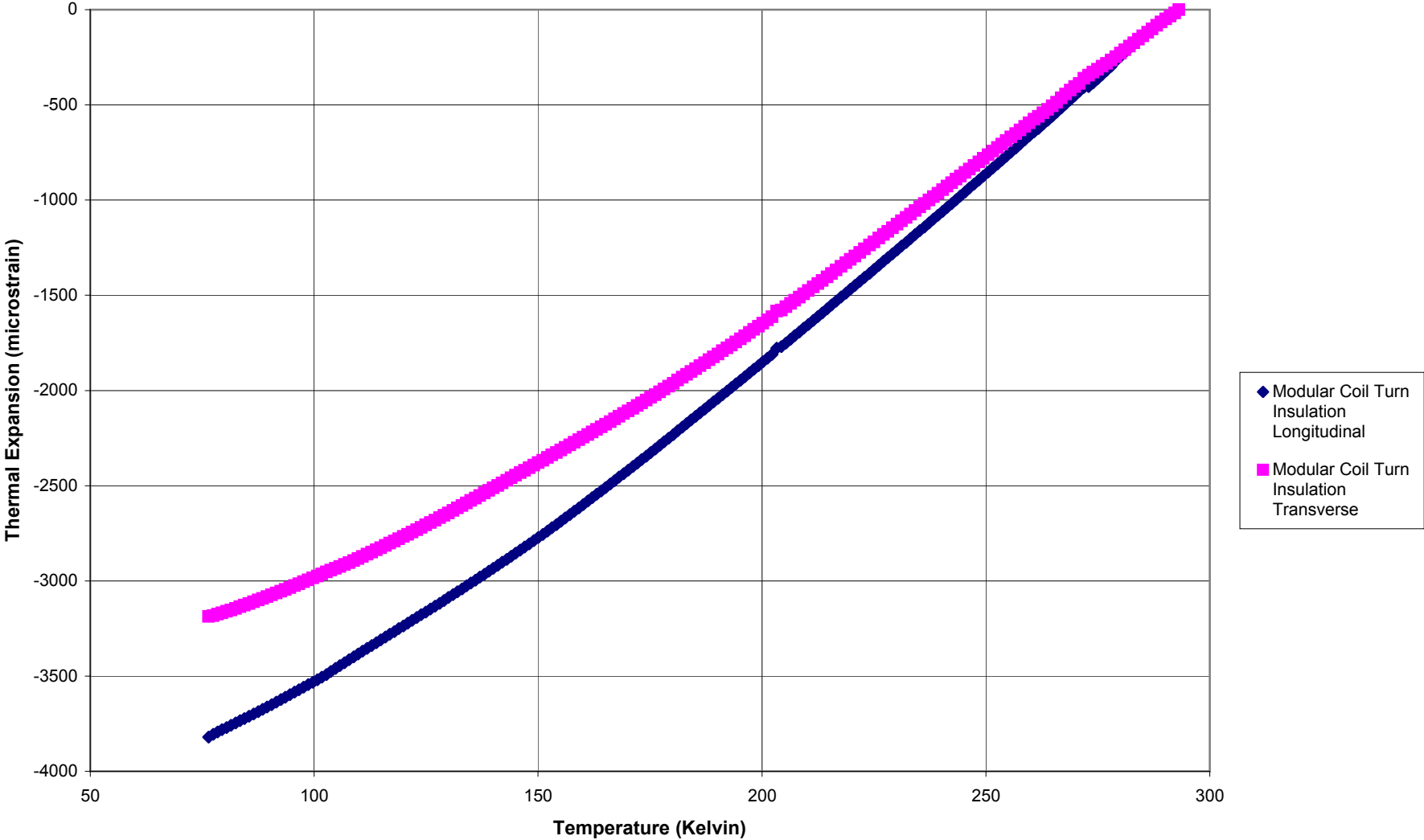
