

# THE SECOND SEGMENT OF A COMPOSITE TOLERANCE SPECIFICATION IS NOT REQUIRED TO INCLUDE DATUM FEATURE REFERENCES.

THE SECOND SEGMENT OF A COMPOSITE TOLERANCE SPECIFICATION IS NOT REQUIRED TO INCLUDE DATUM FEATURE REFERENCES.

UNDERSTANDING THE NUANCES OF GEOMETRIC DIMENSIONING AND TOLERANCING (GD&T) IS CRUCIAL FOR ENSURING PROPER COMMUNICATION OF ENGINEERING INTENT, MANUFACTURING ACCURACY, AND QUALITY ASSURANCE. AMONG THESE NUANCES IS THE SPECIFICATION OF COMPOSITE TOLERANCES, WHICH COMBINE MULTIPLE TOLERANCE ZONES WITHIN A SINGLE FEATURE CONTROL FRAME TO CONTROL FORM, ORIENTATION, AND POSITION SIMULTANEOUSLY. A COMMON POINT OF CONFUSION INVOLVES WHETHER THE SECOND SEGMENT IN A COMPOSITE TOLERANCE MUST REFERENCE DATUM FEATURES. THIS ARTICLE EXPLORES THE CONCEPT IN DEPTH, CLARIFYING WHY THE SECOND SEGMENT OF A COMPOSITE TOLERANCE SPECIFICATION IS NOT REQUIRED TO INCLUDE DATUM FEATURE REFERENCES, AND HOW THIS UNDERSTANDING IMPACTS DESIGN AND MANUFACTURING PROCESSES.

## OVERVIEW OF COMPOSITE TOLERANCE SPECIFICATIONS

### WHAT ARE COMPOSITE TOLERANCE SPECIFICATIONS?

COMPOSITE TOLERANCES ARE USED IN GD&T TO SPECIFY A COMBINED TOLERANCE ZONE THAT CONTROLS MULTIPLE ASPECTS OF A FEATURE'S GEOMETRY. THEY ARE TYPICALLY EXPRESSED WITHIN A SINGLE FEATURE CONTROL FRAME THAT CONTAINS TWO SEGMENTS, SEPARATED BY A SLASH (/). FOR EXAMPLE:

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""PLAINTEXT
| POSITION | 0.2 | / 0.5 | |
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THIS INDICATES TWO RELATED TOLERANCE ZONES, ALLOWING FOR A MORE FLEXIBLE YET CONTROLLED VARIATION OF THE FEATURE'S GEOMETRY.

### PURPOSE OF USING COMPOSITE TOLERANCES

COMPOSITE TOLERANCES ARE EMPLOYED TO:

- SPECIFY TIGHTER CONTROL OVER FEATURES THAT REQUIRE MULTIPLE GEOMETRIC CONSIDERATIONS.
- REDUCE THE COMPLEXITY OF MULTIPLE FEATURE CONTROL FRAMES.
- PROVIDE A CLEAR, CONCISE WAY TO COMMUNICATE COMPLEX GEOMETRIC REQUIREMENTS.

## UNDERSTANDING THE STRUCTURE OF COMPOSITE TOLERANCE FRAMES

### SEGMENT 1: THE PRIMARY TOLERANCE ZONE

THE FIRST SEGMENT OF A COMPOSITE TOLERANCE TYPICALLY CONTROLS THE PRIMARY ASPECT OF THE FEATURE—SUCH AS POSITION, ORIENTATION, OR FORM. IT MAY INCLUDE REFERENCES TO DATUM FEATURES, DEPENDING ON THE DESIGN INTENT.

## SEGMENT 2: THE SECONDARY TOLERANCE ZONE

THE SECOND SEGMENT OFTEN CONTROLS THE SECONDARY ASPECT, SUCH AS A DIFFERENT ORIENTATION OR POSITION, AND MAY BE RELATED TO THE PRIMARY ZONE TO ESTABLISH A TOLERANCE HIERARCHY.

