# A few words about Z.shift=1.5

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1 + 1 = 3

**The following is a Q&A session between student and tutor.**

S: As you know, the Six Sigma methodology states that when we don't have rational sub-grouping we can shift the Z value by 1.5. I have some concerns about this.
T: So do I, it's non-value-added, although it is convention.

S: As alternative to the Z.shift = 1.5, sometimes I've heard people talking about an inflation factor for the standard deviation. In particular: stdev LT=1.3*stdev ST
T: Yes indeed – and sometimes higher; between 1.3 and 1.8 depending upon your knowledge of the state of control of the process; if you know the process has lots of special causes you would use a high factor and vice versa. (This logic could also be applied to the 1.5 shift.) But this then leads to subjectivity – at least with the 'arbitrary' 1.5 or 1.3 factors you know where you stand.)

S: To me it makes more sense than the Z.shift, because given a dataset with rational subgroups, the Z.shift can strongly change depending on the spec limits, while the stdev ST and LT are always the same.
T: If you have rational subgroups it's a moot point; always calculate the real Z.shift value – never, ever use the 1.5 (or 1.3) when it's unnecessary.
They make a similar amount of 'sense', in that they are both somewhat arbitrary constants which don't represent any real process accurately.

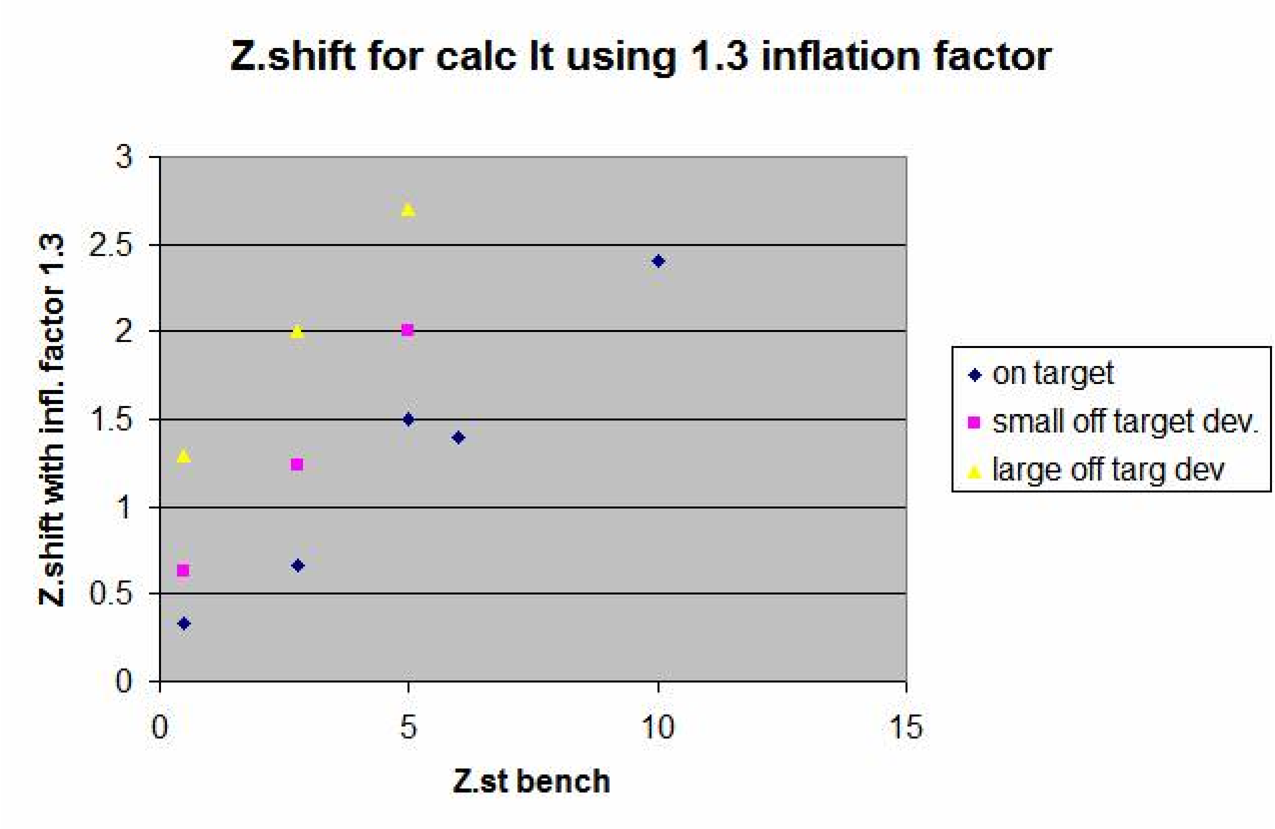
S: If you inflate the Z LT with a fixed Z.shift independently of the value of Z LT itself (1.8, or 2.5, or 4.5 etc) the result could be misleading
T: It is only misleading if too much is read into it. It is a CONVENTION and should be treated as such and it should be understood that the real Z.shift could be anything.
The standard deviation inflation factor is susceptible to the same problem as the 1.5 shift; it's an arbitrary constant and should be treated as a convention. The real danger is when some people use Z.shift of 1.5 and some people use the stdev inflation factor. As long as people use the same convention everyone knows where they stand – even if it's on shaky ground!!

S: If you have some data with rational subgroups you can try to calculate Z.st and Z.lt. Changing the spec limits you'll see that the Z.shift changes
T: The same is true for the 1.3 inflation factor method.
The following graph was generated for different specification limits, for mean on target, slightly off target and very off target (diamonds, squares and triangles respectively).
The short term standard deviation and target values were fixed and the long term standard deviation calculated using the 1.3 inflation factor.
The lines are only valid for this particular data set, of course, but you get the point . . . it shows that Z.shift is dependent upon the short term process capability (spec limits) and the deviation from target (mean).
The diamonds are for a process which is on target, with various values of Z.st.bench due to different spec limits around the fixed target.
At around 6 Sigma performance the shift is around 1.5 (which is no coincidence, by the way). (Excuse the incorrect point on the graph at Z.st=5, the result should be Z.shift=1.1).

For high potential process capability (10 Sigma), the shift is almost 2.5, whilst it is <<1.5 for a process with poor potential capability.
This variation is a result of the properties of the normal distribution; it's non-linearity.

For a process with a mean which is significantly off target (2 standard deviations away in this example), the triangles show how Z.shift varies with Z.st.bench. For a given Z.st.bench, Z.shift, as calculated here, is always higher than for a process which is on target.

So, you see that the inflation factor doesn't really help – in fact it could be harder to explain the value of Z.shift when using it than for the constant 1.5 we're used to.




S: So, if we don't have rational subgroups, don't you think it would be better to correct the standard deviation with an inflation rate and calculate the corresponding Z.shift?

T: If there is only short term data available, I would prefer people to quote Z.st.bench **ONLY**.
If there is only long term data available, I would prefer people to quote Z.lt.bench **ONLY**.
There is really no need to add or subtract constants which have no real practical application, but it has become part of 6 Sigma mythology (I choose the word carefully!)

However, if people must quote both then it doesn't matter which convention is used from a practical point of view, provided that they stick to it and everyone else in the organisation uses the same one.

**PS:**
In the above Z.st is defined as the capability when the process is on target – this is different to the default used by Minitab, which uses the mean, and so does not represent the true 'best' the process could achieve with only common cause variation.