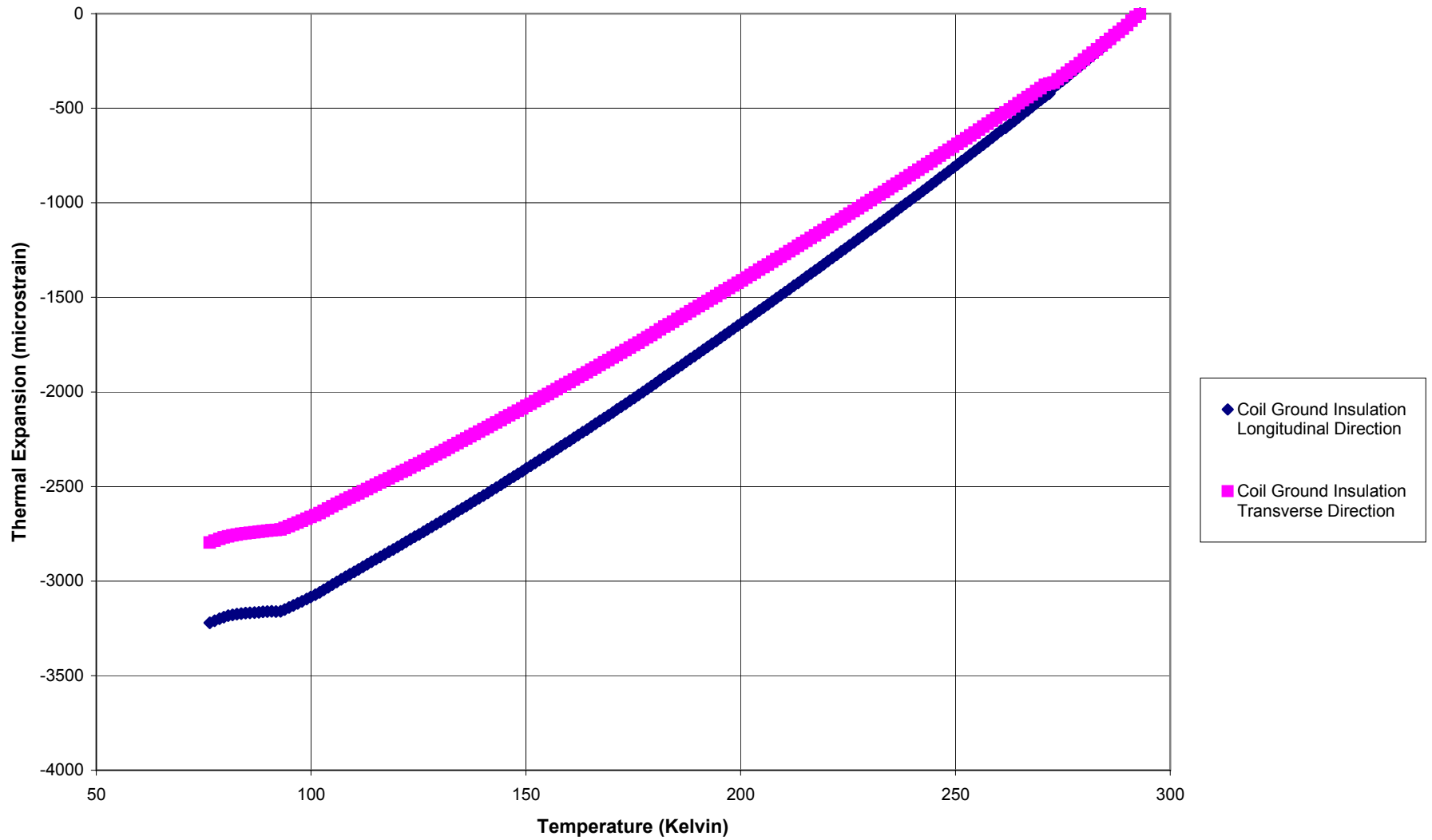


