CSC Action Matrixes and Safe Operation States

This document presents the Action Matrixes and the Safe Operation States for the CSC Sub-detector for CMS.

The CSC sub-detector has three independent systems

S1 Racks			
	FED	S1G06, 08	DAQ crates
	GigaBit	S1G07	Network to Peripheral Crates
	TF	S1E04	CSC Track Finder
	TTC	S1E05	CSC TTC fan out rack (passive)
HV			
	UF HV	S1A10, 11, 12	HV for chambers
	ME1/1 HV	S1D10	HV for ME1/1 Chambers
	UXC	X2, X4 Racks	HV distribution racks
LV		The UPS LV from S4 to the cavern	
		S4F04	PFC modules
		S4F04	ATLAS PS
		S4F10	CSC LV DCS computers
		X2, X4 Racks	Maraton Racks
		X1, X3, X5 Racks	Peripheral Crate Racks
		CSC	Chambers

Level of Safety - Control - Monitoring

Operator	CSC Shifter - CSC Expert - CMS Shifter - SLIMOS
DCS CSC	CSC DCS
DCS Rack	Rack DCS provided by CMS
DSS	
Local	Built into the Hardware

Table 1 – The major sub-divisions of the CSC sub-detector of CMS.

The CSC Sub-detector falls into three mostly independent systems. The first of the three is the racks in counting room S1. These are standard CMS racks and house the CSC Track Finder, CSC-TF, the CSC-TTC signal distribution rack, and the three FED racks. The second is the HV system which spans S1 and the Cavern, UXC. The third is the detector Low Voltage that spans S4 and the Cavern.

This document will address each of these three in order.

CSC Hardware in S1

Safe Operation States >>CSC Hardware in S1 Racks

System State			Required Detector State					
Cooling		Power	Rack					
S1 water	Turbine	S1 Rack	S1D04	S1D05	S1G06	S1G07	S1G08	S1G10
OFF	x	x	OFF	OFF	OFF	OFF	OFF	OFF
ON	OFF	x	OFF	OFF	OFF	OFF	OFF	OFF
ON	ON	ON	ON	ON	ON	ON	ON	ON

Each of the 6 racks are independent
Loss of Water, Turbine, or Power to any single rack or group of racks requires that only that single rack or group of racks be OFF

After power outage, each rack may be re-powered without intervention.
Crates / Hardware will remain in SAFE STATE.

DCS > Rack DCS is used to control and monitor each of these racks
DSS > DSS is used to safeguard each of these racks.

Table 2 – Safe Operation States for the CSC Racks in S1

Each of the 6 CSC racks located in S1 are independent. A loss of Water, Turbine, or Power to any single rack or group of racks only requires that single rack or group of racks be switched OFF.

Serial Number	Failure Condition	Location	Monitored by	Action taken by	Status of Implementation	Comment
	High Temperature	S1E04 TF	DSS	Turbine Trips Rack Power	implemented	50 C trip point >> only on crate, no powered equipment
	High Temperature	S1E04 TF	DCS	Turn OFF power in rack	implemented	40 C trip point >> only on crate, no powered equipment
	High Temperature	S1E05	DSS	Turbine Trips Rack Power	implemented	50 C trip point >> no powered equipment in rack
	High Temperature	S1E05	DCS	Turn OFF power in rack	implemented	40 C trip point >> no powered equipment in rack
	High Temperature	S1G06, S1G08	DSS	Turbine Trips Rack Power	implemented	50 C trip point
	High Temperature	S1G06, S1G08	DCS	Turn OFF power in rack	implemented	40 C trip point
	High Temperature	S1G07	DSS	Turbine Trips Rack Power	implemented	50 C trip point
	High Temperature	S1G07	DCS	Turn OFF power in rack	implemented	40 C trip point
	High Temperature	S1G10	DSS	Turbine Trips Rack Power	implemented	50 C trip point
	High Temperature	S1G10	DCS	Turn OFF power in rack	implemented	40 C trip point

Table 3 – Action Matrix for CSC S1 Racks

The CSC hardware in S1 is all mounted within standard CMS racks. Therefore they have the standard DSS protections plus the CMS DCS rack protections. The above table lists only the High Temperature protections which under CMS DCS rack protections can be set at different temperature thresholds. Protections for other eventualities such as water leeks, smoke detection, loss of DCS communication, all follow the CMS standard.

