EIN 5226

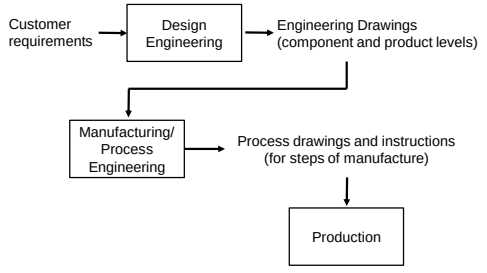
Normal Distribution & Defective Products

Chapter 7 Sections 7.2, 7.3

Note: Need Calculator & Z table Handout for lecture

Karen E. Schmahl Ph.D., P.E.

Creating Process Requirements for Manufacturing



2

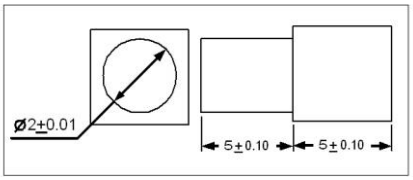
Engineering/process drawings

- Specification limits
  - Nominal or target value
  - Upper and lower specification limits
    - May be referred to as tolerance limits
- Notes
  - Information other than drawings or dimensions
  - Examples
    - References to standards
    - Cleaning, surface prep, tools
    - Plating, painting, heat treat, surface finish
    - Test and inspection notes

3

GATEWAY

Size Tolerances

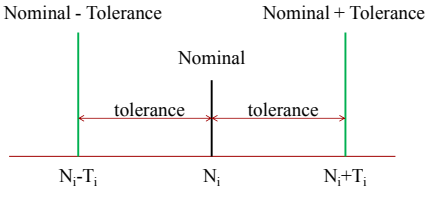


Plus/minus tolerance

Acceptable range is stated in terms of a nominal value and plus/minus value

GATEWAY

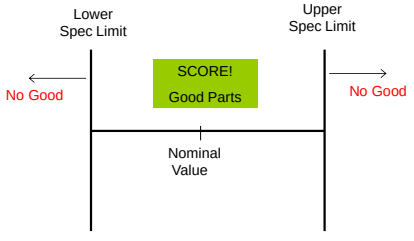
Tolerance Notation



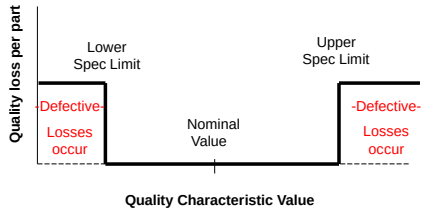
Equal Bilateral Tolerance

- Variation from nominal is same in both directions

Traditional View – Goalpost Approach



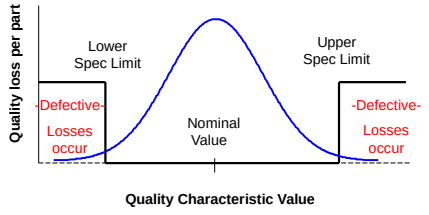
Traditional Approach – A step loss function



7

Traditional Approach

Determine losses based on the process distribution

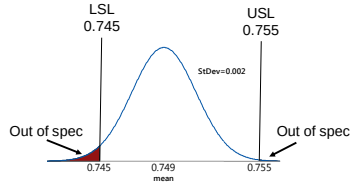


8

Calculating % defective with normal distribution

A hole in a part has a process specification of 0.750 ± 0.005.

The process is currently averaging 0.749 with a standard deviation of 0.002

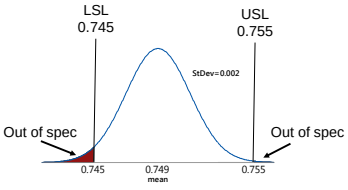


9

Calculating % defective with normal distribution

A hole in a part has a process specification of 0.750 ± 0.005.

The process is currently averaging 0.749 with a standard deviation of 0.002



$Z=(x-\mu)/\sigma$
$Z=(0.755-.049)/.002$
$= 3.000$

From Table,
$P(Z<3.000) = .9987$

$P(Z>3.000) = 1-.9987$
$= .0013 = 0.13\%$

10

Calculating % defective with normal distribution

A hole in a part has a process specification of 0.750 ± 0.005.

