comply with any of the procedures listed above, the procedure will be deemed a special circumstance, and the parameter's properties will be explicitly stated either in the text or on a drawing.

DRAWING TOLERANCE BLOCK INCLUDING ILLUSTARTIVE EXAMPLE

MEASUREMENT			EXAMPLE		
TYPE	**PRECISION**	**TOLERANCE**	**PRECISION**	**ALLOWABLE RANGE**	**ALLOWABLE MEASUREMENT RANGE***
ANGULAR (degrees)	X	± 1	90	91 89	91.499999… 88.500000…
NON-ANGULAR (inches)	X.X	± 0.1	6.0	6.1 5.9	6.149999… 5.850000…
	X.XX	± 0.01	6.00	6.01 5.99	6.014999… 5.985000…
	X.XXX	± 0.005	6.000	6.005 5.995	6.005499… 5.994500…
	X.XXXX	± 0.0010	6.0000	6.0010 5.9990	6.001049… 5.998950…

** Where the … notation means the number preceding the notation is repeated to the extent of the capability of the measuring instrument or to infinity.*