Safe Operation States for CSC at CMS

Safe Operation States >> **USC55** (S1)

Cooling	Power		HV	FED	TF
OFF	**OFF**	→	OFF	OFF	OFF
OFF	ON	→	OFF	OFF	OFF

- HV racks must be off within 10 minutes
- ME1/1 HV racks must be off within 10 minutes
- FED racks must be off within 10 minutes
- TF rack must be off within 10 minutes

ON	**OFF**	→	OFF	OFF	OFF
ON	ON	→	ON	ON	ON

- Safe Operation States >> **UXC55 (cavern)**

Cooling	Power	Gas		HV	LV Disk & tower LV from S4
OFF	x	x		OFF	OFF

- Maratons must be off within 2 min
- Pcrates within 5 min
- LV to chamber within 10 min
  - Note LV to chambers is turned off by pcrate turn off
- HV must be off within 60 min

ON	**OFF**	**OFF**	→	OFF	OFF
ON	**OFF**	ON	→	OFF	OFF
ON	ON	**OFF**	→	OFF	ON
ON	ON	ON	→	ON	ON

The CSC sub-detector must be in one of these Safe Operation States at all times. It is ultimately the responsibility of the CSC Detector Shifter to ensure that these conditions are met.

The failure modes outlined in these matrixes assume complete loss of Cooling, Power, or Gas. When a partial loss of any occurs other action may be appropriate. In that case follow the more detailed procedures for partial failures

Could we give these states ID numbers and create DCS buttons to go to each?

DSS Action Matrix – CSC LV

EXD # tweedo	Shuts Off LV Power to this Dest. Rack	DSS alarm in any of these racks					
Armoires	UXC55	Maraton	PCrate	PCrate	Maraton	PCrate	PCrate
EXD 2003	X4A51+X2J52	X4A51	X5R51	X3A51	X2J52	X5U51	X3J51
EXD 2004	X4A41	X4A41	X5R41				
EXD 2005	X2A41	X2A41	X1R41	X3A41			
EXD 2006	X4A31	X4A31	X5R31				
EXD 2007	X2J41	X2J42	X1U41				
EXD 2008	X4J41	X4J41	X3J41	X5U41			
EXD 2009	X2A33	X2A33	X1R31	X3A31			
EXD 2010	X2J31	X2J31	X1U31				
EXD 2011	X4J31	X4J31	X3J31	X5U31			
EXD 2012	X4S31	X4S31	X5L31				
EXD 2013	X2V31	X2V31	X1E31				
EXD 2014	X4V31	X4V31	X3V31	X5E31			
EXD 2015	X2S33	X2S33	X1L31	X3S31			
EXD 2016	X2V41	X2V42	X1E41				
EXD 2017	X4V41	X4V41	X3V41	X5E41			
EXD 2018	X2V52 & X4S51	X2V52	X5E51	X3V51	X4S51	X5L51	X3S51
EXD 2019	X4S41	X4S41	X5L41				
EXD 2020	X2S41	X2S41	X1L41	X3S41			

- The LV for the CSC on-chamber and peripheral crate electronics > is supplied by
- Maratons in X2 & X4 racks in UXC > which are supplied by
- OPFC modules in S4F04 > which are supplied by
- Tweedos in S4
- This action matrix shows which twedos trip with any DSS alarm within these UXC racks

CSC Unattended Operation

Contents

- This covers the CSC + TF + ME1/1
  - Racks >
    - S1A* HV
    - S1D04 TF
    - S1G06-8 FED
    - S1G10 HV ME1/1
    - S4F* LV
    - X(1-5)*
      - Pcrate racks > 24 mini-racks & 12 tower racks > X1, X3, & X5 racks
      - LVM (Low Voltage Modules) > X2 & X4 levels
      - Maraton racks > 20 tower racks > X2 and X4 racks
      - HV > 8 tower racks, 6 shared with Maraton > X2 & X4 racks
  - Does NOT cover rack mounted computers in S2 or on surface
  - Does NOT cover GAS safety

General Risks to CSC

- (1) What are the major risks for damage to the detector and electronics? Tabulate the risk, comment on the likelihood and the extent of damage possible, repair time etc
-
- Smoke

Smoke detection is located with the turbine unit of each rack and is attached to the rack DSS. The racks are interlocked by turbine sensors.
The CSC, chambers, are protected by the general cavern system and not to any dedicated local system.