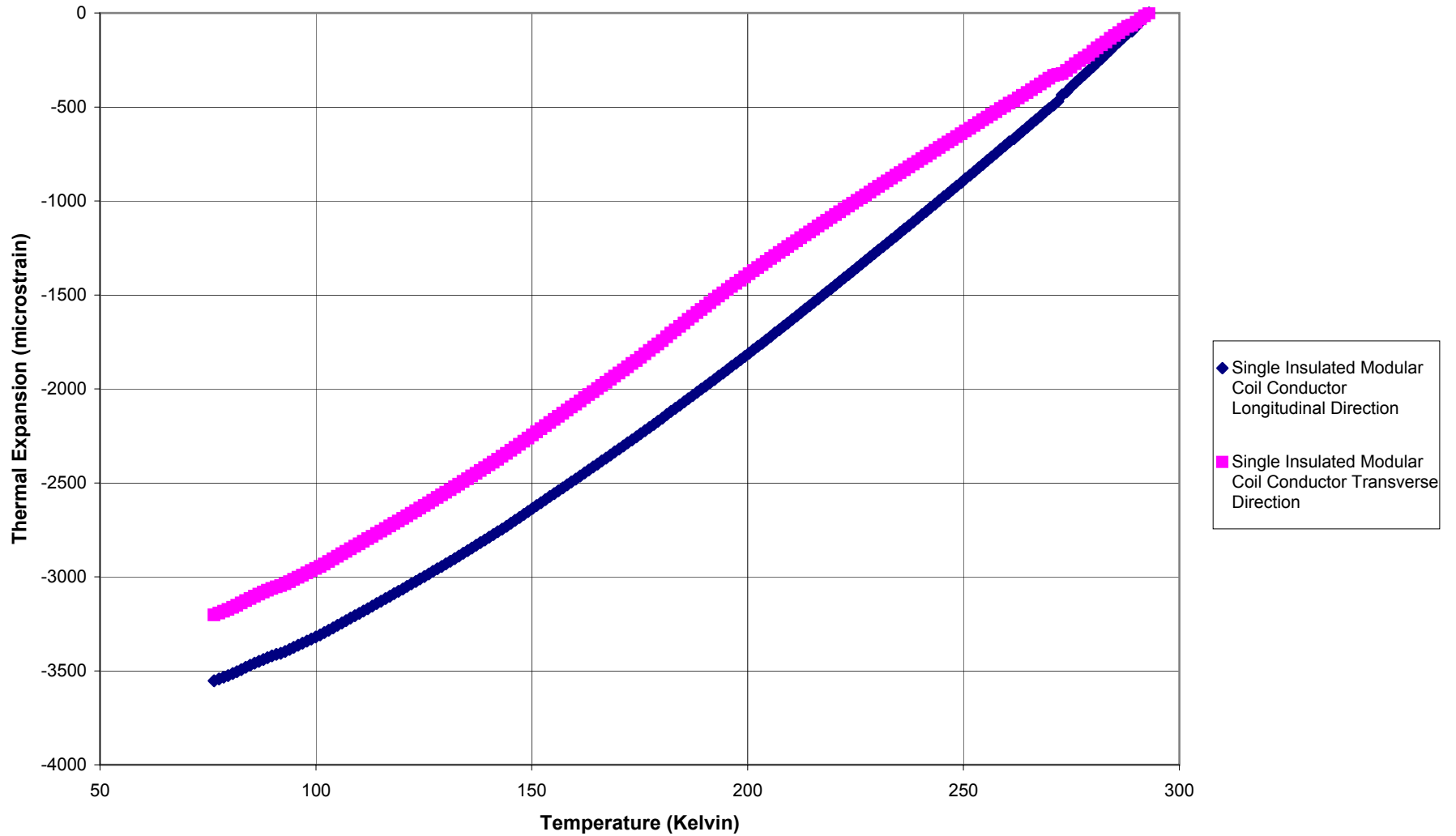
Thermal Expansion of Modular Coil Turn Insulation Longitudinal vs. Transverse Direction



