MTTR and Spare parts for the LHC BACKBONE (TS/CV)

G. Peon, J. Inigo-Golfin TS/CV

Outline

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- IV- TS/CV CRITICAL COMPONENTS IN THE INJECTORS CHAIN
- V- RECUPERATION AFTER MAJOR FAILURES
- VI- CONCLUSIONS

I- INTRODUCTION

TS/CV equipment for accelerators

- This presentation concerns the cooling and ventilation equipment necessary for the operation of the accelerators:
  - Primary cooling plants (cooling towers), make-up water and demineralised water production systems
  - Secondary cooling systems
  - HVAC systems
  - Compressed air production and distribution systems
  - Discharge water systems

II- BEAM STOP STATISTICS

CV MERIs over the last 3 years: 2005 - 1/3

	Accel.	Impact	Cause	TTR	Status for the future	Actions
1	SPS & North area (564542)	SPS cooling towers	Process control communication cable between BA4 (raw water regulation tank for SPS ring) and BA6 cut during AB shutdown works in the tunnel	2 hours 30 minutes	OK	Cable repaired
2	LHC injectors chain not affected Cryo SDH8 (599990)	UW primary water pump	Disconnection by TS/CV of fieldbus power supply, which transmits analog values towards UW85 PLC=> EP balancing valve in UW85 closes => no flow to SF8, stopping the UW EP pump unit	2 hours 10 minutes	Modifications under way (consolidation) to make system more robust	Intervention was planned but not coordinated in advance, nor was there any risk analysis beforehand

CV MERIs over the last 3 years: 2005 - 2/3

	Accelerator	Impact	Cause	TTR	Remarks
3	LHC8 (all CRYO) CAST (598839)	All primary water circuits in SF8 stopped	SF8 48V Voltage relay SP was set too high (43V) compared to the 38.5V supplied by UPS during diesel generator tests, taking into account also the voltage drop on the supply cable from SE8	1 hour 22 minutes	Apparently not all users had been warned in advance about the diesel tests, i.e. **installation were operational and any immediate stops dangerous**. Transmitted to EL for corrective action
4	PS (603238)	Demineralised water cooling station in building 237 stopped	Short circuit on secondary supply valve, due to oil leaking into valve actuator electronics box	2 hours 38 minutes	Valve was changed at next machine stop. Also a verification campaign on similar existing valves was launched
5	LEIR (608225)	ED water cooling station for LEIR stopped	Drain valve was accidentally opened by non-CV staff during re-cabling works	51 minutes	Valve handle was dismounted and an instruction was put in place

injectors chain not affected

CV MERIs over the last 3 years: 2005 - 3/3

	Accelerator	Impact	Cause	TTR	Remarks
6	LEIR (616152)	Demineralised water cooling station for LEIR stopped	Demineralised water station stopped due to water leak on bending magnet water supply (flexible)	3 hours 11 minutes	Corresponding flexible valve closed. ED circuit service pressure too high (28 bar instead of 25). Flow rate adjusted since.
7	LEIR (636607)	Demineralised water cooling station for LEIR stopped	ED water station stopped due to water leak on LEIR quadrupole magnet	2 hours 46 minutes (PS) - 5 hours 25 minutes (ISOLDE)	No alarm was transferred to the TI nor was there any errors on the supervision - solved?
8	PS & ISOLDE (636608)	Demineralised water cooling station for LINAC2 stopped	Motor protection tripped (pump 1), stopping the ED station and LINAC	1 hour 16 minutes	No alarm was transferred to the TI nor was there any error logged by the supervision. Motor embedded thermistances since by-passed.