Water Leak –

Presently not detected by any automatic means. Human detection and intervention only is the only protection in place. CMS has plans for detector wide leak detection systems. CSC is installing water pressure sensors on the

individual water circuits for each disk. This will give us an indication of a large leak in real time. A smaller leak can be detected by the loss of water in the circuit. CMS plans to incorporate this check into the safety system.
Cut power to rack / chamber upon a detected water leak.

- S1 Rack > person (cut CSM-DCS rack power) OR ((turn of crates) AND (turn off rack breakers))
- Cavern HV rack > cut power to HV segment including rack
- Maraton Rack > Person cut power at PFC modules (2) AND cut power at Maraton (switch or CSC-DCS)
- Pcrate Rack > DCS (person) cut power at PCB on pcrate, AND cut power at Maraton (switch or CSC-DCS)
- Chamber > same procedure as for pcrate rack

Over Temperature

- DSS > rack interlocked by turbine sensors
- DCS >
  - temperature sensor in turbine
  - Temperature sensors in UXC55 racks

General Risks to CSC

Power Cut

- S1 Racks
  - No special action
  - Select control computers in racks on S1 UPS
- LV on LV-UPS
  - Receive shut down signal from LV-UPS
    - CSC-DCS
      - » soft shut down LV
      - » Soft shut down local CSC-DCS computers
  - DSS shut down (order requested from CMS)
    - Atlas supply crate first (1) [immediately]
    - then shut down 60 PFC modules in X4F04 [after 10-30 sec]
    - then shut down 2 local CSC-DCS PC's [after minutes]

- Repair time
  - Chambers and their on-chamber electronics require the most time for access and repair. Need to open disks for access. Access to 'back' chambers could require removal of 1 or 2 front chambers. Some board problems could require chamber swap.
  - UXC electronics are located on towers. Only cavern access is required to change or repair components. The X1 level mini-racks also fit this description, but access is difficult.

Risks to CSC > chambers & on-chamber electronics

Smoke

- DSS > No dedicated sensors, relies on cavern wide sensors
- Chambers us non-flammable gas
- Repair would involve removal and replacement > 1 day to 1 week

• Over temperature
- Water cooling to each chamber
  - Temperature saturates in about 15 minutes
  - Can run without cooling > but best turned off by operator
- DSS > no connection
- CSC-DCS > monitors temperature of boards, provides for human intervention-interlock, plan for automatic reaction by DCS
- Damage to electronics would require access, could require removal > 4 hours to 1 week

Gas flow rate

- Flow loops to chambers
- Connected to CMS gas system on towers
- HV CAN operate for ~24h without gas flow, but HV SHOULD be turned off within 1 hour of gas interruption
  - No immediate effects from flow interruption
  - Long term effects are a concern
- No immediate repair foreseen as a result of gas flow interruption

HV to chambers

- HV system induces trips for over current in chambers, system is self protected
  - HV distribution from racks on towers
  - ME1/1 distribution from S1G10
- CSC-DCS > monitors HV status at chambers, provides for human intervention
- HV distribution system is in tower racks and S1 > no access to chambers needed > expect 1-4 hours to repair with access to cavern

LV to on-chamber electronics

- Distribution from Maraton in rack on tower (9 chambers), to LVM on tower (9), to individual chambers
- Over current protection at Maraton channel, input fused at LVM, input fused at each chamber and/or each chamber board

- Fuse in chamber requires access to chamber. May require removal of chambers.

Repair time

- Chambers and their on-chamber electronics require the most time for access and repair. Need to open disks for access. Access to 'back' chambers could require removal of 1 or 2 front chambers. Some board problems could require chamber swap.

Risks to Racks & Rack Mounted Electronics > Cavern

- Smoke
  - DSS > all racks interlocked by turbine sensors
- Over temperature
  - Water cooling
    - to heat exchanger in each rack
    - to each pcrate BP CRB, (Crate Regulator Board)
  - DSS protection for rack from turbine
  - Rack-DCS monitors input and output manifold temperature, plus temperatures at select places in the air flow with each rack
  - CSC-DCS monitors temperature of boards
- HV distribution racks
  - HV fused.
  - (Fred – I am unclear on protection here, need to confer further with experts.)