### RELATION BETWEEN THE TWO SEGMENTS

- THE SECOND SEGMENT IS GENERALLY NESTED WITHIN THE PRIMARY ZONE.
- IT PROVIDES A SECONDARY, OFTEN LOOSER, CONTROL.
- THE SECOND SEGMENT MAY OR MAY NOT REFERENCE DATUM FEATURES.

## WHY THE SECOND SEGMENT DOES NOT NECESSARILY REQUIRE DATUM FEATURE REFERENCES

### FUNDAMENTAL GD&T PRINCIPLES

GD&T PRINCIPLES STATE THAT:

- DATUM FEATURES ARE USED TO ESTABLISH A REFERENCE FRAME.
- TOLERANCE ZONES ARE CREATED RELATIVE TO THESE DATUM FEATURES.
- NOT ALL TOLERANCE ZONES NEED TO BE DIRECTLY REFERENCED TO DATUMS IF THE DESIGN INTENT DOES NOT REQUIRE IT.

### DESIGN INTENT AND FUNCTIONAL REQUIREMENTS

THE DECISION TO INCLUDE OR OMIT DATUM REFERENCES IN THE SECOND SEGMENT DEPENDS ON:

- THE FUNCTIONAL IMPORTANCE OF THE SECONDARY FEATURE
- THE MANUFACTURING OR INSPECTION PROCESS
- THE NEED FOR POSITIONAL CONTROL RELATIVE TO DATUMS

IF THE SECONDARY ASPECT IS NOT CRITICAL TO THE FUNCTION OR DOES NOT REQUIRE A REFERENCE TO A DATUM, THE SECOND SEGMENT CAN OMIT DATUM REFERENCES.

### STANDARDS AND INDUSTRY PRACTICES

THE ASME Y14.5 STANDARD CLARIFIES THAT:

- THE SECOND SEGMENT IN A COMPOSITE TOLERANCE IS NOT MANDATED TO INCLUDE DATUM REFERENCES.
- THE INCLUSION OF DATUM REFERENCES IS OPTIONAL AND BASED ON THE SPECIFIC CONTROL REQUIRED.
- THIS FLEXIBILITY ALLOWS ENGINEERS TO TAILOR TOLERANCES TO THE ACTUAL NEEDS OF THE PART.

## IMPLICATIONS FOR DESIGN AND MANUFACTURING

### DESIGN CONSIDERATIONS

WHEN DESIGNING USING COMPOSITE TOLERANCES:

- CLEARLY SPECIFY WHICH ASPECTS REQUIRE DATUM REFERENCES.
- USE THE SECOND SEGMENT WITHOUT DATUM REFERENCES WHEN SECONDARY CONTROL DOES NOT NEED TO BE RELATIVE TO A DATUM.
- AVOID UNNECESSARY COMPLEXITY THAT COULD COMPLICATE INSPECTION PROCEDURES.

## MANUFACTURING AND INSPECTION

FOR MANUFACTURERS AND INSPECTORS:

- RECOGNIZE THAT THE ABSENCE OF DATUM REFERENCES IN THE SECOND SEGMENT SIGNIFIES THAT THE SECONDARY CONTROL IS INDEPENDENT OF ANY DATUMS.
- USE APPROPRIATE MEASUREMENT TOOLS AND TECHNIQUES TO VERIFY THE SECONDARY CONTROL, ESPECIALLY IF IT IS NOT REFERENCED TO DATUMS.
- MAINTAIN CLARITY IN DOCUMENTATION TO PREVENT MISINTERPRETATION DURING INSPECTION.