CV MERIs over the last 3 years: 2006 – 1/2

	Accelerator	Impact	Cause	TTR	Remarks
9	SPS (753433)	Main Magnet demineralised cooling water station BA2 stopped	Intermittent flow interlock generated by IM (multiplexer) unit via demineralised water control system	12 minutes	Due to the temporary nature of the generation of the interlock, several stops took place before understanding the cause of the problem
10	CTF3 (753896)	LPI Demineralised cooling water station secondary side stopped	Pump units running outside their rated capacity, eventually stopping these due to temperature increase on motor windings	7 hours 2 minutes	Flow demand on user side (CTF3) had been set to > than the nominal flow capacity of secondary motor pump units
11	COMPASS (759300)	North area primary water pump and cooling tower start up failure	Faulty configuration of pump and tower start up sequence	1 hour 45 minutes	A thorough analysis by maintenance contractor should have solved the problem earlier

injectors chain not affected

injectors chain not affected

CV MERIs over the last 3 years: 2006 – 2/2

	Accelerator	Impact	Cause	TTR	Remarks
12	PS (788570)	Primary water cooling pump failure Centre Anneau	Several micro power cuts experienced due to weather conditions	4 hours 30 minutes	Stand-by pump did not start up automatically. PLC program modified
13	PS Hall Est (793727)	Demineralised water cooling station Zone Est stopped	Gradual emptying of the demineralised water expansion tank due to several minor water leaks on ED circuits. Water leaks were > than the required make up water volume	4 hours 51 minutes	This stop could have been prevented as the TS-CV maintenance contractor was alerted to the problem already 24h in advance.
14	PS & SPS (794904)	Demineralised water station Aimant PS stopped due to high temp primary water	Cooling tower fan blade misalignment puncturing cell and as a consequence stopping the unit.	3 hours	Second tower unit assured a degraded operation. Preventive programme for cooling tower fans being investigated.

injectors chain not affected

CV MERIs over the last 3 years: 2007 – 1/4

	Accelerator	Impact	Cause	TTR	Remarks
15	SPS (841479)	All cooling circuits in BA6	CPU of PLC breakdown	4h51min	CPU in store did not have enough memory. A second CPU was a different series -> configuration
16	SPS (848471)	Cooling circuits in Bldg. BA3 stopped (including compensator BEQ1)	Water leak on demineralised circuit 315 due to drain valve left open by users (Klystron)	51 minutes	Missing alarm transmission in TI – fault was seen by SPS operators
17	SPS (848535)	Demineralised water BB3	Contractor unforeseen action after false interpretation of request	1h 55min	Despite warnings, the contractor carried out the work without following CERN instructions
18	PS (858589)	Cooling station bldg 363 LINAC 2	Sudden stop of one of the pumps	1h 10 min	Internal protection of pump (degraded by old age) stopped unit without fault

CV MERIs over the last 3 years: 2007 – 2/4

	Accelerator	Impact	Cause	TTR	Remarks
19	AD (868039)	Ventilation CV1-00175 Building 196	Motor blocked	2 jours	Spare was not on store Poor reaction from new maintenance contractor and no escalation applied
20	PS & SPS (858936)	LEIR Demineralised water plant	Stop of secondary pump due to a damaged motor bearing	24 min	The stand-by pump has no frequency drive and there is no control of the pressure needed for the LINACS
21	CNGS (875445)	CNGS ventilation stopped	Error in Profibus repeaters possibly due to radiation – communication lost	7 hours 5 minutes	Profibus fault, disappeared with intervention - CNGS project 2008
22	TI2 Test (878802)	TI2 ED cooling circuit in UW25 stopped	Regulation process for buffer tank is not adequate for test requirements	2 hours 16 minutes	The TI2 circuit not designed for such duty (40 degrees)

injectors chain not affected

injectors chain not affected

injectors chain not affected

CV MERIs over the last 3 years: 2007 – 3/4

	Accelerator	Impact	Cause	TTR	Remarks
23	SPS North area (880176)	All demineralised cooling circuit in BA80 stopped	Water leak on exp. machine element	8 hours and 18 minutes (reduced service until final repair)	4 hours waiting time before access to machine zone due to radiation
24	SPS (881829)	Several cooling circuits in BA3 stopped	Water leak inside AB/PO electrical cubicle	2 hours and 25 minutes	Flow meter connection broken, which resulted in the leak?
25	PS Booster (852697)	Primary cooling of booster cooling circuit stopped	Overheating of pump motor	1 hour and 3 mins	Degradation of the coil embedded thermal protection, again no alarm (see 18)
26	HVAC CCR (853776)	Air conditioning of the CC Racks room stopped	Stop of HVAC following power cut, without automatic restart	2 hours and 50 mins	Modification of the control system software for automatic restart after power cut