Thermal Expansion of the Coil Ground Insulation Longitudinal vs. Transverse Direction



Thermal Expansion of Single Insulated Modular Coil Conductor Longitudinal vs. Transverse Direction





COMPOSITE TECHNOLOGY DEVELOPMENT, INC.

ENGINEERED MATERIAL SOLUTIONS

PRELIMINARY

TEST CONDITIONS

Material:	Single Insulated Modular Coil Conductor	Load Range Card:	NA
Matrix:	CTD-101K	Stroke Range Card:	NA
Reinforcement:	Kapton film interwoven w/ glass fabric attached to Cu Conductor		
Fiber Lay-up:	NA		
Nominal Specimen Dimensions:	26 mm L x 20 mm W x 17 mm T		
Material Reference:	7021-300		
Customer:	PPPL		
Load Rate:	NA		
Strain Measurement:	.125 inch Strain Gage 0°/90° Configuration	Specimen Conditioning:	NA
Strain Gage Type:	SK-06-125TM-350		
Test Fixture:	CTE Test Fixture	Test Temperature:	76-293 K
Test Date:	7/30/2003	Temperature Hold Time:	Natural Warm-up

TEST RESULTS

Specimen Single Insulated Modular Coil Conductor Longitudinal Direction			
Temperature (Kelvin)	TE (microstrain)	Percent TE	CTE 10x-6 m/mK
76	-3563	-0.36	9.53
80	-3515	-0.35	9.84
90	-3413	-0.34	10.57
100	-3309	-0.33	11.74
110	-3194	-0.32	12.70
120	-3064	-0.31	13.10
130	-2931	-0.29	13.51
140	-2790	-0.28	14.62
150	-2636	-0.26	15.42
160	-2479	-0.25	15.76
180	-2156	-0.22	16.44
200	-1810	-0.18	17.64
220	-1447	-0.14	18.34
240	-1074	-0.11	18.86
260	-686	-0.07	19.40
280	-264	-0.03	21.66
293	0	0.00	22.35

Specimen Single Insulated Modular Coil Conductor Transverse Direction			
Temperature (Kelvin)	TE (microstrain)	Percent TE	CTE 10x-6 m/mK
76	-3203	-0.32	9.41
80	-3163	-0.32	9.89
90	-3054	-0.31	10.97
100	-2944	-0.29	12.00
110	-2824	-0.28	12.85
120	-2689	-0.27	13.73
130	-2551	-0.26	14.53
140	-2405	-0.24	15.27
150	-2245	-0.22	15.94
160	-2081	-0.21	16.54
180	-1743	-0.17	17.53
200	-1388	-0.14	18.08
220	-1073	-0.11	18.92
240	-776	-0.08	19.77
260	-479	-0.05	20.63
280	-187	-0.02	21.49
293	0	0.00	22.00



PRELIMINARY

TEST CONDITIONS

Material:	Modular Coil Turn Insulation	Load Range Card:	NA
Matrix:	CTD-101K	Stroke Range Card:	NA
Reinforcement:	Kapton film interwoven w/ glass fabric		
Fiber Lay-up:	NA		
Nominal Specimen Dimensions:	44mm L x 14mm W x 2.3 mm T		
Material Reference:	7021-300		
Customer:	PPPL		
Load Rate:	NA		
Strain Measurement:	.125 inch Strain Gage 0°/90° Configuration	Specimen Conditioning:	NA
Strain Gage Type:	SK-06-125TM-350		
Test Fixture:	CTE Test Fixture	Test Temperature:	76-293 K
Test Date:	7/30/2003	Temperature Hold Time:	Natural Warm-up