CSC HV and Gas Systems

System State									Safe Detector State					
Cooling						Power		Gas	HV					
S1D10 Cooling	S1A Cooling	Endcap water	YE1 tower water	UXC rack fan	S1 Rack	UXC Rack		S1D10 Hardware	S1A10 Computers	S1 Hardware	UXC Tower Hardware	ME1/1 Chamber HV	Chamber HV
OFF	x	x	x	x	x	x	x	OFF	x	x	x	OFF	x
ON	x	x	x	x	x	x	OFF	x	x	x	x	OFF	x
ON	x	x	x	x	x	x	ON	x	x	x	x	x	x
x	OFF	x	x	x	x	x	x	x	OFF	OFF	OFF	x	OFF
x	x	OFF	x	x	x	x	x	x	ON	ON	OFF	x	OFF
x	x	x	OFF	x	x	x	x	x	ON	ON	OFF	x	OFF
x	x	x	x	OFF	x	x	x	x	ON	ON	OFF	x	OFF
x	ON	ON	ON	ON	OFF	OFF	x	x	OFF	OFF	OFF	x	OFF
x	ON	ON	ON	ON	ON	OFF	x	x	ON	OFF	OFF	x	OFF
x	ON	ON	ON	ON	OFF	ON	x	x	OFF	OFF	OFF	x	OFF
ON	ON	ON	ON	ON	ON	ON	OFF(1)	x	x	ON	OFF	OFF	OFF
ON	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON

x = x in system or detector state indicates it may be either ON or OFF

(1) Gas When gas goes OFF
Have 12-24 hours to turn OFF HV

Table 4 – the Safe States for the CSC HV and Gas Systems

CSC gas system is within the CMS gas system. Therefore conditions within the system are not addressed in this document. This document considers only whether the entire CSC gas system is ON and functioning in the correct manner.

The CSC HV is in two parts. The HV for the 72 ME1/1 chambers on YE+1 and YE-1, and the HV for the remaining 396 chambers. The ME1/1 HV is provided by a CAEN system with the control crates located in S1G10. For this system the HV is generated in S1 and conveyed directly to the chambers in the cavern via HV Cables. The HV for the remainder of the chambers is a custom system located in the S1A racks and within tower racks in the cavern. The HV is generated in S1 and conveyed to several tower racks where it is actively fanned out for the individual channels within individual chambers. The HV from these racks is conveyed to each chamber via HV cables. The distribution hardware located within the cavern tower racks requires power from each distribution rack for its active control. A loss of power to a tower rack will result in the HV being shut OFF at that point.

Serial Number	Failure Condition	Location	Monitored by	Action taken by	Status of Implementation	Comment
	Loss of GAS FLOW to ALL or Part of CSC	All / Part of CSC	gas monitor	Detector or SLIMOS shift personnal at hand	Finish documentaion	No automatic response upon loss of gas flow is indicated. Experts should be notified, through the CSC shifter if possible, to respond to the condition.
	Loss of DCS Control & Monitoring of HV System	All / Part of CSC	Operator	Detector or SLIMOS shift personnal at hand	not implemented	**Access to USC** >> Operator attends HV computer in S1A10 and controls from there, **NO Access to USC** >> Turn off HV S1A11 and S1A12 racks with CMS DCS, or Turn of racks with remote DSS shut off
	High Temperature	S1A10, S1A11, S1A12	DSS	Turbine Trips Rack Power	implemented	50 C trip point
			CMS DCS	Turn OFF crates in rack	implemented	40 C trip point
		X4J33 X4J41, X4J51, X2A41	DSS	Turbine Trips Rack Power	implemented	50 C trip point
			CMS DCS	Turn OFF crates in rack	??	40 C trip point
		X2S41, X4V33, X4V41, X4V51	DSS	Turbine Trips Rack Power	implemented	50 C trip point
			CMS DCS	Turn OFF crates in rack	??	40 C trip point
	Cooling Water Interruption	S1A10, S1A11, S1A12	DSS	No intervention	n/a	We have no hardware interlock on loss of water flow
			CMS DCS	Turn OFF crates in rack	Not implemented	40 C trip point
		X4J33 X4J41, X4J51, X2A41	DSS	No intervention	n/a	We have no hardware interlock on loss of water flow
			CMS DCS	Turn OFF crates in rack	??	40 C trip point
		X2S41, X4V33, X4V41, X4V51	DSS	No intervention	n/a	We have no hardware interlock on loss of water flow
			CMS DCS	Turn OFF crates in rack	??	40 C trip point

Table 5 – The Action Matrix for the CSC HV system.

