

Cold Temperature Application Information

This section provides information regarding cold temperature characteristics of FR3 fluid. The following documents are included:

- **Cold Temperature Research and Tests**
 - CPS presentation on climatic data and fluid physical states at very cold temperatures.
 - CPS presentation on cold start transformer temperature rise under very cold ambient conditions.
 - IEEE Technical Paper: Behavior of Natural Ester Fluids near the Pour Point.
 - CPS Engineering Development Report: Envirotemp FR3 Fluid Filled Transformer Extreme Cold Start (Gelled Fluid) Thermal Model
 - CPS Bulletin S900-20-3: Transformer Cold Start and Cold temperature Controls
 - CPS Application Brief: Alliant Energy Cold Start February 2007

Conclusions: Test data shows that core losses alone are sufficient to keep FR3 fluid liquid in cold environments, performing the heat transfer required of insulating fluids. During Cold Start applications, where FR3 fluid may be gelled or solidified, data shows that FR3 fluid warms, liquefies, and conducts heat away from the coils before excessive hot spot temperatures can be reached, even when the transformer is fully loaded. In addition, unlike mineral oil, FR3 fluid does not saturate with water at low temperatures, and that FR3 fluid maintains dielectric strength down to -50°C . CPS is further evaluating FR3 fluid behavior under cold start condition, including switching surge capability and radiator thaw rates. Results will be published once ongoing tests have been completed