Sectioning and Analysis of Iteration #2 Coil End Parts

Iteration #2 coil end parts were designed to incorporate changes suggested by a study of sectioned iteration #1 end assemblies. Cable shape change parameters were revised in an attempt to more closely conform to observed cable cross-section changes in the ends.

One of these these parameters is cable mid-thickness. End pressure applied to the coil ends during the cure cycle is not sufficient to push each end part to its designed position. End pressures high enough to close the end were shown to damage insulation, end parts, and even cable strands. The allowable end pressure was therefore limited, resulting in the inability to achieve a closed coil end with iteration #1 end parts.

To compensate for this limit, the mid-thickness of each cable was allowed to increase as it wound around the end. The intent was to produce a space between closed end parts that corresponded to the space produced by the accepted end force. This would allow end closure, and reduced gaps between end parts and wedges, while maintaining the current mid-thickness compaction of cables within a group.

Measurement of the sectioned iteration #2 inner coil assembly shows that even though the average allowed space per conductor was increased by .006 inches, the end did not close to its designed length. The total length over the design length was around .085 inches. This is about half the length that similair iteration #1 coil ends were too long, but still far from the anticipated closed length.

The iteration #2 coils were wound using cable tension alone to conform each cable to its winding surface. No additional forces, such as pushing or tapping, were applied during winding. After curing, the last-wound group in the end was closed to less than its designed length by around .008 inches. Thus, only the last-wound group was affected by the applied end force; the total length increase of the end is the result of the first-wound groups being wound too large and remaining unaffected by the applied end force. This confirms the previously observed fact that if the cables in first-wound groups are not made to closely conform to the parts and underlying turns in the winding process, they will not be made to do so by the application of end force in curing.

Another cable shape change parameter is cable keystone angle. Analysis of the iteration #1 sections showed that the cable keystone angle changes in the ends; the cable cross-section becoming more like a rectangle than a trapezoid. The evidence for this is plain, the cables are more tightly compressed at the bottom of a group designed for trapezoids than at the top.

The iteration #2 design practically eliminated the keystone angle of the cable, using an angle obtained by multiplying the original cable keystone by 0.1 at the nose of the parts. This would provide more space at the bottom of a group where compaction was tight, and provide less space at the top of a group where compaction appeared to be less. The intent was to provide more uniform compaction, across their width, of the cables within a group. It was also hoped that this change would improve the curling problem observed in the upper edge of the first turns of each group.

Measurement of sectioned iteration #2 assemblies shows that compaction across the width of the cables is more uniform and that the expected increase in space at the bottom of a group, and the decrease in space at the top of a group, was achieved as designed. Because the iteration #2 coils were not conformed well to the parts and because the applied end force was significantly smaller, direct comparison to the iteration #1 sections is difficult.

The curl of the upper edge of the first-wound cables in a group was not eliminated as hoped. Since this curl appeared even in the last-wound group where end force transfer was good, it appears that this phenomena can only be minimized by application of conforming force during the winding process.