

## Welcome

Welcome to the September/October issue of MechNEWS™, a service provided by MechSigma Consulting, Inc. Our feature article explores the application of *least material condition* (LMC) modifiers. Although similar to maximum material condition modifiers, LMC offers some unique differences.

We hope you enjoy this issue of MechNEWS™ and continue to [tell your colleagues about it](#).

### LMC for Wall Thickness

Typically, we modify features at their Least Material Conditions (LMC) when we want to *preserve wall thicknesses*. Common applications include maintaining structural integrity, concern for holes breaking out, and ensuring material on castings for post-machining. An abstract way of thinking about this is that features referenced at LMC must never violate a *boundary of material*. This boundary is the feature's virtual condition and we refer to it as the *LMC virtual condition*.

In Figure 1, the LMC virtual condition of the external feature on the left is  $\phi .626$ . Since we specified a zero positional tolerance at LMC,  $\boxed{\oplus \phi .000 \text{ (L) A B (L) - C (L)}}$ , a  $\phi .626$  feature must be perfectly located, prohibiting the feature from violating the  $\phi .626$  LMC virtual condition boundary. A  $\phi .656$  feature (MMC), however, is allowed to be out of tolerance by as much as  $\phi .030$ , but it, too, will not violate the  $\phi .626$  LMC virtual condition boundary.

In order to control the minimum wall thickness between the  $\phi .641 \pm .015$  feature and datum feature C, we referenced datum C at LMC in the above feature control frame. Paragraph 2.11.3 in Y14.5 states, "Where a virtual condition equal to the maximum material condition or the least material condition is the design requirement, a zero tolerance at MMC or LMC is specified." Since datum feature C is controlled by  $\boxed{\oplus \phi .000 \text{ (L) A B (L)}}$ , its LMC virtual condition is also equal to its LMC,  $\phi .252$ . Obviously, a perfectly located LMC hole ( $\phi .252$ ) would not violate the  $\phi .252$  LMC virtual condition boundary. An MMC hole ( $\phi .248$ ) is allowed to be out of tolerance by  $\phi .004$ , which also will not violate the  $\phi .252$  LMC virtual condition boundary.

(Continued)

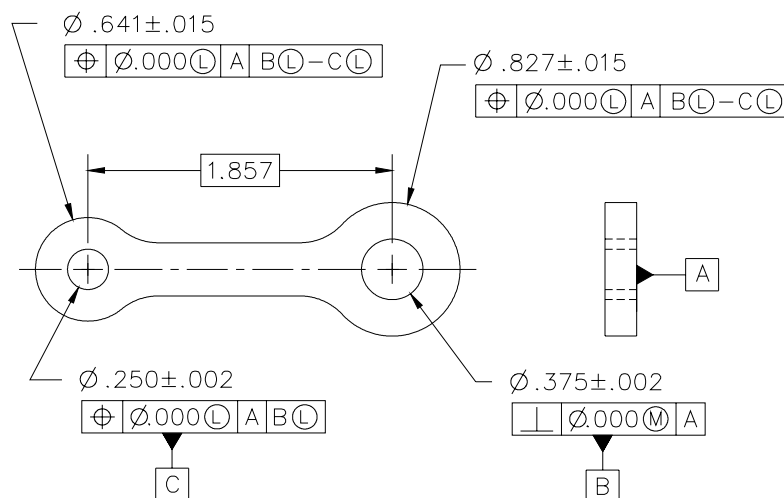


Figure 1

### Public Courses

We are putting together our calendar for next year's public offerings. If you would like for us to offer our three-day **GD&T** course or our two-day **Mechanical Tolerancing for Six Sigma (MTSS)** in your city, please [let us know](#).

### Engineering Services and On-site Training

Having problems with your designs?

MechSigma offers consulting and on-site training in mechanical tolerancing and GD&T.



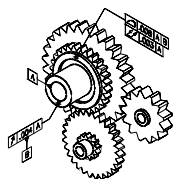
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## Perfect Form at LMC

A simple tolerance analysis reveals the minimum wall thickness between the two features is  $.187 ((.626-.252)/2)$ . This minimum wall thickness calculation is valid as long as the LMC features ( $\varnothing.626$  and  $\varnothing.252$ ) are perfectly cylindrical. In fact, this minimum wall thickness calculation is valid when *all* holes remain inside a perfect  $\varnothing.252$  (LMC) cylinder and all external features remain outside a perfect  $\varnothing.626$  (LMC) cylinder.

To ensure this, paragraph 5.3.5 in Y14.5 states, "Specification of LMC requires perfect form at LMC. Perfect form at MMC is not required. Where the feature departs from its LMC limit of size, an increase in positional tolerance is allowed, equal to the amount of such departure." Since Rule #1 is overridden, a feature produced at its MMC limit of size is permitted to vary from true form to the maximum variation allowed by the boundary of perfect form at LMC.

Thus, our minimum wall calculation remains correct.

## Summary

In Figure 1, our structural analysis requires us to control the minimum wall thickness to be greater than or equal to  $.187$ . For these types of applications, we apply LMC modifiers to assure an adequate "boundary of material". LMC modifiers (applied to controlled features and datum features) override Rule #1 (for both features.) Additionally, this invokes a perfect form boundary at LMC. An MMC feature does not need to have perfect form, but it may not violate the LMC perfect form boundary.



## Joke of the Bi-Month

A psychologist, engineer, and a theologian were hunting in the wilderness of Northern Canada.

Suddenly, the temperature dropped and a furious snowstorm was upon them. They came across an isolated cabin, far removed from any town. The hunters had heard that the locals in the area were quite hospitable, so they knocked on the door to seek permission to rest.

No one answered their knocks, but they discovered the cabin was unlocked and they entered. It was a simple place — two rooms with a minimum of furniture and household equipment. Nothing was unusual about the cabin except the stove. It was large, pot-bellied, and made of cast iron. What was strange about it was its location — it was suspended in mid-air by wires attached to the ceiling beams.

"Fascinating," said the psychologist. "It is obvious that this lonely trapper, isolated from humanity, has elevated this stove so that he can curl up under it and vicariously experience a return to the womb."

"Nonsense!" replied the engineer. "The man is practicing the laws of thermodynamics. By elevating his stove, he has discovered a way to distribute heat more evenly throughout the cabin."

"With all due respect," interrupted the theologian, "I'm sure that hanging his stove from the ceiling has religious meaning. Fire lifted up has been a religious symbol for centuries."

The three heatedly debated the point for several hours without resolving the issue. When the trapper finally returned, they immediately asked him why he had hung his heavy pot-bellied stove from the ceiling.

The trappers' answer was succinct. "Had plenty of wire — not much stove pipe."



## Events:

The next GD&T committee meeting is scheduled for May 2-5, 2005 in Minneapolis, MN. These meetings are open to the public. We'll have more details in future newsletters.