- LV to electronics
  - Pcrates in X1, X5 & X3 racks. Powered by Maratons only.
    - DSS > Input from Maraton interlocked from local turbine to PFC module feed in S4F04.
    - CSC-DCS interlocked PCB to pcrate. (To be established)
    - Boards in crate fused
  - LVM, LV for chambers on X2 & X4 levels.
    - Input to LVM from Maraton fused at LVM
    - DSS > no special protection
    - CSC-DCS > interlock from chamber monitoring to Maraton. (To be established)
- Repair time
  - UXC electronics is located on towers. Only cavern access is required to change or repair components. The X1 level mini-racks also fit this description, but access is difficult.
  - Board repairs require a board swap > 1h for swap, + 1hr to verify success,

  - Crate repair or replacement would take from 4 to 8h > repair or replace of an X1 level pcrate in a mini-rack on YE1 or 2 would require opening gap between YE1 & 2.
  - Fuse replacement in LVM would take ~1h with no special access

Risks to Maratons

- Smoke
  - DSS > rack interlocked by turbine sensors
- Over temperature
  - Water cooling to heat exchanger in each rack
  - Internal over temperature trip built into each Maraton unit
  - DSS protection for rack from turbine
  - Rack-DCS
    - monitors input and output manifold temperature,
    - monitors temperatures at select places in the air flow with each rack
- LV - Maraton supplies in X2 & X4 racks. Input 385VDC
  - CSC-DCS >
    - Monitoring established and interlock to be established on voltage and current readings from Maraton
    - Monitoring established and interlock to be determined on voltage and current readings from pcrate PCB, boards, and on-chamber boards
- Repair time
  - Maraton units are located on towers and can be quickly removed from their power bines. Only cavern access is required to change or repair components. Access to some are difficult due to railings and other obstacles. ~1 hr to swap and verify.
  - Power bin and LV cables > much less prone to failure, but would require several hours to repair or replace

Risks to CSC

- (3) What systems and services do you rely on?
  - which electrical circuits for what purpose - and on UPS or diesel?
- We have our downstairs computers for hardware control and DCS on UPS. The two in S4 are on the LV UPS and the remainder are on the general UPS in S1/S2
- The USC equipment is supplies from circuits within each rack
- The UXC equipment is supplied from USC via the tunnel and cable chains.
  - The LV system is suupplied by the CMS LV UPS system
- - what cooling systems, gas systems, beam monitoring... and for what purpose?

- We rely on the S1/S2 and S4 cooling systems for these racks.
- We rely on the Endcap cooling circuits in the cavern
  - Disk circuits >> NAME
  - YE1 tower circuits >> NAME
- We are connected to the CMS gas system and distribution racks on the detector >> no special equipment
- We require NO beam or loss monitoring
- We require NO magnet field monitoring

- - what role does DCS play?
  - what do you require from and provide to the CMS DSS?
- We have all of our hardware components monitored by DCS
- We have no special DSS inputs from our system
- We require a special DSS matrix due to our LV distribution in UXC

Risks to CSC

- (7) Summarize the current status of the systems in (4) and where appropriate the testing procedure for (5)
- Internal systems
  - In place and tested prior to installation
- DSS
  - In place in S4 and USC
  - In place in plus end caps
  - Being tested in minus end caps
- CSM DCS
  - In place in S4 and USC
  - Being installed in cavern racks
  - Additional temperature sensors within cavern racks being installed
- CSC DCS
  - Monitoring with human intervention in place for all equipment
    - ME1/1 HV is being added
  - Automatic response is in development stage

Last Comments

- Attended operation has given us experience in the safe operation of our equipment and feedback on how it may operate in unattended conditions
- Operation plans
  - Plan to operate with all systems on from Monday morning through Saturday evening.
    - Now have shifters day and evening Monday through Friday and day on most Saturdays
  - After CRUZET 3 may go to 24/7 based on experience from now through run.
  - Have an on-call operations person at all times
  - Have designated on-call experts for all sub-systems