injectors chain not affected

injectors chain not affected

CV MERIs over the last 3 years: 2007 – 4/4

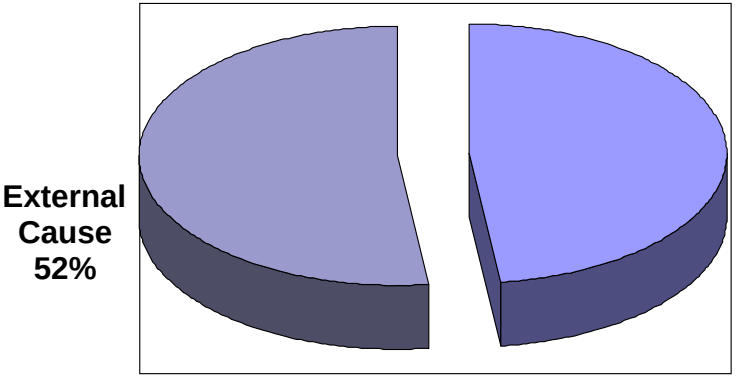
	Accelerator	Impact	Cause	TTR	Remarks
27 injectors chain not affected	Computer center B. 513 (880176)	HVAC local UPS 2 stopped	Manipulation of wiring during visit by “bureau de control electrique” creates sc due to incorrect connection. No alarm transmitted	5 hours and 48 minutes (reduced service until final repair) 348	Fault only detected when temperature rises and UPSs trigger due to high temp.

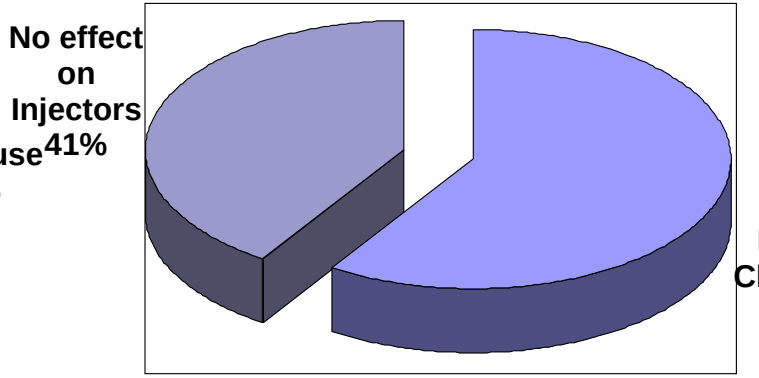
Summary of major events (05 - 07)

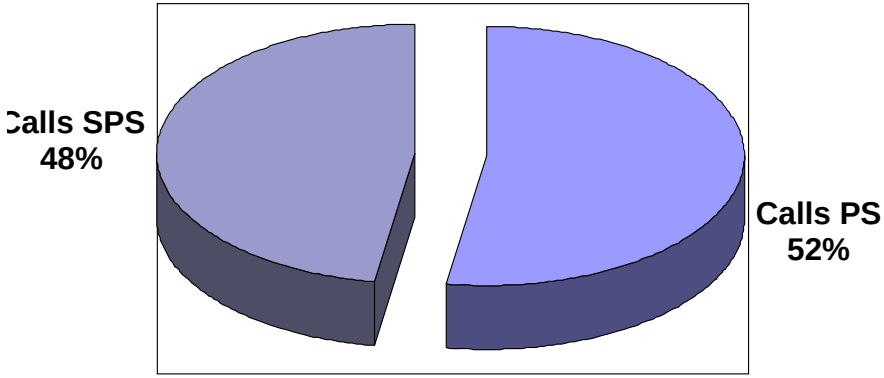
- 27 MERIs over the runs 2005-2007 of which 16 affecting the injectors chain with Physics loss
- 13 MERIs due to CV, 14 due to causes external to CV
- 209 calls in 2007 from CCC for the PS, 190 for SPS (over 10 times the number of MERIs)