The process is currently averaging 0.749 with a standard deviation of 0.002

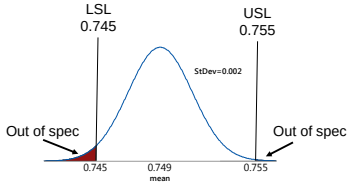
The percent out of spec below LSL is

a. 0.0550

b. 0.0228

c. 0.0315

d. 0.0633



11

If out of spec

Scrap - action on a *nonconforming product* or *service* to preclude its originally intended use*

Rework - action on a *nonconforming product* or *service* to make it conform to the *requirements**

Generally used when reprocessing a part using original or equivalent processes.

Repair - action on a *nonconforming product* or *service* to make it acceptable for the intended use*

Generally refers to restoring functional capability, without meeting original requirements

Flat tire

Scrap
Get rid of it.

Rework
Put more air in it

Repair
Put patch on it

*ISO 9000:2015 Definitions

12

If out of spec

Regrade - alteration of the *grade* of a *nonconforming product* or *service* in order to make it conform to *requirements* differing from the initial requirements *

Provide for customer that does not have as high of requirements

Concession -permission to use or *release* a *product* or *service* that does not conform to specified *requirements**

A concession is generally limited to the delivery of products and services that have *nonconforming characteristics* within specified limits and is generally given for a limited quantity of products and services or period of time, and for a specific use.*

*ISO 9000:2015 Definitions

13

Consider the process of making toast. Which type of action are you taking with each of the following situations?

The toast comes out too light. I put it back in the toaster again.
Scrap Rework Repair Regrade Concession

The toast comes out burnt. I throw it away.
Scrap Rework Repair Regrade Concession

The toast comes out too dark. I feed it to the dog.
Scrap Rework Repair Regrade Concession

The toast comes out too light. I eat it anyway
Scrap Rework Repair Regrade Concession

The toast comes out too dark. I scrape off the burnt parts.
Scrap Rework Repair Regrade Concession

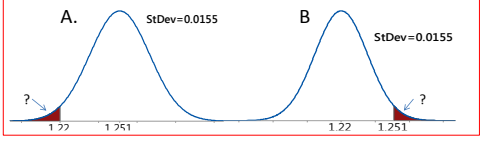
14

Normal Distribution Problem

A part is machined to a critical dimension and the mean of the process is 1.251. The standard deviation of the process is .0155.

The lower specification limit for the dimension is 1.22 and all parts below the lower specification must be scrapped. What percent of the parts must be scrapped?

The diagram depicting the problem is



15

Normal Distribution Problem

A part is machined to a critical dimension and the mean of the process is 1.251. The standard deviation of the process is .0155.

The lower specification limit for the dimension is 1.22 and all parts below the lower specification must be scrapped. What percent of the parts must be scrapped?

Z used to work this problem is

A. +2.0 B. -2.0 C. -1.45 D. +1.45

The percent of the parts must be scrapped is

A. 1.5% B. 1.9% C. 3.5% D. 2.28%

16

Normal Distribution Problem

A part is machined to a critical dimension and the mean of the process is 1.251. The standard deviation of the process is .0155.

The upper specification limit for the dimension is 1.28 and all parts over the upper specification must be reworked. What percent of the parts must be reworked?

Z used to work this problem is

A. +2.15 B. -2.15 C. -1.87 D. +1.87

The percent of the parts must be reworked is

A. 1.5% B. 2.7% C. 3.1% D. 3.8%

17

Normal Distribution Problem

An improvement project focused on the process in the previous problem. The process mean is now 1.25 and is centered between the specification limits. The variation has been reduced, so the standard deviation is now .010.

Given the specification limits of 1.22 and 1.28, what percent of the parts now meet the specification?

The percent of the parts now meeting specs is

A. 98.32% B. 99.74% C. 96.50% D. 97.32%

18

Related Assignments

See Blackboard for related assignments