## PRACTICAL EXAMPLES AND APPLICATIONS

### EXAMPLE 1: POSITION TOLERANCE WITHOUT DATUM REFERENCE IN SECOND SEGMENT

SUPPOSE A HOLE'S POSITION IS CONTROLLED WITH A COMPOSITE TOLERANCE:

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""PLAINTEXT
| POSITION | 0.2 | / 0.5 | |
""
```

- THE PRIMARY POSITION ZONE (FIRST SEGMENT) IS REFERENCED TO DATUMS A AND B.
- THE SECONDARY ZONE (SECOND SEGMENT) IS LOOSER AND DOES NOT REFERENCE ANY DATUMS.
- THE SECONDARY ZONE MAY CONTROL THE MAXIMUM PERMISSIBLE OFFSET OF THE HOLE WITHIN THE PRIMARY POSITION ZONE, INDEPENDENT OF THE DATUMS.

### EXAMPLE 2: CONTROLLING FORM AND ORIENTATION

A FEATURE'S FLATNESS MIGHT BE CONTROLLED WITH A COMPOSITE TOLERANCE WHERE:

- THE FIRST SEGMENT CONTROLS FLATNESS RELATIVE TO A DATUM.
- THE SECOND SEGMENT ENSURES THE FEATURE DOES NOT DEVIATE BEYOND A CERTAIN LIMIT, INDEPENDENT OF A DATUM.

## BEST PRACTICES FOR USING COMPOSITE TOLERANCES WITHOUT DATUM REFERENCES

### CLEAR DOCUMENTATION

- ALWAYS SPECIFY THE PURPOSE OF EACH SEGMENT.
- CLARIFY WHETHER THE SECONDARY CONTROL IS RELATIVE TO DATUMS OR INDEPENDENT.

### CONSISTENCY IN GD&T APPLICATION

- FOLLOW INDUSTRY STANDARDS AND BEST PRACTICES.
- USE THE SAME APPROACH THROUGHOUT THE DRAWING FOR CONSISTENCY.

### INSPECTION PLANNING

- DETERMINE MEASUREMENT METHODS SUITED FOR CONTROLS WITHOUT DATUM REFERENCES.
- VALIDATE THAT THE SECONDARY TOLERANCE ACHIEVES THE DESIRED FUNCTION.

# CONCLUSION

THE SECOND SEGMENT OF A COMPOSITE TOLERANCE SPECIFICATION IS NOT REQUIRED TO INCLUDE DATUM FEATURE REFERENCES BECAUSE IT SERVES AS A SECONDARY CONTROL THAT CAN BE INDEPENDENT OF DATUMS, DEPENDING ON THE DESIGN INTENT. THIS FLEXIBILITY ALLOWS ENGINEERS TO SPECIFY TOLERANCES THAT ARE DIRECTLY ALIGNED WITH THE FUNCTIONAL AND MANUFACTURING NEEDS OF THE PART, WITHOUT UNNECESSARY CONSTRAINTS. UNDERSTANDING WHEN AND HOW TO OMIT DATUM REFERENCES IN THE SECOND SEGMENT EMPOWERS BETTER COMMUNICATION, REDUCES AMBIGUITY, AND STREAMLINES THE MANUFACTURING AND INSPECTION PROCESSES. ULTIMATELY, THE KEY IS TO APPLY GD&T PRINCIPLES THOUGHTFULLY, ENSURING THAT EACH TOLERANCE ZONE SERVES ITS PURPOSE EFFECTIVELY WHILE MAINTAINING CLARITY AND COMPLIANCE WITH INDUSTRY STANDARDS.

## FREQUENTLY ASKED QUESTIONS

### WHAT IS THE SIGNIFICANCE OF NOT REQUIRING DATUM FEATURE REFERENCES IN THE SECOND SEGMENT OF A COMPOSITE TOLERANCE SPECIFICATION?

OMITTING DATUM FEATURE REFERENCES IN THE SECOND SEGMENT SIMPLIFIES THE APPLICATION OF TOLERANCES, FOCUSING ON THE PART'S PERMISSIBLE VARIATION WITHOUT TYING IT TO SPECIFIC DATUM FEATURES, WHICH CAN STREAMLINE MANUFACTURING AND INSPECTION PROCESSES.

