For Category IV transformers (above 10 000 kVA single-phase, and above 30 000 kVA three-phase), a single through-fault protection curve applies as is shown in Figure A.4. This curve reflects both thermal and mechanical damage considerations and is to be used for selecting protective device time-current characteristics for all applications regardless of the anticipated level of fault incidence. There are different curves for different transformer impedances. The curves are derived considering that the fault currents are from 50% to 100% of the maximum possible fault current and reflect $I^2t = K$; $K$ is 2 s for the worst-case mechanical duty.

The delineation of infrequent- versus frequent-fault-incidence applications for Category II and III transformers can be related to the zone or location of the fault as is shown in Figure A.5. For convenience, the through-fault protection curves for Category I, II, III, and IV transformers are summarized in Table A.1.

Fuse or overcurrent relay coordination with the through-fault protection curves, or both, are shown in Figure A.6, Figure A.7, and Figure A.8.

A coordination issue when delta-wye transformers are to be protected is worth considering here. (The primary winding is connected in delta and the secondary winding is connected in wye.) Assume that the transformation ratio is 1:1. On the secondary side, the current in each phase winding is the same as the current in the outgoing line. When a three-phase fault occurs, the line currents on the primary side are 1.73 times the currents in the primary winding.

When a single-phase-to-ground fault occurs on the secondary side of the transformer, the line currents on the primary side are 0.577 times the line current on the primary side. The operating characteristic of the primary-side fuse or relay should be shifted to the right on the coordination plots.

When a two-phase fault occurs on the secondary side of the transformer, the current in the faulted phases is 86.6% of the three-phase fault current on the secondary side. On the primary side, current will be 100% of the three-phase fault current in one phase and 50% of the three-phase fault current in the other two phases. The applicable primary-side curves should be shifted to the left on the phase-to-phase fault coordination plots.

An example of the application of the new thermal/mechanical limit curves to a three-winding autotransformer (wye-wye-delta) with overcurrent relays on the 30 MVA tertiary follows using Table A.2 nameplate data.

The coordination steps are as follows:

i) Select the category from the minimum nameplate rating of the principal winding (75 000 kVA is Category IV).

ii) Select the impedance to use so as to plot the Category IV curves (Z for 132/13.2 kV = 7.94% at 30 000 kVA).

100/7.79 =12.59

iii) Calculate "constant" $K = \left[ I^2t = \left(\frac{100}{7.94}\right)^2 \times 2 = 317.24 \right]$ at 2 s.

iv) Times normal base current at 2 s >> 12.59.

v) The 50% point is $\left[\frac{317.24}{(12.59+2)^2}\right]$ >> 8 s.

The coordination of the overcurrent relays for this example is shown in Figure A.9.

317.24/((12.59/2)^2) = 8.0 seconds