TEST RESULTS

Specimen Modular Coil Turn Insulation Longitudinal Direction			
Temperature (Kelvin)	TE (microstrain)	Percent TE	CTE 10x-6 m/mK
76	-3820	-0.38	11.90
80	-3770	-0.38	11.92
90	-3649	-0.36	11.94
100	-3519	-0.35	13.76
110	-3369	-0.34	14.46
120	-3221	-0.32	14.66
130	-3087	-0.31	14.84
140	-2934	-0.29	15.69
150	-2772	-0.28	16.48
160	-2599	-0.26	17.70
180	-2232	-0.22	18.71
200	-1850	-0.19	19.24
220	-1449	-0.14	19.74
240	-1059	-0.11	20.15
260	-641	-0.06	20.70
280	-246	-0.02	21.22
293	0	0.00	21.58

Specimen Modular Coil Turn Insulation Transverse Direction			
Temperature (Kelvin)	TE (microstrain)	Percent TE	CTE 10x-6 m/mK
76	-3187	-0.32	6.63
80	-3160	-0.32	7.55
90	-3073	-0.31	9.58
100	-2974	-0.30	9.89
110	-2871	-0.29	11.10
120	-2756	-0.28	11.95
130	-2643	-0.26	13.11
140	-2512	-0.25	13.21
150	-2379	-0.24	13.31
160	-2245	-0.22	13.52
180	-1963	-0.20	15.03
200	-1647	-0.16	16.46
220	-1294	-0.13	17.68
240	-945	-0.09	17.97
260	-576	-0.06	18.28
280	-228	-0.02	18.57
293	0	0.00	18.76



PRELIMINARY

TEST CONDITIONS

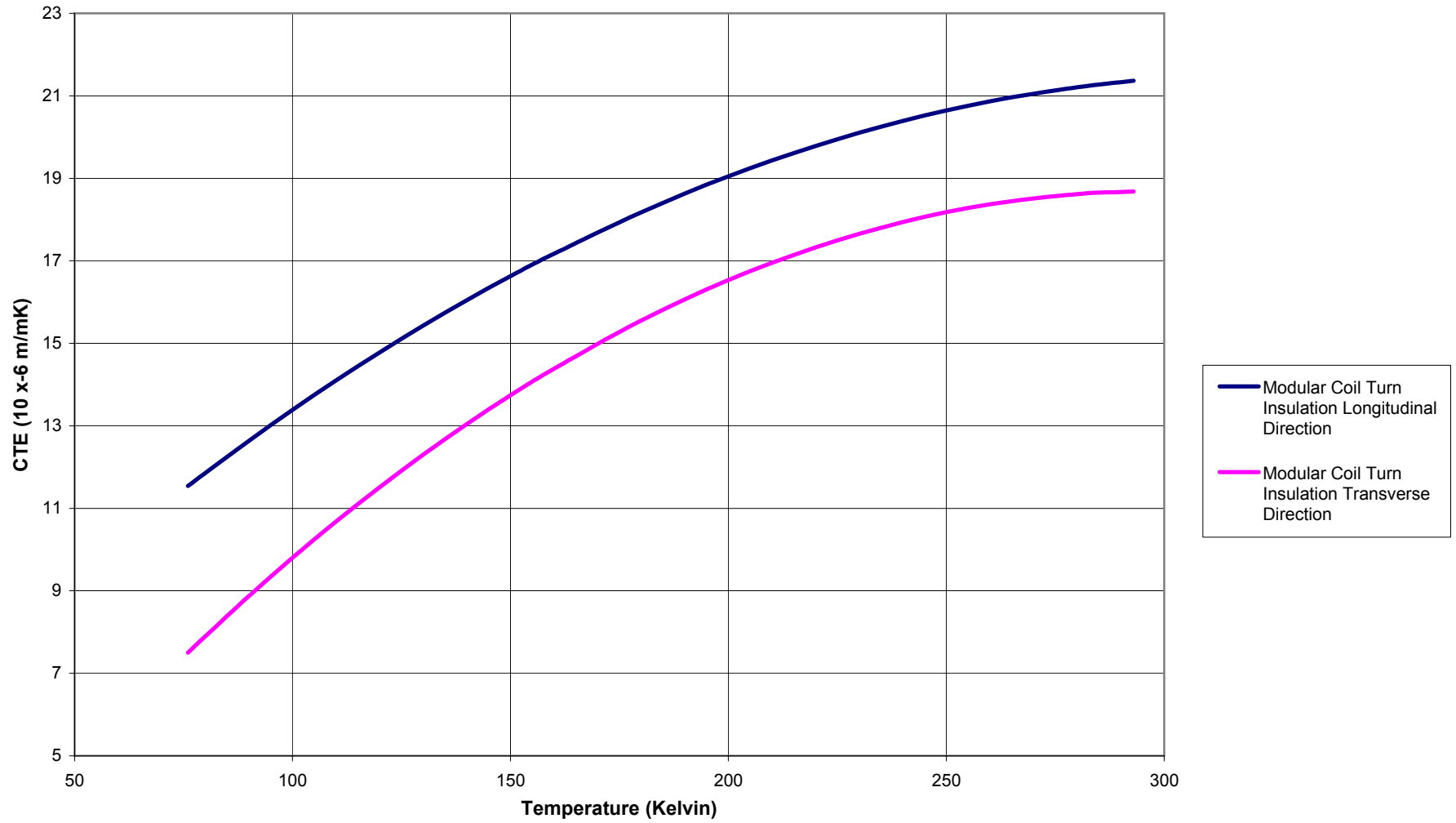
Material:	Coil Ground Insulation	Load Range Card:	NA
Matrix:	CTD-101K	Stroke Range Card:	NA
Reinforcement:			
Fiber Lay-up:	NA		
Nominal Specimen Dimensions:	44mm L x 14mm W x 2.3 mm T		
Material Reference:	7021-300		
Customer:	PPPL		
Load Rate:	NA		
Strain Measurement:	.125 inch Strain Gage 0°/90° Configuration	Specimen Conditioning:	NA
Strain Gage Type:	SK-06-125TM-350		
Test Fixture:	CTE Test Fixture	Test Temperature:	76-293 K
Test Date:	7/30/2003	Temperature Hold Time:	Natural Warm-up