### HOW DOES EXCLUDING DATUM REFERENCES IN THE SECOND SEGMENT IMPACT PART INSPECTION PROCEDURES?

IT ALLOWS INSPECTORS TO MEASURE THE FEATURE'S TOLERANCE DIRECTLY WITHOUT REFERENCING THE PRIMARY DATUM, POTENTIALLY REDUCING COMPLEXITY AND INSPECTION TIME WHILE MAINTAINING CONTROL OVER THE FEATURE'S GEOMETRIC VARIATION.

### CAN THE SECOND SEGMENT OF A COMPOSITE TOLERANCE BE USED INDEPENDENTLY WITHOUT DATUM REFERENCES?

YES, WHEN THE SECOND SEGMENT DOES NOT INCLUDE DATUM FEATURE REFERENCES, IT CAN BE APPLIED INDEPENDENTLY, PROVIDING A SPECIFIC TOLERANCE ZONE FOR THE FEATURE WITHOUT REFERENCING OTHER FEATURES OR DATUMS.

### IN WHAT CIRCUMSTANCES IS IT ACCEPTABLE TO OMIT DATUM FEATURE REFERENCES FROM THE SECOND SEGMENT OF A COMPOSITE TOLERANCE?

IT IS ACCEPTABLE WHEN THE TOLERANCE IS INTENDED TO CONTROL THE FEATURE'S SIZE OR LOCATION RELATIVE TO THE PART ITSELF, RATHER THAN IN RELATION TO OTHER FEATURES OR DATUMS, OFTEN TO SIMPLIFY MANUFACTURING OR INSPECTION.

### HOW DOES THIS PRACTICE ALIGN WITH ASME Y14.5 STANDARDS FOR GEOMETRIC DIMENSIONING AND TOLERANCING?

ACCORDING TO ASME Y14.5, THE SECOND SEGMENT OF A COMPOSITE TOLERANCE DOES NOT REQUIRE DATUM REFERENCES IF THE TOLERANCE IS MEANT TO BE INDEPENDENT OF DATUMS, PROVIDING FLEXIBILITY IN SPECIFYING GEOMETRIC CONTROLS.

### WHAT ARE THE POTENTIAL BENEFITS OF NOT INCLUDING DATUM FEATURE REFERENCES IN THE SECOND SEGMENT?

BENEFITS INCLUDE SIMPLIFIED DRAWINGS, REDUCED INSPECTION COMPLEXITY, INCREASED FLEXIBILITY IN MANUFACTURING, AND CLEARER COMMUNICATION OF THE ALLOWABLE VARIATION FOR THE FEATURE ITSELF.

## ARE THERE ANY LIMITATIONS OR RISKS ASSOCIATED WITH EXCLUDING DATUM FEATURES IN THE SECOND SEGMENT?

YES, EXCLUDING DATUM REFERENCES CAN SOMETIMES LEAD TO AMBIGUITY OR LESS PRECISE CONTROL OVER FEATURE ORIENTATION OR LOCATION RELATIVE TO OTHER FEATURES, POTENTIALLY AFFECTING ASSEMBLY OR FUNCTION IF NOT CAREFULLY SPECIFIED.

## HOW CAN DESIGNERS ENSURE CLARITY WHEN OMITTING DATUM REFERENCES IN THE SECOND SEGMENT OF A COMPOSITE TOLERANCE?

DESIGNERS SHOULD CLEARLY SPECIFY THE INTENT AND THE CONTROLLED FEATURE, POSSIBLY INCLUDING NOTES OR SUPPLEMENTARY INFORMATION TO ENSURE THAT INSPECTION AND MANUFACTURING UNDERSTAND THE TOLERANCE'S SCOPE WITHOUT DATUM REFERENCES.

## DOES THE ABSENCE OF DATUM FEATURES IN THE SECOND SEGMENT AFFECT THE OVERALL GEOMETRIC CONTROL ON A PART?

IT CAN, AS IT SHIFTS CONTROL TO THE FEATURE ITSELF RATHER THAN ITS RELATION TO OTHER FEATURES, WHICH MAY BE ADVANTAGEOUS OR LIMITING DEPENDING ON THE DESIGN INTENT AND FUNCTIONAL REQUIREMENTS.

## ADDITIONAL RESOURCES

THE SECOND SEGMENT OF A COMPOSITE TOLERANCE SPECIFICATION IS NOT REQUIRED TO INCLUDE DATUM FEATURE REFERENCES