This system is located in 3 racks in S1 row A, and 8 racks in the cavern. These 8 racks are located 4 on each of the PLUS and MINUS end disks in the tower racks on levels X2 and X4.

CSC LV System and Other CSC UXC Racks

Safe Operation States >>CSC Low Voltage System										
System State						Required Detector State				
Cooling			Power			LV				
Endcap water - 1of6	YE1 tower water	UXC rack fan	LV UPS	S4 Rack	UXC Rack	twidoes	PFC	Maraton	Peripheral Crate	CSC
OFF	OFF	OFF	x	x	x	OFF	x	OFF	OFF	x
OFF	x	x	x	x	x	OFF	x	OFF	OFF	x
x	OFF	x	x	x	x	OFF	x	OFF	OFF	x
x	x	OFF	x	x	x	OFF	x	OFF	OFF	x
OFF	OFF	OFF	x	x	x	OFF	x	OFF	OFF	x
OFF	x	x	x	x	x	OFF	x	OFF	OFF	x
x	OFF	x	x	x	x	OFF	x	OFF	OFF	x
x	x	OFF	x	x	x	OFF	x	OFF	OFF	x
ON	ON	ON	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF
ON	ON	ON	x	ON	x	x	x	x	x	x
ON	ON	ON	ON	x	OFF					
			OFF	x	ON					
ON	ON	ON	ON	x	ON	ON				

The CSC LV System has 12 independent parts
- 2x > Plus End Cap, Minus End Cap
- 3x > Disks YE1, YE2, YE3
- 2x > Near side of disk (+x) and Far side of disk (-x)

Each of these 12 parts has
- 4 PFC modules (2 for YE3)
- 4 Maraton supplies in 2 racks (2 in YE3) > X2 (2/2) & X4 (2/0)
- 6 Peripheral Crates in 3 racks (3 in YE3) > X1 (2/1), X3 (2/1), and X5(2/1)

PFC modules can only be switched ON or OFF by local front panel switch > NO remote c
CSC in a TS are OFF whenever Peripheral Crate (PCB) for that TS is OFF

Table 6 – Safe Operation States for the LV System

Serial Number	Failure Condition	Location	Monitored by	Action taken by	Status of Implementation	Comment
	loss of DCS communicaion	UXC Racks	Operator	Access S4 and take appropriate action	not implemented	The CSC LV DCS computes are located in S4F10 and the system can be controlled from there. Also the pcrates can be turned off remotely from S4F04. And the PFC can be turned of at S4F04. Without access to S4 a remote switch must switch off the PFC.
	loss of DCS communicaion	on chamber electronics	Operator	Turn off Appropriate chambers	implemented	This is a subset of the line above. The same action should be taken.
	Water Leak	UXC Racks	Operator	Turn off Appropriate Racks	implemented	there is no water leak protection for endcaps
	Water Flow Stop	UXC Racks	DSS	DSS	not implemented	
			CMS DCS	DCS	not implemented	turn off appropriate racks

Table 7 – Action Matrix for the CSC LV System and other Cavern Racks

Water flow failure
- Sensor on disk loop senses water pressure drop
- Rack DCS is notified
- Rack DCS notifies CSC DCS and waits x sec
  - CSC DCS turns off appropriate PCB's
  - CSC DCS Waits 0.5 sec
  - CSC DCS Turns off appropriate Maratons
- Rack DCS turns off rack power

