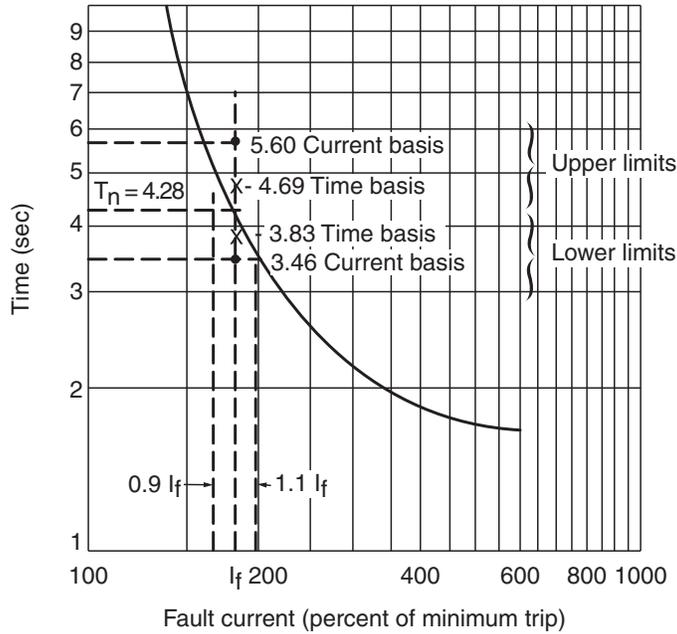


# Interpretations of tolerance on recloser time-current characteristics



### Interpreting TCC's

Making accurate coordination studies can be difficult when several reclosers are in series. The usual practice is to assume a fixed-fault current on the line and determine the minimum and maximum clearing times for each protective device. Applying a given plus and minus tolerance to the nominal clearing time associated with the assumed fault current may yield an erroneous result. Interpretation of the tolerance on recloser curves can be more correctly made by understanding how the limits are determined.

Time-current characteristics, commonly abbreviated "TCC's", are based on laboratory measurements. They relate the fault current passing through the recloser to the time required for the recloser to interrupt the fault. "Clearing time" is measured from fault initiation to power arc extinction. Some published curves show "maximum clearing time"; but more often "average clearing time" is plotted and a  $\pm$  ten percent variation is given. This means that for every fixed current ( $I_f$ ) the corresponding time ( $T_n$ ) can vary on a straight  $\pm$  ten percent time basis, or on a  $\pm$  ten percent current basis. Whichever variation yields the greatest deviation is the accepted limit.

### Examples

For example, assume the need to establish the time limits for a fault current of 180 percent of minimum trip on the hypothetical curve shown in Figure 1. This current will be labeled  $I_f$  and the nominal clearing time for it  $T_n$ .  $T_n$  is found to equal 4.28 seconds by entering the TCC at  $I_f$  and reading across to the time scale. Applying the  $\pm$  ten percent tolerance on a straight time basis yields apparent limits of 4.69 seconds and 3.83 seconds.

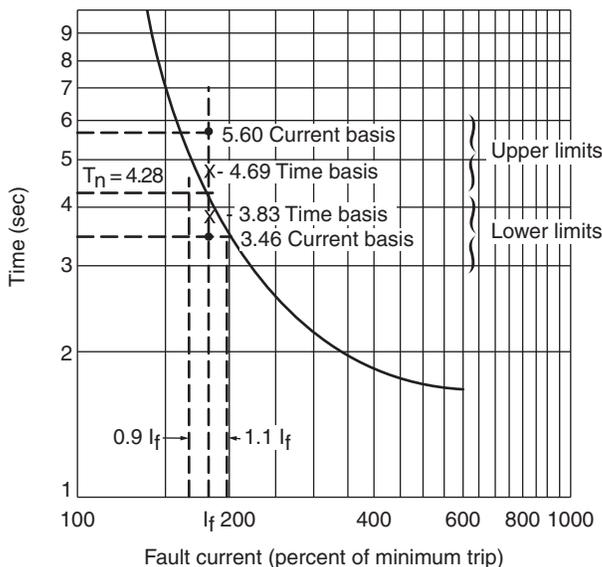


Figure 1. TCC tolerances for time and current

However, to be assured of obtaining the maximum applicable limits, the limits calculated on a current basis must also be investigated. In this case, apply the  $\pm$  ten percent variation to  $I_f$  and get two currents of  $0.9 I_f$  and  $1.1 I_f$  or 162 percent and 198 percent of minimum trip current, respectively. Following up these two current ordinates, intersect the TCC at 5.60 seconds and 3.46 seconds. These values are the accepted timing limits for this particular current. Thus, any time between 5.60 seconds and 3.46 seconds is considered with a  $\pm$  ten percent tolerance for this fault current on our hypothetical curve.

Calculating and plotting a series of such limits about the nominal curve results in a characteristic as shown in Figure 2. Points shown by "dots" are deviations in time calculated on a current basis. Points shown by "X's" are deviations on a straight time basis. The envelope is drawn through the points that present the greatest tolerance. Note that in the steeper region of the curve (low-current end) the bandwidth is determined by variations in current; in the flatter portion of the curve (high-current end) the bandwidth is governed by variations in time.

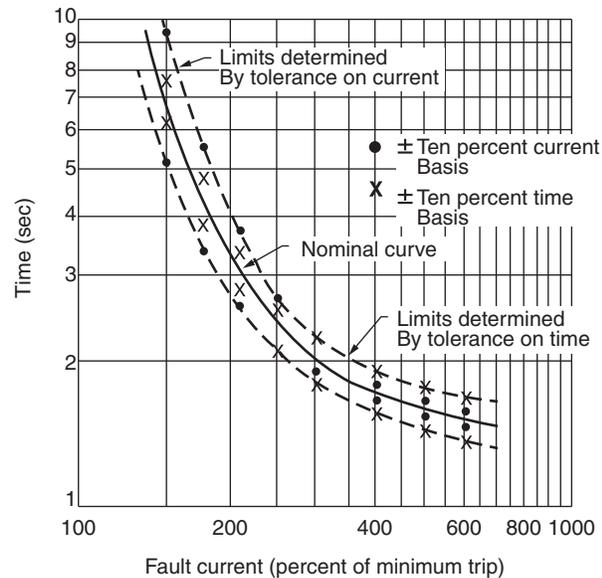


Figure 2. TCC limits determined by tolerances on time and current

For every inverse TCC's the time limits can exceed the simple  $\pm$  ten percent variation from the nominal time. Applying tolerance calculated on both current and time basis is required to determine the maximum timing limits at any point. Following this interpretation, reliable coordination can be achieved.

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