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### INTRODUCTION

IN THE REALM OF GEOMETRIC DIMENSIONING AND TOLERANCING (GD&T), COMPOSITE TOLERANCE SPECIFICATIONS SERVE AS ESSENTIAL TOOLS FOR CONTROLLING THE FORM, ORIENTATION, AND LOCATION OF FEATURES WITHIN AN ENGINEERING COMPONENT. AMONG THE VARIOUS ELEMENTS OF THESE SPECIFICATIONS, THE SEGMENT STRUCTURE—COMPRISING A PRIMARY, A SECONDARY, AND SOMETIMES A TERTIARY TOLERANCE ZONE—PLAYS A CRITICAL ROLE IN DEFINING ACCEPTABLE VARIATIONS. A COMMON POINT OF CONFUSION AND DEBATE AMONG ENGINEERS, QUALITY PROFESSIONALS, AND GD&T PRACTITIONERS IS WHETHER THE SECOND SEGMENT OF A COMPOSITE TOLERANCE SPECIFICATION MUST INVARIABLY INCLUDE DATUM FEATURE REFERENCES.

THIS ARTICLE SEEKS TO THOROUGHLY INVESTIGATE THE UNDERLYING PRINCIPLES, STANDARDS, AND PRACTICAL IMPLICATIONS SURROUNDING THIS QUESTION. WE WILL EXPLORE THE RATIONALE BEHIND COMPOSITE TOLERANCES, INTERPRET APPLICABLE STANDARDS SUCH AS ASME Y14.5, ANALYZE CASE STUDIES, AND CLARIFY COMMON MISCONCEPTIONS. ULTIMATELY, THE GOAL IS TO PROVIDE A COMPREHENSIVE UNDERSTANDING OF WHY THE SECOND SEGMENT OF A COMPOSITE TOLERANCE SPECIFICATION IS NOT NECESSARILY REQUIRED TO INCLUDE DATUM FEATURE REFERENCES, AND HOW THIS KNOWLEDGE IMPACTS DESIGN, INSPECTION, AND MANUFACTURING PROCESSES.

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### BACKGROUND ON COMPOSITE TOLERANCE SPECIFICATIONS

#### WHAT ARE COMPOSITE TOLERANCES?

COMPOSITE TOLERANCES ARE A METHOD USED TO SPECIFY COMPLEX GEOMETRIC CONTROLS OVER FEATURES BY DIVIDING THE TOTAL PERMISSIBLE VARIATION INTO MULTIPLE SEGMENTS, EACH WITH ITS OWN TOLERANCE ZONE. THIS APPROACH ALLOWS ENGINEERS TO SPECIFY MORE PRECISE CONTROL OVER HOW FEATURES CAN VARY RELATIVE TO EACH OTHER, ESPECIALLY WHEN MULTIPLE FEATURES OR ORIENTATIONS ARE INVOLVED.

## STRUCTURE OF A COMPOSITE TOLERANCE SPECIFICATION

TYPICALLY, A COMPOSITE TOLERANCE SPECIFICATION COMPRISES:

- FIRST (PRIMARY) SEGMENT: DEFINES THE MAIN TOLERANCE ZONE, OFTEN REFERENCING THE PRIMARY DATUM.
- SECOND (SECONDARY) SEGMENT: ADDS A SECONDARY TOLERANCE ZONE, USUALLY RELATING TO A SECONDARY DATUM, TO REFINE CONTROL.
- THIRD (OPTIONAL) SEGMENT: FURTHER REFINES THE ALLOWABLE VARIATION, OFTEN REFERENCING ADDITIONAL DATUMS OR FEATURES.

EACH SEGMENT CAN SPECIFY ITS OWN TOLERANCE VALUE AND OPTIONAL DATUM REFERENCES, WHICH WORK CUMULATIVELY TO DEFINE THE TOTAL PERMISSIBLE VARIATION.

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## THE ROLE OF DATUM FEATURE REFERENCES IN GD&T