Event numbers	Common cause	Number of times	MTTR
6, 7, 16, 23, 24	Water leaks from users	5	191+166+498+145+51 210min=3.5h
4, 14, 8, 18, 19, 20, 25	Mechanical failure	7	158+180+76+70+2880+24+63 493min=8.2h
11, 12, 15, 26	Controls malfunction	4	105+270+291+170 209min=3.5h
21	High radiation on CV equipment	1	425 425min=7.1h
2, 3, 17, 27	Manipulations by CV or others while systems running (Human error)	4	130+82+115+348 168min=2.8h
9	Faulty interlock	1	12min=0.2h
10	Faulty operation (overflow) of users	1	122min=2h
13	Wrong action by maintenance contractor	1	291min=4.8h
22	Learning process	1	136min=2.3h
1, 5	Works by other groups (neither users nor CV)	2	150+51 100min=1.7h

Major Event Summary - Charts







Major events for injectors chain: Summary

- In the last 3 years 27 major events, with:
  - grand total of 120 hours lost and an overall MTTR of 4.4 hours
  - the 13 MERI due to CV total 73 hours, with an MTTR of 5.7 h
  - water leaks from users account for 17.5h, with an MTTR of 3.5 h
  - unauthorised manipulations of CV systems during run account for 11.2h, with an MTTR of 2.8 h
  - control problems (HW & SW) account for 21h with an MTTR of 4.2 h
- Many isolated cases which do not fall easily into any large category:
  - even those falling within the same category have little resemblance (lack of maintenance, aging equipment).
  - New category with radiation damage!

III- TS/CV ORGANISATION

Organisation of Stand-by service

In general

- Who intervenes?
  - One team (two people) per zone (LHC, SPS, PS)
  - PS & SPS at the charge of maintenance contractors
  - LHC and 513 in charge of CV staff
- How are teams contacted?
  - Stand by phone number available in CCC
  - Contacted mainly by CCC
- Interventions timescale?
  - Contractual obligation to arrive on site within 15 min. during working hours,
  - 45 min. outside working hours.
  - Diagnosis and troubleshooting within 1 h after arrival.
  - If no solution is found, escalation procedure.
- Factors external to CV that could influence MTTR
  - Procedure for intervention in the vicinity of asbestos
  - Procedure for Radio Protection or confined spaces, special access procedures
  - Procedure for interventions in SPS in the vicinity of electrical equipment not defined. “Consignation”
  - Environmental factors (legionella) may require stop of plants

Spare parts

Policy

- D7i contains at present information on:
  - List of spare parts available in the stores
  - 70% of process components have their associated spare parts defined
  - Four different CV stores totaling 5130 m2, containing 20350 referenced parts. 99096 of these parts available on-site
- Foreseen in the mid term:
  - Determine key spares for critical equipment (defined as single point of failure, not following the N+1 general rule)
  - Determine and buy minimum stock of spares
  - Complete the process control parts
- Mostly relevant for Preventive maintenance. Troubleshooting based on N+1 redundancy policy
- Yearly stores activity:
  - 4800 parts for 1.2 MCHF (bought, accepted, stored and dispatched)
  - 44 shippings for repairs organized
  - 1 person only for this activity as from Jan. 1st 2008

D7i policy

- Each component of the different circuits (including electrical and control parts) has been entered in the database
- Spare parts are also traced with D7i
- Preventive maintenance
  - Work orders describing maintenance plans are automatically launched for rounds and annual maintenance
  - Reports on the actions performed for each component are stored in EDMS and can be access through D7i
- Corrective maintenance:
  - Either the CCC or a TS/CV staff creates work orders in D7i for corrective actions.
  - The contractor checks regularly the work orders (WO) created and reports on the actions taken
  - Statistics can be generated from the CAMS or using Business Objects