Serial Number	Failure Condition	Location	Monitored by	Action taken by	Status of Implementation	Comment
	High Temperature	AC Power for X2, X4 Maraton Racks	DSS	Turbine Trips Rack Power	implemented	50 C trip point
	High Temperature	LV Power for X2, X4 Maraton Racks	DSS	Turbine Trips PFC (Twidoe) to Maraton for this Rack	implemented	50 C trip point
	High Temperature	AC Power for X2, X4 Maraton Racks	CMS DCS	Turn OFF crates in rack	implemented	??
	High Temperature	LV Power for X2, X4 Maraton Racks	CMS DCS	Trip off PFC for Maraton a. la. DSS	not implemented	35 C trip point ?
	High Temperature	LV Power for X2, X4 Maraton Racks	CSC DCS	Turn OFF PCB in rack (6 PC's??)	not implemented	How many maratons? All maraton output channels?
	High Temperature	AC Power for Pcrate Racks	DSS	Turbine Trips Rack Power	implemented	50 C trip point
	High Temperature	LV Power for Pcrate Racks	DSS	Turbine Trips PFC (Twidoe) to Maraton for this Rack	implemented >> See note #1	50 C trip point
	High Temperature	AC Power for Pcrate Racks	CMS DCS	Turn OFF crates in rack	not applicable	no AC power in rack
	High Temperature	LV Power for Pcrate Racks	CMS DCS	Trip off PFC for Maraton a. la. DSS	not implemented	35 C trip point ?
	High Temperature	LV Power for Pcrate Racks	CSC DCS	Turn OFF PCB in rack (6 PC's??)	not implemented	How many maratons? All maraton output channels?
	High Temperature	On Chamber Electronics	CSC DCS	DSS - none	implemented	Local cooling loss will **NOT** result in harmfull temperature levels.
	High Temperature	On Chamber Electronics	CSC DCS	CSC DCS - Turn OFF PCB in rack (6 PC's??)	not implemented	

Table 8 – Action Matrix for CSC LV System

The CSC LV system receives its power from the CMS LV UPS system in S4. In rack S4F04 the UPS power is converted to 385V DC by the Wiener Maraton System PFC modules and conducted to Maraton Power Crates mounted in tower racks located with end cap disk towers on levels X2 and X4. Each Maraton has 6 outputs which are sent in pairs of outputs to either two trigger sectors, TS, of 9 chambers plus a single peripheral crate, pcrate, or to 3 pcrates.

Note 1 - Because the LV power is supplied externally to both the Maraton racks and the pcrate racks, the DSS for these racks must have a special set up. First the DSS for

each Maraton rack must be set up to trip the twidoe in S4 that supplies the UPS power to the PFC-Maraton combination. Second, since each pcrate rack receives external LV power in turn from the Maraton rack, the DSS in each pcrate rack must be set up to trip the twidoe which originates the LV power for the pcrate rack.

Circuit Breaker	Dest. Rack	*Maraton*	PCrate	PCrate	*Maraton*	PCrate	PCrate
EXD20 03/55	X4A51+ X2J52	*X4A51*	X5R51	X3A51	*X2J52*	X5U51	X3J51
EXD20 04/55	X4A41	*X4A41*	X5R41				
EXD20 05/55	X2A41	*X2A41*	X1R41	X3A41			
EXD20 06/55	X4A31	*X4A31*	X5R31				
EXD20 07/55	X2J41	*X2J42*	X1U41				
EXD20 08/55	X4J41	*X4J41*	X3J41	X5U41			
EXD20 09/55	X2A33	*X2A33*	X1R31	X3A31			
EXD20 10/55	X2J31	*X2J31*	X1U31				
EXD20 11/55	X4J31	*X4J31*	X3J31	X5U31			
EXD20 12/55	X4S31	*X4S31*	X5L31				
EXD20 13/55	X2V31	*X2V31*	X1E31				
EXD20 14/55	X4V31	*X4V31*	X3V31	X5E31			
EXD20 15/55	X2S33	*X2S33*	X1L31	X3S31			
EXD20 16/55	X2V41	*X2V42*	X1E41				
EXD20 17/55	X4V41	*X4V41*	X3V41	X5E41			
EXD20 18/55	X2V52+ X4S51	*X2V52*	X5E51	X3V51	*X4S51*	X5L51	X3S51
EXD20 19/55	X4S41	*X4S41*	X5L41				
EXD20 20/55	X2S41	*X2S41*	X1L41	X3S41			

Table 9 – DSS dependencies for pcrate racks.

A DSS alarm condition in any of the pcrate racks listed in the right columns, must result in DSS tripping the circuit breaker in the first column. The DCS system must follow this same map for action taken.