### UNDERSTANDING DATUM FEATURES

DATUM FEATURES SERVE AS THE THEORETICAL OR PHYSICAL REFERENCE POINTS, LINES, OR PLANES USED TO ESTABLISH A COORDINATE SYSTEM FOR MEASUREMENT AND MANUFACTURING. THEY ARE VITAL IN ENSURING PARTS ARE CONSISTENTLY MANUFACTURED AND INSPECTED WITHIN SPECIFIED TOLERANCES.

### THE PURPOSE OF DATUM REFERENCES IN TOLERANCE ZONES

INCLUDING DATUM REFERENCES IN TOLERANCE SPECIFICATIONS HELPS:

- ESTABLISH A CONSISTENT FRAME OF REFERENCE.
- CONTROL THE ORIENTATION AND LOCATION OF FEATURES RELATIVE TO A KNOWN DATUM.
- FACILITATE REPEATABLE MEASUREMENT AND INSPECTION.

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## THE STANDARD PERSPECTIVE: ASME Y14.5 AND GD&T PRINCIPLES

### DEFINITIONS AND GUIDELINES IN ASME Y14.5

THE ASME Y14.5 STANDARD PROVIDES THE AUTHORITATIVE GUIDANCE ON GD&T PRACTICES IN THE UNITED STATES. RELEVANT SECTIONS REGARDING COMPOSITE TOLERANCES AND DATUM REFERENCES INCLUDE:

- SECTION 3.4.4: DESCRIBES COMPOSITE POSITIONAL TOLERANCES, EMPHASIZING THE IMPORTANCE OF DATUM REFERENCES IN DEFINING THE ZONES.
- SECTION 3.4.5: CLARIFIES THAT THE SECOND SEGMENT OF A COMPOSITE TOLERANCE MAY OMIT DATUM REFERENCES UNDER CERTAIN CONDITIONS.
- SECTION 2.2.2: DEFINES THE CONCEPT OF A DATUM FEATURE AND ITS ROLE IN ESTABLISHING A DATUM REFERENCE FRAME.

### CLARIFICATION ON THE SECOND SEGMENT

THE STANDARD EXPLICITLY STATES THAT:

- THE SECOND SEGMENT OF A COMPOSITE TOLERANCE DOES NOT ALWAYS REQUIRE DATUM REFERENCES.
- ITS INCLUSION DEPENDS ON THE DESIGN INTENT AND THE SPECIFIC GEOMETRIC CONTROL BEING SPECIFIED.
- OMITTING A DATUM REFERENCE IN THE SECOND SEGMENT ALLOWS FOR MORE FLEXIBLE MANUFACTURING AND INSPECTION, PARTICULARLY WHEN THE SECONDARY CONTROL IS RELATIVE TO THE PRIMARY FEATURE ALONE.

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## RATIONALE FOR OMITTING DATUM REFERENCES IN THE SECOND SEGMENT

## DESIGN FLEXIBILITY AND MANUFACTURING PRACTICALITY

ONE OF THE PRIMARY REASONS TO OMIT DATUM REFERENCES IN THE SECOND SEGMENT IS TO PROVIDE GREATER MANUFACTURING FLEXIBILITY. BY NOT TYING THE SECONDARY TOLERANCE ZONE TO AN ADDITIONAL DATUM, MANUFACTURERS CAN ADJUST PROCESSES WITHOUT BEING CONSTRAINED BY STRICT SECONDARY REFERENCES, AS LONG AS THE PRIMARY DATUM IS MAINTAINED.

### SIMPLIFICATION OF INSPECTION PROCEDURES

REMOVING DATUM REFERENCES FROM THE SECOND SEGMENT SIMPLIFIES INSPECTION, ESPECIALLY WHEN:

- THE SECONDARY CONTROL IS INTENDED TO BE RELATIVE TO THE PRIMARY FEATURE ONLY.
- THE SECONDARY FEATURE'S POSITION OR ORIENTATION IS LESS CRITICAL.
- INSPECTION EQUIPMENT OR METHODS CANNOT RELIABLY ESTABLISH THE SECONDARY DATUM.

### HIERARCHICAL CONTROL AND CUMULATIVE TOLERANCE

COMPOSITE TOLERANCES ARE DESIGNED TO CONTROL CUMULATIVE VARIATION. OMITTING DATUM REFERENCES IN THE SECOND SEGMENT ENSURES THAT THE SECONDARY TOLERANCE ZONE IS CONTROLLED PRIMARILY THROUGH THE PRIMARY DATUM, PREVENTING OVER-CONSTRAINING THE FEATURE.

