



- ❖ There will always be seven total gridlines on the vertical torque axis, including the top and bottom gridlines that also act as borders for the graph
- ❖ The vertical axis will measure torque in both directions, but the maximum and minimum values of the window will not necessarily have the same absolute value
- ❖ Since the gridline for zero will depend on the maximum and minimum values in the window, the first step is to determine which of the seven gridlines will represent zero torque
  - First, the overall range ( $\Delta$ ) of the window must be set by taking the value of  $T_{\max} - T_{\min}$  and
    - a) rounding up to the nearest multiple of 600 if less than 3,000
    - b) rounding up to the nearest multiple of 6,000 if between 3,000 and 30,000
    - c) rounding up to the nearest multiple of 60,000 if the value is greater than 30,000
  - Example from template  $\rightarrow T_{\max} - T_{\min} = 2,790 - (-1,878) = 4,668$ , which falls into (b) above and rounds to  $\Delta = 6,000$
  - $Z = 6 * T_{\max} / (T_{\max} - T_{\min})$  rounded up to the nearest integer will return the number of gridlines from the top that the zero gridline should sit
  - The lowest maximum value and the highest minimum value on the graph is zero (in other words, the zero gridline must always be shown)
  - If the formula returns a number above seven, then the zero gridline is at the bottom (e.g. all plotted values in the window are positive)
  - If the formula returns a negative number, then the zero gridline is at the top (e.g. all plotted values in the window are negative)
  - Example from template  $\rightarrow Z = 6 * 2,790 / (2,790 - (-1,878)) = 3.6$  which rounds up to 4, so the zero gridline is the fourth line from the top of the graph (in the middle)
- ❖ The final step is to determine the scale interval of the graph in order to determine the value for the top, bottom, and all other gridlines
  - Since there are seven gridlines, the space between each gridline ( $\delta$ ) will be the total range divided by six, or  $\delta = \Delta / 6$
  - Example from template  $\rightarrow \delta = 6,000 / 6 = 1,000$
  - If  $\delta$  is less than the maximum value of  $|T_{\max} / (Z - 1)|$  and  $|T_{\min} / (Z - 7)|$  then  $\Delta$  needs to be increased in order to fit all values on the screen
  - $\Delta$  needs to be rounded to the next nearest multiple of 600, 6,000, or 60,000 (see above) until  $\delta$  is greater than the maximum value of  $|T_{\max} / (Z - 1)|$  and  $|T_{\min} / (Z - 7)|$
  - The lowest possible value for  $\delta$  is 100
  - Example from template  $\rightarrow |2,790 / (4 - 1)| = 930$  or  $|-1,878 / (4 - 7)| = 626$ ,  $\delta = 1,000$  is greater than 930, so proceed
  - Finally, based on the zero gridline position from the top ( $Z$ ) and the scale interval ( $\delta$ ), the gridline values can be calculated from top to bottom using the formula  $(Z - n) * \delta$ , where  $n$  is the gridline from the top ( $1 \leq n \leq 7$ )
  - Example from template  $\rightarrow$  from top to bottom,  $(4 - 1) * 1,000 = 3,000$ ;  $(4 - 2) * 1,000 = 2,000$ ;  $(4 - 3) * 1,000 = 1,000$ ;  $(4 - 4) * 1,000 = 0$ ;  $(4 - 5) * 1,000 = -1,000$ ;  $(4 - 6) * 1,000 = -2,000$ ;  $(4 - 7) * 1,000 = -3,000$