

# Course Contents: ASME GDTP - Senior Level

(per ASME Y14.5 2009 Standard)

## (A) Datum selection:

### (a) Immobilization of Part

- (1) purpose—measurable relationships
- (2) true geometric counterparts
  - (a) a plane
  - (b) maximum material condition boundary
  - (c) least material condition boundary
  - (d) virtual condition boundary
  - (e) actual mating envelope
  - (f) mathematically defined contour

### (b) Application

- (1) measurement origin
- (2) examples of simulated datums
- (3) surface extremities establish datums

### (c) Datum Reference Frame

- (1) purpose
  - (a) relate features
  - (b) restrict motion of part
- (2) multiple datum reference frames
  - (a) functional requirements
  - (b) requires different datum simulation methods

### (d) Datum Feature Selection Criteria

### (e) Datum Feature Symbol Placement

### (f) Datum Feature Controls

- (1) to account for datum feature variations
- (2) datum targets used alternatively

### (g) Selection of Datum Feature (Order of Precedence )

- (1) design requirements
- (2) functional requirements
- (3) process requirements
- (4) verification requirements/principles

### (h) Establishing Datums from Datum Features

- (1) datum features not subject to size variations
  - (a) unstable
  - (b) restrained
- (2) datum features subject to size variations
  - (a) diameters and widths
  - (b) datum features RFS
    - (1) primary datum feature — diameters or width RFS
    - (2) secondary datum feature — diameter or width RFS
    - (3) tertiary datum feature — diameter or width RFS
  - (c) datum features at MMC
    - (1) size of a primary or single datum feature
    - (2) size of a secondary or tertiary datum feature
  - (d) datum features at LMC
  - (e) effects of datum precedence and material condition
    - (1) cylindrical feature at RFS primary
    - (2) cylindrical feature at MMC secondary

- (3) multiple datum features
  - (a) simulation of a single datum plane (coplanar)
  - (b) single axis of two coaxial features
- (4) pattern of features
- (5) screw threads, gears and splines
- (6) partial surface as datum features
- (7) mathematically defined surface
- (8) multiple datum reference frames
- (9) simultaneous versus separate requirements
- (10) simultaneous requirements and composite feature control
- (11) Customized datum reference frame
- (12) New datum features: Conical, Linear extruded feature, complex shape
- (13) MMB calculation for datum FOS

**(i) Datum Targets**

- (1) purpose/applications
- (2) datum target area dimensions
- (3) datum planes established by datum targets
  - (a) primary, secondary and tertiary datums
  - (b) stepped surfaces
- (4) methods of establishing a primary datum axis
- (5) secondary datum axis
- (6) equalizing datums
- (7) datums established from complex or irregular surfaces
- (8) translation modifier

**(B) Geometric tolerancing & related principles, tolerance calculation and appendices:**

**(a) General Need for Expressing Tolerances**

**(b) Application**

- (1) means of expressing tolerances
- (2) controlling features of size
- (3) controlling other features

**(c) Direct Tolerancing Methods**

- (1) general
  - (a) limit dimensioning
  - (b) plus and minus tolerancing
- (2) metric limits and fits
- (3) limits and tolerance symbols
- (4) tolerance symbols and limits
- (5) millimeter tolerancing
  - (a) unilateral tolerancing
  - (b) bilateral tolerancing
  - (c) limit dimensioning
  - (d) with basic dimensions
- (6) inch tolerances
  - (a) unilateral tolerancing
  - (b) bilateral tolerancing
  - (c) limit dimensioning
  - (d) with basic dimensions
- (7) angle tolerances
- (8) plated or coated parts
- (9) single limits
- (10) tolerance accumulation
  - (a) chain dimensioning
  - (b) base line dimensioning
  - (c) direct dimensioning
- (11) dimensional limits related to an origin

**(d) Limits of Size**

- (1) individual feature of size (Rule #1)
  - (a) when form control does not apply
  - (b) indicating that perfect form at MMC not required
- (2) relationship between individual features
  - (a) no relationship unless otherwise specified
  - (b) zero tolerance of orientation
  - (c) zero tolerance of position
  - (d) control with general note
  - (e) relate dimensions to a datum reference framework with a general note

**(e) Applicability of RFS, MMC and LMC**

- (1) appropriate applications
- (2) all applicable geometric tolerances (Rule #2)
- (3) alternate practice for position control
- (4) effect of RFS
- (5) effect of MMC
- (6) effect of zero tolerance at MMC
- (7) effect of LMC
- (8) effect of zero tolerance at LMC