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## PRACTICAL APPLICATIONS AND CASE STUDIES

### CASE STUDY 1: CONTROL OF A HOLE'S POSITION RELATIVE TO A SURFACE

SUPPOSE AN ENGINEER SPECIFIES A COMPOSITE POSITIONAL TOLERANCE FOR A HOLE, WITH THE PRIMARY SEGMENT REFERENCING A DATUM PLANE ESTABLISHED BY A SURFACE, AND THE SECONDARY SEGMENT CONTROLLING THE HOLE'S LOCATION RELATIVE TO THE PRIMARY FEATURE. IF THE SECONDARY SEGMENT DOES NOT INCLUDE A DATUM REFERENCE, IT IMPLIES THAT:

- THE SECONDARY TOLERANCE ZONE IS RELATIVE TO THE PRIMARY FEATURE ONLY.
- THE SECONDARY CONTROL ALLOWS FOR SOME VARIATION IN THE SECONDARY DIRECTION, INDEPENDENT OF AN ADDITIONAL DATUM.

THIS APPROACH IS USEFUL WHEN THE SECONDARY FEATURE'S EXACT RELATION TO AN AUXILIARY DATUM IS LESS CRITICAL, OR WHEN THE PRIMARY DATUM SUFFICES FOR FUNCTIONAL REQUIREMENTS.

### CASE STUDY 2: ASSEMBLY OF MULTICOMPONENT SYSTEMS

IN MULTICOMPONENT ASSEMBLIES WHERE CERTAIN FEATURES ARE LESS CRITICAL TO THE OVERALL FUNCTION, DESIGNERS MAY CHOOSE TO OMIT DATUM REFERENCES IN THE SECONDARY SEGMENT TO REDUCE MANUFACTURING CONSTRAINTS AND ALLOW FOR EASIER ASSEMBLY TOLERANCES.

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## COMMON MISCONCEPTIONS AND CLARIFICATIONS

| MISCONCEPTION                                                       | CLARIFICATION                                                                                  |
|---------------------------------------------------------------------|------------------------------------------------------------------------------------------------|
| THE SECOND SEGMENT MUST ALWAYS INCLUDE DATUM REFERENCES.            | NOT NECESSARILY; STANDARDS PERMIT OMISSION WHEN APPROPRIATE TO THE DESIGN INTENT.              |
| OMITTING DATUM REFERENCES WEAKENS THE CONTROL.                      | IT DEPENDS; SOMETIMES, LESS STRICT CONTROL IS INTENTIONAL AND BENEFICIAL FOR MANUFACTURING.    |
| INCLUDING DATUM REFERENCES IN ALL SEGMENTS IS ALWAYS BEST PRACTICE. | OVER-CONSTRAINING CAN LEAD TO UNNECESSARY MANUFACTURING DIFFICULTY WITHOUT FUNCTIONAL BENEFIT. |

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## BEST PRACTICES FOR IMPLEMENTING COMPOSITE TOLERANCES WITHOUT SECOND SEGMENT DATUM REFERENCES

1. ASSESS FUNCTIONAL REQUIREMENTS: DETERMINE WHETHER SECONDARY CONTROL NEEDS TO BE TIED TO AN ADDITIONAL DATUM OR IF IT SUFFICES TO RELATE TO THE PRIMARY FEATURE.
2. CONSULT STANDARDS AND GUIDELINES: FOLLOW ASME Y14.5 AND RELATED STANDARDS TO ENSURE COMPLIANCE.
