Requirements for 2G Wire in Practical Applications: Session II

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WTEC Report 1997 (Dick Blaugher et al.)

APPLICATION	INDUSTRY-DRIVEN DEVICE GOALS							
	Jc (A/cm^2)	Field (T)	$Temp_{op}$ (K)	I_c (A)	Wire Length (m)	Strain (%)	Bend Radius (m)	Cost ($/kA-m)
Fault-current limiter	$10^4 – 10^5$	0.3-3	40-77	10^3 - 10^4	1,000	0.2	0.1	10-30
Large motor (1,000 HP)	10^5	2-4	25-77	100-500	1,000	0.2-0.3	0.05	10
Motor (125 HP)	1.5 x 10^4	1.0	27	75-80	~300		0.01	10-100
Generator (100 MVA)	5 x 10^4 [a]	4-5	20-50	500-1,000	500-1,000	0.2	0.1	10
SMES (1 MWh)	10^5	5-10	20-77	10^4	1,000	0.2	1	2-5
Transmission cable	$10^4 – 10^5$	<0.2	65-77	25-30 [b]	100	0.4	2 [c]	10-100
Transformer	$10^4 – 10^5$	0.1	20-77	200-1,400	1,000	0.2	0.2	10

Comparison 1997-2006

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	J_c (A/cm^2)	Field (T)	$Temp_{op}$ (K)	I_c (A)	Wire Length (m)	Strain (%)	Bend Radius (m)	Cost ($/kA-m)
Fault-current limiter 97	$10^4 – 10^5$	0.3-3	40-77	10^3 - 10^4	1,000	0.2	0.1	10-30
Fault-current limiter 06			70-77		> 1,000			10-50
Generator (100 MVA) 97	5 x 10^4 [a]	4-5	20-50	500-1,000	500-1,000	0.2	0.1	10
Generator (300 MVA) 06	J_e > 10,000	2-3(5)	50-65	125 at T_{op}, 3 T	> 1,000	0.4-0.5	0.1	5-10
Transmission cable 97	$10^4 – 10^5$	<0.2	65-77	25-30 [b]	100	0.4	2 [c]	10-100
Transmission cable 06	J_c>10^5	< 0.1	67-77	200 A, 77 K, sf	> 1,000	0.4	2	10-50
Transformer 97	$10^4 – 10^5$	0.1	20-77	200-1,400	1,000	0.2	0.2	10
Transformer 06	J_c>10^6 J_e>12,500	0.15	70-77	>100 at 0.15 T	>1,000	~0.3	.05	10-20

Issues	Tape issue	System issue	Progress	Prospect
DC critical current	x		300-400 A/cm at 77K 100 A/cm at 65K, 3T perp	Good
Over-current fault tolerance	x	x	Temp limit on 1G/2G tape > 300 K: cable tests ok	Good with stabilization but limits J_e < 50,000 A/cm^2 at 77K, self-field
Quench recovery (coils)	x	x	Detection in noisy ac systems difficult; slow propagation (mm/s to cm/s)	TBD: can we make a quench not a credible event? Can we detect local hot spots in large coils?
AC losses	x	x	Limited to date: working with flat tapes and filaments	Fair: can change tape geometry to reduce losses; some changes reduce I_c
Mechanical properties	x	x	Good: 2G better, substrate and stabilizer help	Good but need to look at synergistic effects with temperature and high voltage
Cryogenics-efficiency		x	10-20% of Carnot	Fair: need 20-25%: but limited R&D to date; progress slow on pulsetubes
Cryogenics-reliability		x	95-99%	Challenging: need 99.8-99.9 % on some applications: requires redundancy but cost more
Cryogenics-cost		x	$100's/watt at 65-80 K	Goal: $25/watt at 65-80 K: only if high production rate
Electrical insulation	x	x	Limited effort to date: **single point** failure issue	Can we solve this on timescale of conductor R&D: key driver on grid applications