**(f) Screw Threads**

- (1) feature
- (2) modifier

**(g) Gears and Splines****(h) Virtual/Resultant Condition**

- (1) determining the appropriateness of MMC and LMC
- (2) virtual condition determination
- (3) resultant condition determination
- (4) datum features at virtual condition
- (5) calculating inner and outer locus

**(i) Angular Surfaces****(j) Conical Tapers****(k) Flat Tapers****(l) Radius****(m) Statistical Tolerancing**

- (1) application to assemblies
- (2) identification

**(n) Tolerances of Location**

- (1) utilization of modifiers
  - (a) effects of RFS (implied)
  - (b) effects of MMC
  - (c) effects of LMC
- (2) displacement allowed by datum features at MMC
- (3) calculating positional tolerance
- (4) zero positional tolerance at MMC
- (5) simultaneous requirements
- (6) separate requirements
- (7) projected tolerance zone
- (8) nonparallel holes
- (9) counterbored holes
- (10) closer control at one end of a feature

- (11) bidirectional positional tolerancing
- (12) noncircular features
- (13) coaxial controls
- (14) concentricity
- (15) symmetry

**(o) Form**

- (1) straightness
  - (a) surface
  - (b) axis
  - (c) center plane
  - (d) applied on a unit basis
- (2) flatness
  - (a) surface
  - (b) applied on a unit basis
  - (C) with MMC modifier
- (3) circularity
- (4) cylindricity

**(p) Profile**

- (1) profile of a line
- (2) profile of a surface
- (3) coplanarity
- (4) for plane surfaces
- (5) on conical features
- (6) unequally disposed profile tolerance

**(q) Orientation Tolerances**

- (1) angularity
  - (a) of a surface
  - (b) applied to features of size
- (2) parallelism
  - (a) of a surface
  - (b) applied to features of size
- (3) perpendicularity
  - (a) of a surface
  - (b) applied to features of size

**(r) Runout Tolerances**

- (1) circular
- (2) total

**(s) Y14.5 Appendices**

- (1) Appendix A - Principal Changes and Improvements
  - (a) Figures
  - (b) Scope, definitions and general dimensioning
  - (c) General tolerancing and related principles
  - (d) Symbolology
  - (e) Datum referencing
  - (f) Tolerances of location
  - (g) Tolerances of form, profile, orientation and runout
  - (h) Principal changes and improvements
  - (I) Formulas for positional tolerancing
  - (j) Form, proportion and comparison of symbols
  - (k) Former practices
  - (I) Decision diagrams for geometric control
- (2) Appendix B - Formulas for Positional Tolerancing
  - (a) General
  - (b) Formula symbols
  - (c) Floating fastener case

- (d) Fixed fastener case
  - (e) Provision for out-of-squareness when projected tolerance zone is not used
  - (f) Coaxial features
  - (g) Limits and fits
- (3) Appendix C - Form, Proportion, and Comparison of Symbols
- (a) General
  - (b) Form and proportion
  - (c) Comparison
- (4) Appendix D - Former Practices
- (a) General
  - (b) Definition for feature of size
  - (c) Applicability of RFS, MMC, and LMC
  - (d) Tangent Radii
  - (e) Datum feature special
  - (f) Projected tolerance zone
- (5) Appendix E - Decision Diagrams for Geometric Control
- (a) Purpose
  - (b) Functional requirements
  - (c) Reference to standard
  - (d) Geometric controls
  - (e) Choosing other controls
  - (f) Use of modifiers
  - (g) Datums:
    - (1) Datum modifiers
    - (2) Multiple datums

## **(C) Application of modifiers in feature control frames application**

### **(a) Types of Modifiers**

- (1) Regardless of Feature Size (RFS)
- (2) Maximum Material Condition (MMC)
- (3) Least Material Condition (LMC)

### **(b) Application**

- (1) to the toleranced feature
- (2) to datums
- (3) when applicable
  - (a) to geometric tolerances
  - (b) to datums
- (4) zero tolerance at MMC
- (5) results of datum features modified
  - (a) RMB (implied)
  - (b) MMC
  - (c) LMC
- (6) results of pattern of features modified
  - (a) RFS (implied)
  - (b) MMC
  - (c) LMC
- (7) simultaneous requirements

## **(D) Composite Tolerancing:**

### **(a) Location of a Pattern of Features**

- (1) location of a pattern of features
- (2) interrelationship of individual features within a pattern
- (3) multiple patterns of features; separate requirements

**(b) Composite profile tolerancing**

**(c) Part Verification Methods**

- (1) functional gaging
- (2) graphical analysis
- (3) mathematical analysis

**(d) Application of Composite Positional Tolerancing versus Two Single-Segment Tolerancing**