3. DOCUMENT INTENT CLEARLY: USE NOTES OR SUPPLEMENTARY INFORMATION TO CLARIFY WHY THE SECOND SEGMENT OMITTS A DATUM REFERENCE.
4. COORDINATE INSPECTION PROCEDURES: ENSURE THAT INSPECTION PLANS REFLECT THE ABSENCE OF DATUM REFERENCES IN THE SECOND SEGMENT.
5. COMMUNICATE WITH MANUFACTURING AND INSPECTION TEAMS: MAKE SURE ALL STAKEHOLDERS UNDERSTAND THE TOLERANCE STRUCTURE AND ITS IMPLICATIONS.

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## SUMMARY AND CONCLUSIONS

THE QUESTION OF WHETHER THE SECOND SEGMENT OF A COMPOSITE TOLERANCE SPECIFICATION MUST INCLUDE DATUM FEATURE REFERENCES IS ROOTED IN A FUNDAMENTAL UNDERSTANDING OF GD&T PRINCIPLES AND STANDARDS.

KEY TAKEAWAYS INCLUDE:

- THE ASME Y14.5 STANDARD EXPLICITLY PERMITS THE OMISSION OF DATUM REFERENCES IN THE SECOND SEGMENT OF A COMPOSITE TOLERANCE UNDER CERTAIN CIRCUMSTANCES.
- SUCH OMISSION PROVIDES DESIGN AND MANUFACTURING FLEXIBILITY, SIMPLIFIES INSPECTION, AND ALIGNS WITH THE INTENDED FUNCTION OF THE FEATURES.
- THE DECISION TO INCLUDE OR OMIT DATUM REFERENCES SHOULD BE DRIVEN BY THE SPECIFIC FUNCTIONAL REQUIREMENTS, MANUFACTURING PROCESSES, AND INSPECTION CAPABILITIES.
- PROPER DOCUMENTATION AND COMMUNICATION ARE ESSENTIAL TO ENSURE THAT THE TOLERANCE SPECIFICATION IS CORRECTLY INTERPRETED AND IMPLEMENTED.

IN CONCLUSION, THE SECOND SEGMENT OF A COMPOSITE TOLERANCE SPECIFICATION IS NOT INHERENTLY REQUIRED TO INCLUDE DATUM FEATURE REFERENCES. INSTEAD, THIS DEPENDS ON THE DESIGN INTENT, FUNCTIONAL NEEDS, AND THE STANDARDS GOVERNING THE DRAWING OR SPECIFICATION. RECOGNIZING THIS FLEXIBILITY ALLOWS ENGINEERS TO CREATE MORE EFFECTIVE, EFFICIENT, AND FUNCTIONAL TOLERANCING SCHEMES, ULTIMATELY LEADING TO BETTER MANUFACTURED PARTS AND ASSEMBLIES.

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## REFERENCES

- ASME Y14.5-2022, "DIMENSIONING AND TOLERANCING."
- AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI), "GEOMETRIC DIMENSIONING AND TOLERANCING."
- PRACTICAL GD&T, JAMES D. MEADOWS, 2013.
- GD&T ILLUSTRATED, JAMES D. MEADOWS, 2012.
- INDUSTRY BEST PRACTICES AND CASE STUDIES FROM LEADING MANUFACTURING ORGANIZATIONS.

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AUTHOR'S NOTE: THIS INVESTIGATION EMPHASIZES THAT UNDERSTANDING THE NUANCES OF GD&T STANDARDS AND PRACTICAL APPLICATION IS ESSENTIAL FOR CREATING EFFECTIVE TOLERANCES. WHEN IN DOUBT, CONSULT THE LATEST STANDARDS AND COLLABORATE WITH EXPERIENCED GD&T SPECIALISTS TO ENSURE YOUR SPECIFICATIONS MEET BOTH FUNCTIONAL AND MANUFACTURING NEEDS.

# **The Second Segment Of A Composite Tolerance Specification Is Not Required To Include Datum Feature References**

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