RBSP-EFW-TN-030
RCN-8818 FLIGHT CABLE ANALYSIS

Performed by G Dalton
8/13/09

A. Introduction

RCN-8818 Rev B custom WL Gore composite cable was designed per Appendix A for use in the Spin Plane and Axial Booms for the RBSP project. This design is based on a previous composite cable design tested empirically and documented in Reference 1, and improved by analysis and redesigned in Reference 2. Three first-run production sample cables of differing outer braid picks-per-inch were produced by WL Gore and evaluated at SSL for the flight construction. The evaluation was performed in Reference 3 and subsequently WL Gore produced flight cable, whose summary analysis is captured in this document.

B. References

1. *Gore Cable Analysis*, Greg Dalton 11/28/07
2. *RBSP Cable Calcs.xls*, David Pankow 4/18/08
3. RBSP-EFW-TN-022 *Gore Flight Cable Evaluation*, Greg Dalton 9/29/08
4. RBSP-SPB-PRO-100 *RCN-8818 Cable Tension Test*, Greg Dalton 9/9/08
5. RBSP-SPB-PRO-101 *RCN-8818 Cable CTE Test*, Greg Dalton
6. *RBSP EFW Gore Cable Damping Test, Post MPDR Update*, Greg Dalton and David Pankow 10/28/08

C. Receipt Inspection and Cable Lengths

The Gore cable was received in two shipments of different lots, and a sample from each lot was required to be tested for qualifying for flight. Table 1 is a summary of the segments of cable delivered and the useable length for fabricating 155ft (47m) SPB and 26ft (8m) AXB flight cables:

Lot #	Segment length (ft)	# Flight cables	Remainder (ft)
1 (inspected 1/8/09)	174	1	19
	173	1	18
	376	2	66
	300 (AXB)	11	14
2 (inspected 5/5/09)	336	2	26
	174	1	19
	510	3	45
	337	2	27

Table 1. Gore cable lots delivered

This is sufficient cable to build eight flight units and four spare SPB cables, and four flight and four spare AXB cables. The entire length of cable segments were inspected for mechanical defects, electrical continuity, and proper construction. Pendulum damping tests were performed on the 30 picks per inch sample described in Reference 3 and documented in Reference 6. Since the damping tests were performed on cables with similar construction as flight cables, pendulum damping tests were not performed on flight cables. Table 2 tabulates the physical cable properties that were observed in both lots of cable.

Cable outer layup	30PPI
Core conductors (7x): AWG 36 (7/44) SPC w/0.002" thick Kapton insulation	✓
Strength member (2x): 200 Denier, 8 ends Kevlar braid	✓
Overall binder: 0.002" thick aluminized Kapton tape	✓
Outer Braid: AWG 42 (1) braid (16 carrier/3 strands)	✓
Cable linear mass (g/m, SPB cable only)	3.53
0.002" thick Tefzel Jacket (AXB cable only)	✓