TEST RESULTS

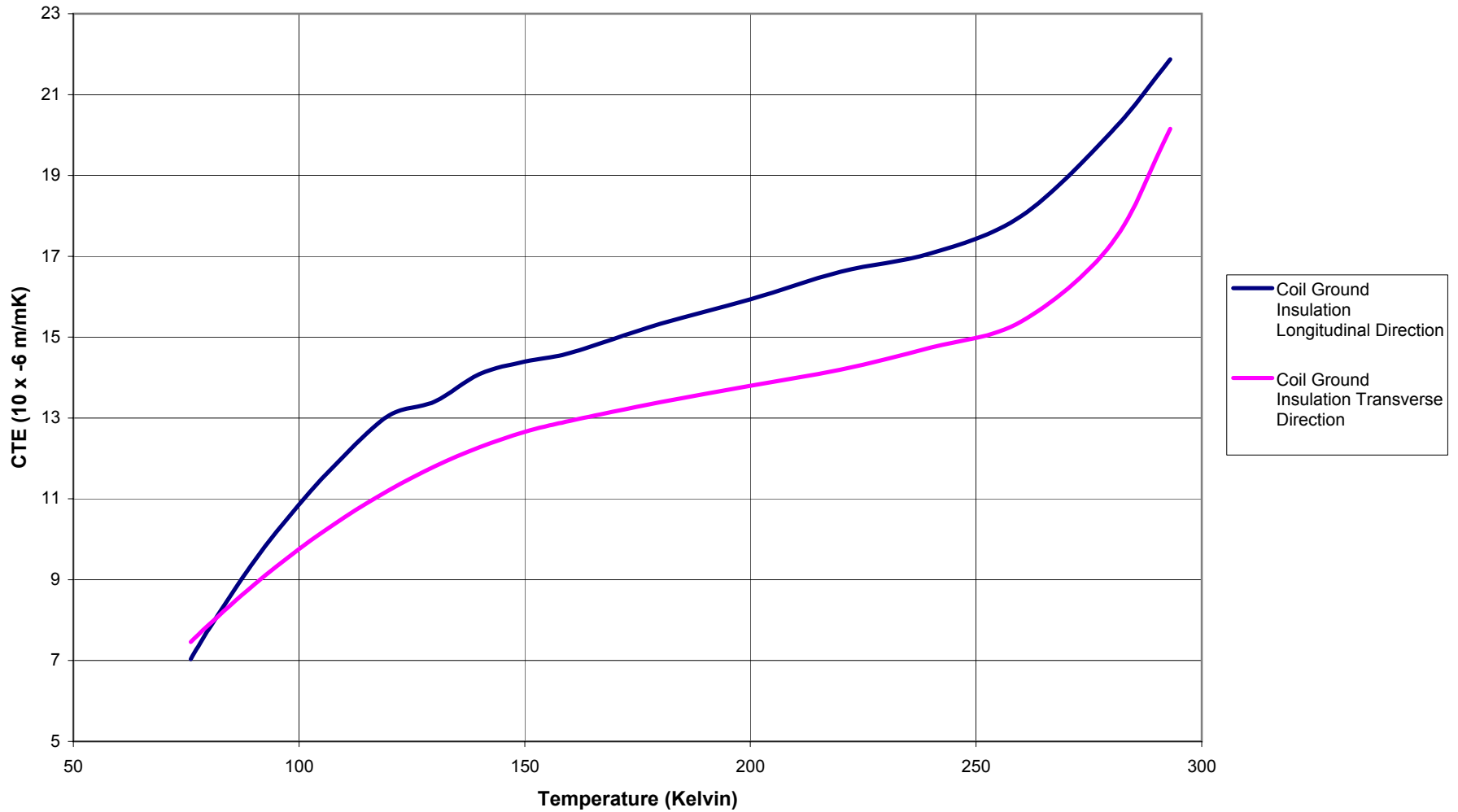
Specimen	Coil Ground Insulation		Longitudinal
	Direction		
Temperature (Kelvin)	TE (microstrain)	Percent TE	CTE 10x-6 m/mK
76	-3220	-0.32	7.12
80	-3183	-0.32	7.12
90	-3160	-0.32	8.58
100	-3072	-0.31	12.02
110	-2951	-0.30	12.92
120	-2819	-0.28	13.16
130	-2686	-0.27	13.39
140	-2547	-0.25	13.95
150	-2404	-0.24	14.36
160	-2258	-0.23	14.76
180	-1954	-0.20	15.57
200	-1634	-0.16	16.03
220	-1308	-0.13	16.51
240	-972	-0.10	17.10
260	-619	-0.06	17.72
280	-240	-0.02	19.54
293	0	0.00	20.32

Specimen	Coil Ground Insulation		Transverse
	Direction		
Temperature (Kelvin)	TE (microstrain)	Percent TE	CTE 10x-6 m/mK
76	-2796	-0.28	7.75
80	-2763	-0.28	7.75
90	-2732	-0.27	7.71
100	-2651	-0.27	10.66
110	-2547	-0.25	10.98
120	-2434	-0.24	11.34
130	-2319	-0.23	11.70
140	-2198	-0.22	12.06
150	-2073	-0.21	12.42
160	-1948	-0.19	12.75
180	-1685	-0.17	13.39
200	-1410	-0.14	13.80
220	-1130	-0.11	14.20
240	-840	-0.08	14.75
260	-535	-0.05	15.39
280	-224	-0.02	17.30
293	0	0.00	20.16

Coefficient of Thermal Expansion Modular Coil Turn Insulation Longitudinal vs. Transverse Direction



Coefficient of Thermal Expansion Coil Ground Insulation Longitudinal vs. Transverse Direction



Coefficient of Thermal Expansion Single Insulated Modular Coil Conductor Longitudinal vs. Transverse Direction

