

Cryomodule Safety Information

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Entries in **RED** are the primary constraints.

Item description	Cryogenic circuit			Notes
	80 K Shield	5 K Shield	2K	
Cooldown requirements				
Maximum cooldown rate, [degree/hr]	10 K/hr	10 K/hr	10 K/hr	300 K to 4 K > 30 hours (Lange) so >10 K/hr
Minimum cooldown rate, [degree/hr]			none	
Maximum cooldown gradient inlet to outlet, dT/dz	50 K/module	50 K/module	50 K/module	(Rolf Lange talk 5-dec-06, e-mail 28 Aug 07)
Minimum cooldown gradient inlet to outlet, dT/dz			none	
Maximum vertical cooldown gradient, dT/dx			15 K	300 mm tube top to bottom
Minimum vertical cooldown gradient, dT/dx			none	
Maximum cooldown flow rate, [kg/sec]	none	none	none	a free parameter within other constraints
Does max cooldown rate vary with temperature?	YES/NO	YES/NO	YES/NO	Judgement (TJP): Constraint is relaxed as temp goes down.
Does max cooldown rate vary with pressure?	YES/NO	YES/NO	YES/NO	Judgement (TJP): Constraint is relaxed as temp goes down.
Can cryogenic circuit be cooldown independently of others	YES/NO	YES/NO	YES/NO	Not desirable (Q disease?).
Warm-up requirements				
Maximum warm-up rate, [degree/hr]	10 K/hr	10 K/hr	10 K/hr	symmetrical constraint relative to cool-down
Minimum warm-up rate, [degree/hr]			none	
Maximum warm-up gradient inlet to outlet, dT/dz	50 K/module	50 K/module	50 K/module	symmetrical constraint relative to cool-down
Minimum warm-up gradient inlet to outlet, dT/dz			none	
Maximum vertical warm-up gradient, dT/dx			15 K	
Minimum vertical warm-up gradient, dT/dx			none	
Maximum warm-up flow rate, [kg/sec]	none	none	none	a free parameter within other constraints
Minimum warm-up flow rate, [kg/sec]	none	none	none	
Does max warm-up rate varies with temperature?	YES/NO	YES/NO	YES/NO	Judgement (TJP): Constraint is relaxed at low temp.
Does max warm-up rate varies with pressure?	YES/NO	YES/NO	YES/NO	Judgement (TJP): Constraint is relaxed at low temp.
Can cryogenic circuit be warm-up independently of others	YES/NO	YES/NO	YES/NO	Not recommended.