Table 2. RCN-8818 construction

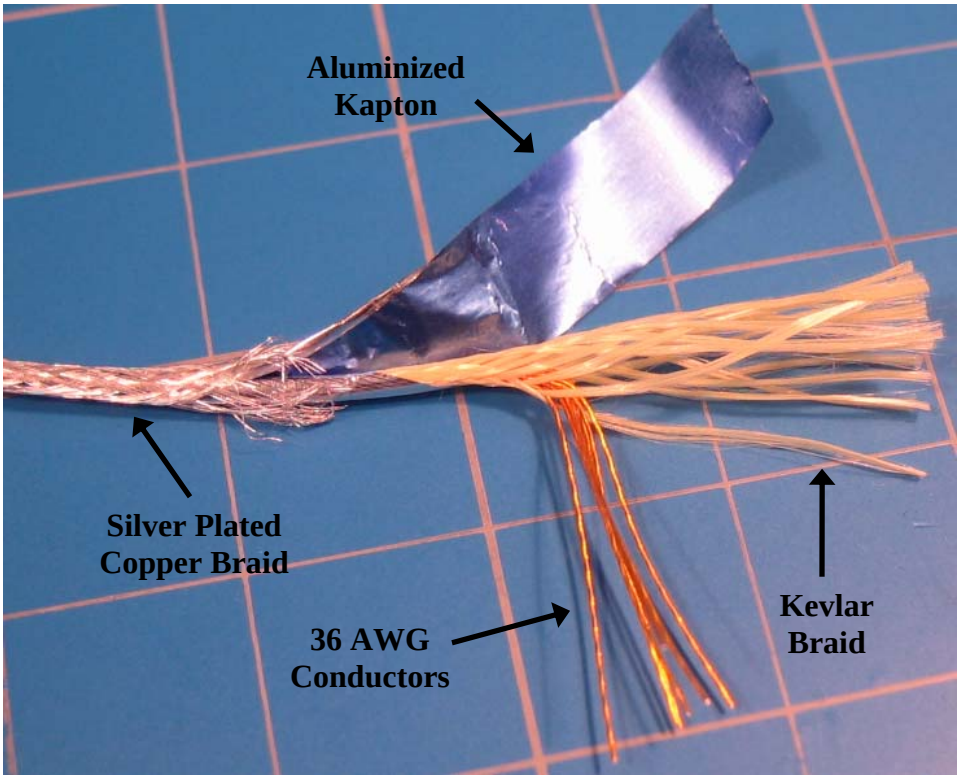


Figure 1. RCN-8818 cable

The outer SPC braid picks-per-inch was selected to lower the overall linear mass and to provide a robust outer protective layer for the cable. The linear mass of the cable was important for the RBSP mission in order to maintain low SPB moments of inertial. Linear mass of 3.53 grams per meter was reported to APL G&C for spacecraft dynamic analysis with deployed SPB's. The Kapton insulation on the conductors was chosen to lower the linear mass, reduce the cross sectional area, and to withstand the radiation environment on orbit.

D. CTE Test

One cable sample from each lot (two total) was measured for coefficient of thermal expansion per Reference 5. The test was performed on a 116-inch sample (results plotted in Figure 2), the resulting CTE is ~15ppm/°C (averaged over the 20-85°C range, three trials per lot sample). CTE is approximately constant for the temperature range the cable will be exposed to on orbit. The goal was to try and construct a cable with low CTE, such that an eclipse event would not cause drastic cable length changes that would affect spacecraft spin rate. The CTE results were forwarded to APL.

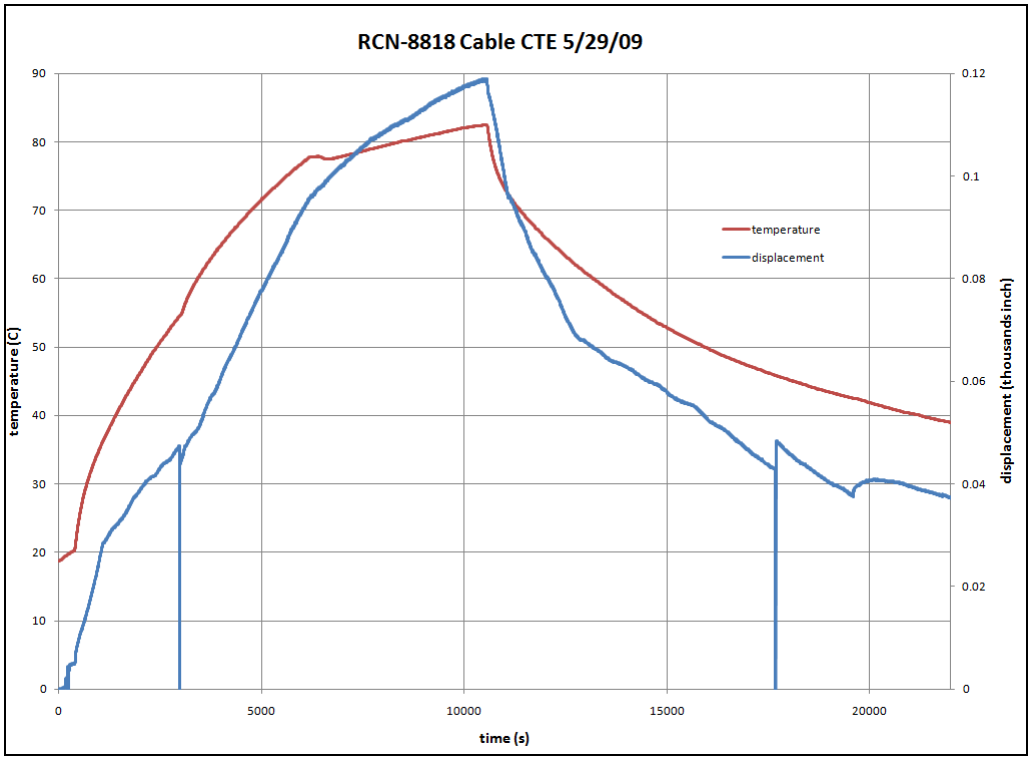


Figure 2. CTE testing flight RCN-8818 Gore composite cable

E. Tensile Test

Three RCN-8818 samples from each lot (6 total) were tested per Reference 4. The actual breaking strength of the cable is consistent with the predicted strength, given the type and amount of Kevlar and copper conductors in the cable design. The conductors maintained continuity until failure of the Kevlar strength member, which indicates that the conductors are not overstressed. All tests were performed with clamshell end conditions to reduce point stresses, and the breaking strength was found to be 143 ± 2 lbs (65 ± 1 kg) for all cable tests. Figure 3 is a screen shot of the data for cable load during the tensile test.

