



## For North American Oil-Filled Distribution Transformers Filled with Envirotemp™ FR3™ Natural Ester Oil and 3M® LFT 155°C Solid Insulation Paper



**Essex Solutions offers multiple insulated magnet wires that are compatible with Envirotemp™ FR3™ natural ester oil and 3M® LFT 155°C solid insulation paper.**

The Essex Solutions magnet wire products listed in Table 3 have been tested per NEMA® MW1000 Sections 3.54.4 and 3.54.5 to verify oil resistance and hydrolytic stability to Envirotemp™ FR3™ natural ester oil and 3M® LFT 155°C solid insulation paper.

### Compatibility Testing Protocol

The purpose of NEMA® MW1000 Sections 3.54.4 and 3.54.5 is to verify no deterioration of the magnet wire (by flexibility, visual appearance, elongation, and dielectric breakdown) after being exposed to transformer oil under pressure and elevated temperature. The duration of exposure for 3.54.4 is 168 hours and for 3.54.5 is 672 hours.

TABLE 1  
Percent of Pressure Vessel Materials Used in the Compatibility Test

MATERIALS IN THE PRESSURE VESSEL PER NEMA® MW 1000 SECTION 3.54.4	
MATERIAL	VOLUME PERCENT OF TOTAL
Envirotemp™ FR3™ natural ester oil	65%
3M® LFT 155°C Paper	4%
Steel	0.5%
Magnet Wire Insulation (See Table 3 for Complete List)	0.26%

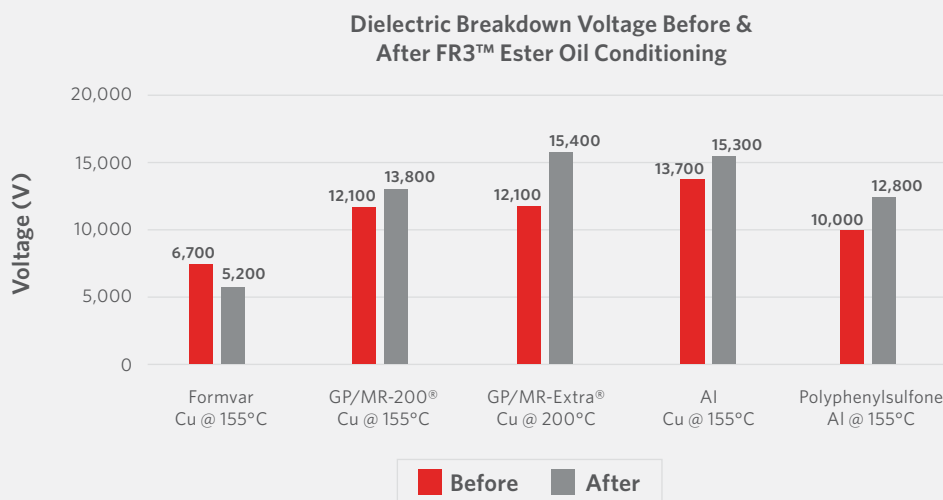


## Compatibility Testing Results

TABLE 2  
Visual Inspection Results per NEMA® MW 1000 Sections 3.54.4 and 3.54.5

MAGNET WIRE INSULATION SYSTEMS TESTED	FLEXIBILITY (CRACKING)	VISUAL APPEARANCE (CRAZING)	ELONGATION (CRACKING)
Formvar Polyvinyl Acetal & Phenolic Resins	Pass	Pass	Pass
GP/MR-200® Modified Polyester basecoat/Polyamide-imide topcoat	Pass	Pass	Pass
GP/MR-Extra® Modified Polyester basecoat/Polyamide-imide topcoat	Pass	Pass	Pass
Al Polyamide-imide	Pass	Pass	Pass
PolyFlex® 225 Polyphenylsulfone	Pass	Pass	Pass

CHART 1  
Dielectric Breakdown Voltage Test Results Before and After FR3™ Ester Oil Conditioning. Testing conducted per NEMA® MW 1000 Sections 3.54.4 and 3.54.5.



1. Oil temperature was 155°C for the test except where noted for GP/MR-Extra® which was tested at 200°C.  
2. Ramp rate for the test was 500V/sec.



## Product Recommendations based upon compatibility testing

TABLE 3  
Essex Insulated Magnet Wire Products Compatible with  
Envirotemp FR3 Natural Ester Oil and 3M® LFT 155°C Paper.  
Testing conducted per NEMA® MW 1000 section 3.54.4

COPPER INSULATED MAGNET WIRE					
ESSEX PRODUCT*	PRODUCT DESCRIPTION	THERMAL CLASSIFICATION	NEMA® PRODUCT SPECIFICATION	ROUND	SHAPED
Formvar	Polyvinyl Acetal & Phenolic Resins	105	MW 15-C, MW 18-C	✓	✓
GP/MR-Extra®	Modified Polyester basecoat/Polyamideimide topcoat	220	MW 37-C, MW 38-C	✓	✓
AI	Polyamide-imide	220	MW 16-C, MW 20-C	✓	✓

ALUMINUM INSULATED MAGNET WIRE					
ESSEX PRODUCT*	PRODUCT DESCRIPTION	THERMAL CLASSIFICATION	NEMA® PRODUCT SPECIFICATION	ROUND	SHAPED
Formvar	Polyvinyl Acetal & Phenolic Resins	105	MW 15-A, MW 18-A	✓	✓
GP/MR -200®	Modified Polyester basecoat/Polyamideimide topcoat	220	MW 37-A, MW 38-A	✓	✓
PolyFlex 225	Polyphenylsulfone	200	Not Applicable	✓	✓

\*Essex standard products listed. Consult factory for custom configurations.

## Summary

Essex Solutions performed compatibility tests using NEMA® MW 1000 Section 3.54.4 and 3.54.5 test methods to verify compatibility of its insulation systems with Envirotemp™ FR3™ natural ester oil and 3M® LFT 155°C Paper. The Essex insulated magnet wire products listed in Table 3 passed the oil resistance, hydrolytic stability and visual inspection tests. These results provide options to transformer designers. They may explore new insulation systems and take advantage of the higher temperature performance to maximize power density and volume.

*Envirotemp and FR3 are trademarks of Cargill. 3M is a registered trademark of 3M. NEMA is a registered trademark and service mark of the National Electrical Manufacturer's Association. GP/MR-200, GP/MR-Extra, and Polyflex are registered trademarks of Essex Solutions Inc.*

*Features and specifications are subject to change.*