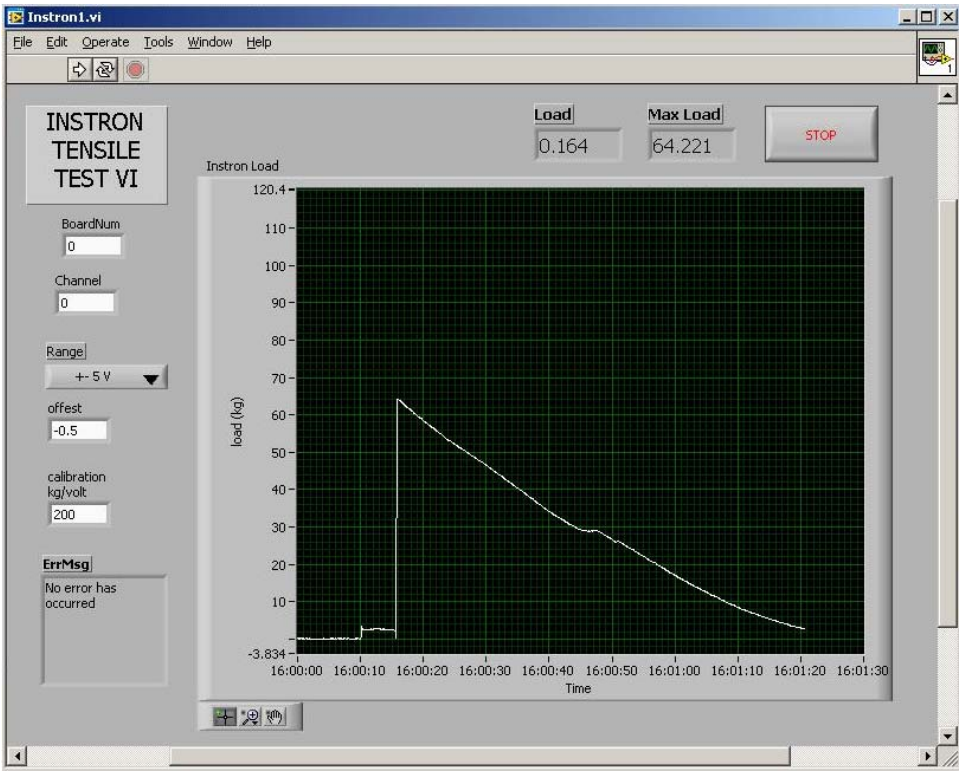


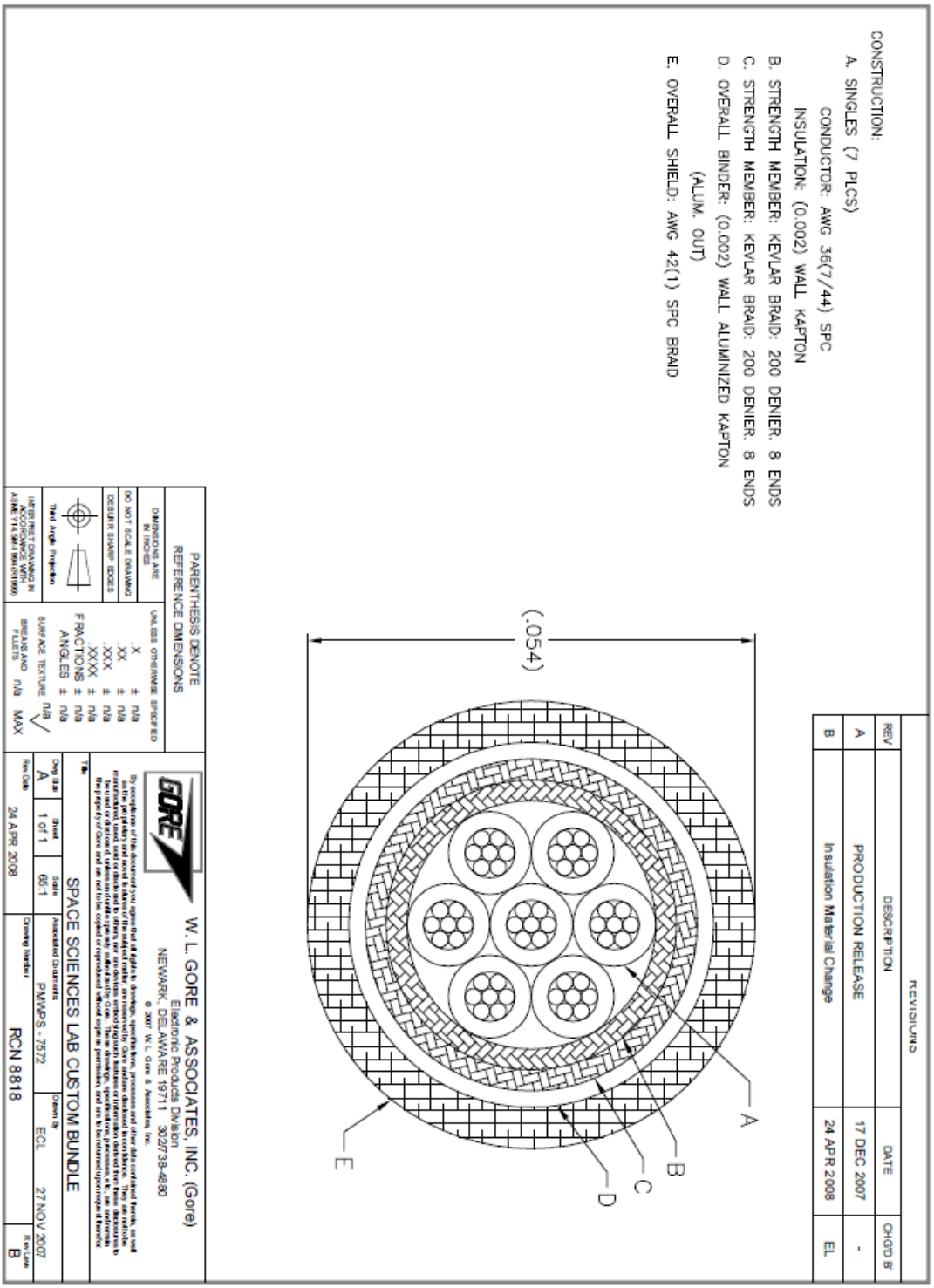
Figure 3. Tensile test

The cable strength, and ensuring electrical continuity until the failure point, is important to provide a 3X design margin between the shear pin strength in the metering wheel and the failure of the SPB cable.

F. Conclusion

Both lots of RCN-8818 Gore cable passed tests and inspections. This cable is qualified for flight instruments on RBSP.

APPENDIX A


CONSTRUCTION:
A. SINGLES (7 PLCS)
CONDUCTOR: AWG 36(7/44) SPC
INSULATION: (0.002) WALL KAPTON
B. STRENGTH MEMBER: KEVLAR BRAID: 200 DENIER, 8 ENDS
C. STRENGTH MEMBER: KEVLAR BRAID: 200 DENIER, 8 ENDS
D. OVERALL BINDER: (0.002) WALL ALUMINIZED KAPTON
(ALUM. OUT)
E. OVERALL SHIELD: AWG 42(1) SPC BRAID
REVISIONS
REV
DESCRIPTION
DATE
CHG'D B
A
PRODUCTION RELEASE
17 DEC 2007
-
B
Insulation Material Change
24 APR 2008
EL
(.054)
A
B
C
D
E
PARENTHESIS DENOTE
REFERENCE DIMENSIONS
UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
DO NOT SCALE DRAWING
DEBUR & SHARP EDGES
.X ± n/a
.XX ± n/a
.XXX ± n/a
.XXXX ± n/a
FRACTIONS ± n/a
ANGLES ± n/a
SURFACE TEXTURE n/a
BREAKS AND FILLETS n/a MAX
Third Angle Projection
INTERPRET DRAWING IN ACCORDANCE WITH ASME Y14.5M-1994(R1999)
W. L. GORE & ASSOCIATES, INC. (Gore)
Electronic Products Division
NEWARK, DELAWARE 19711 302738-4880
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SPACE SCIENCES LAB CUSTOM BUNDLE
Dwg Size A
Sheet 1 of 1
Scale 65:1
Associated Documents
PMWPS - 7572
Drawn By ECL 27 NOV 2007
Rev Date 24 APR 2008
Drawing Number RCN 8818
Rev Level B