Documentation policy

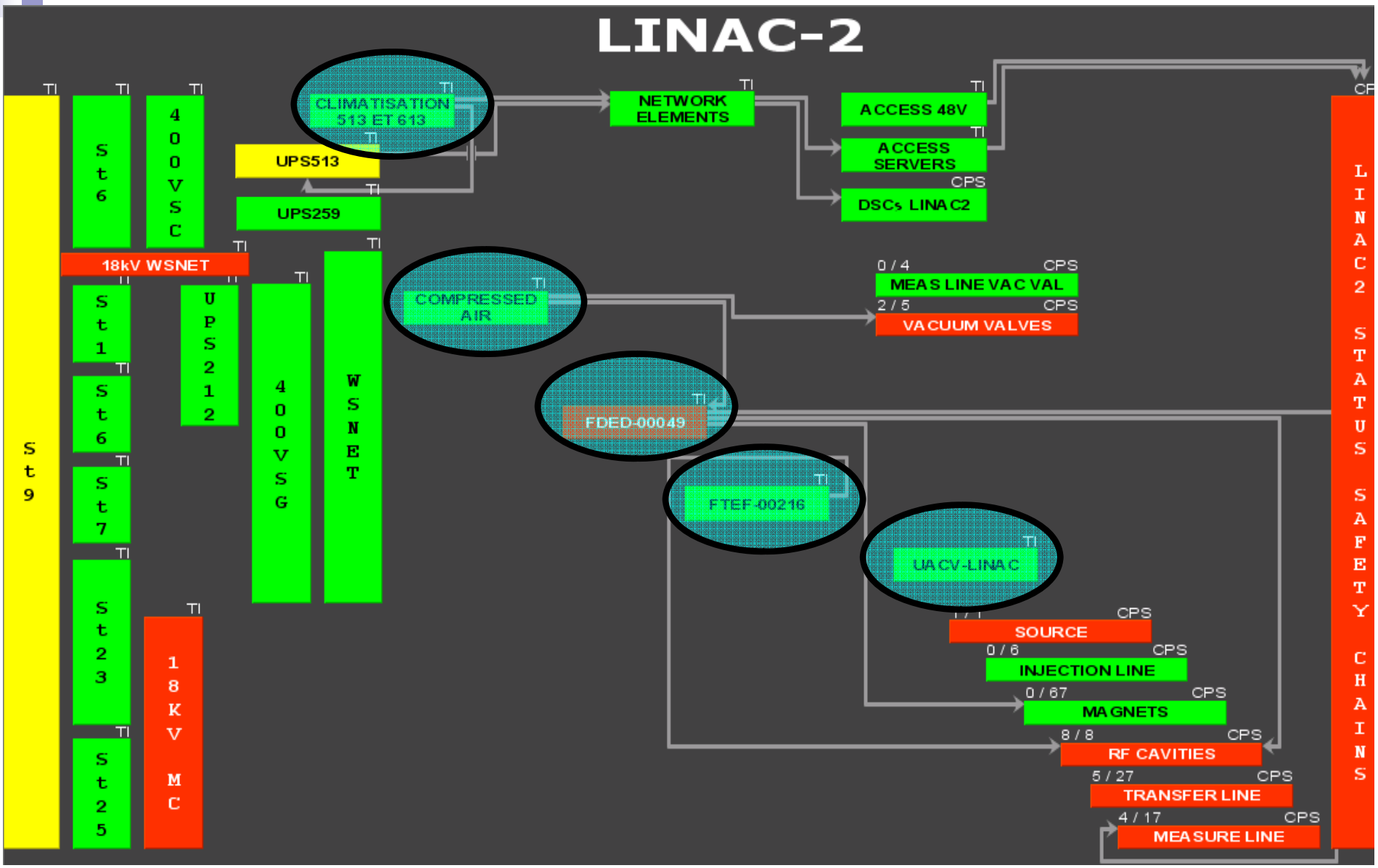
- Reasonable quantity and quality of technical documentation on paper related to CV equipment
- Lack of CDD-based information for PS and SPS, mostly hardcopy drawings and some information with TS-FM (scans of plans)
- Lack of EDMS-based information
- Absence of safety instructions which concern entire system (in particular no PUI)

IV- CRITICAL CV COMPONENTS IN THE INJECTORS CHAIN

Critical elements

- Those that are not redundant and its breakdown results in the stoppage of an accelerator
- Identification of critical plants and elements based on GTPM tool
- Summary list given here with proposed remedies to decrease the impact while…
- waiting for consolidation funding to eliminate it from the list

PS COMPLEX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St 9
St 6
400VSC
CLIMATISATION 513 ET 613
UPS513
UPS259
NETWORK ELEMENTS
ACCESS 48V
ACCESS SERVERS
DSCs LINAC2
CPS
18kV WSNET
St 1
St 6
St 7
St 23
St 25
UPS212
400VSG
WSNET
COMPRESSED AIR
0 / 4
MEAS LINE VAC VAL
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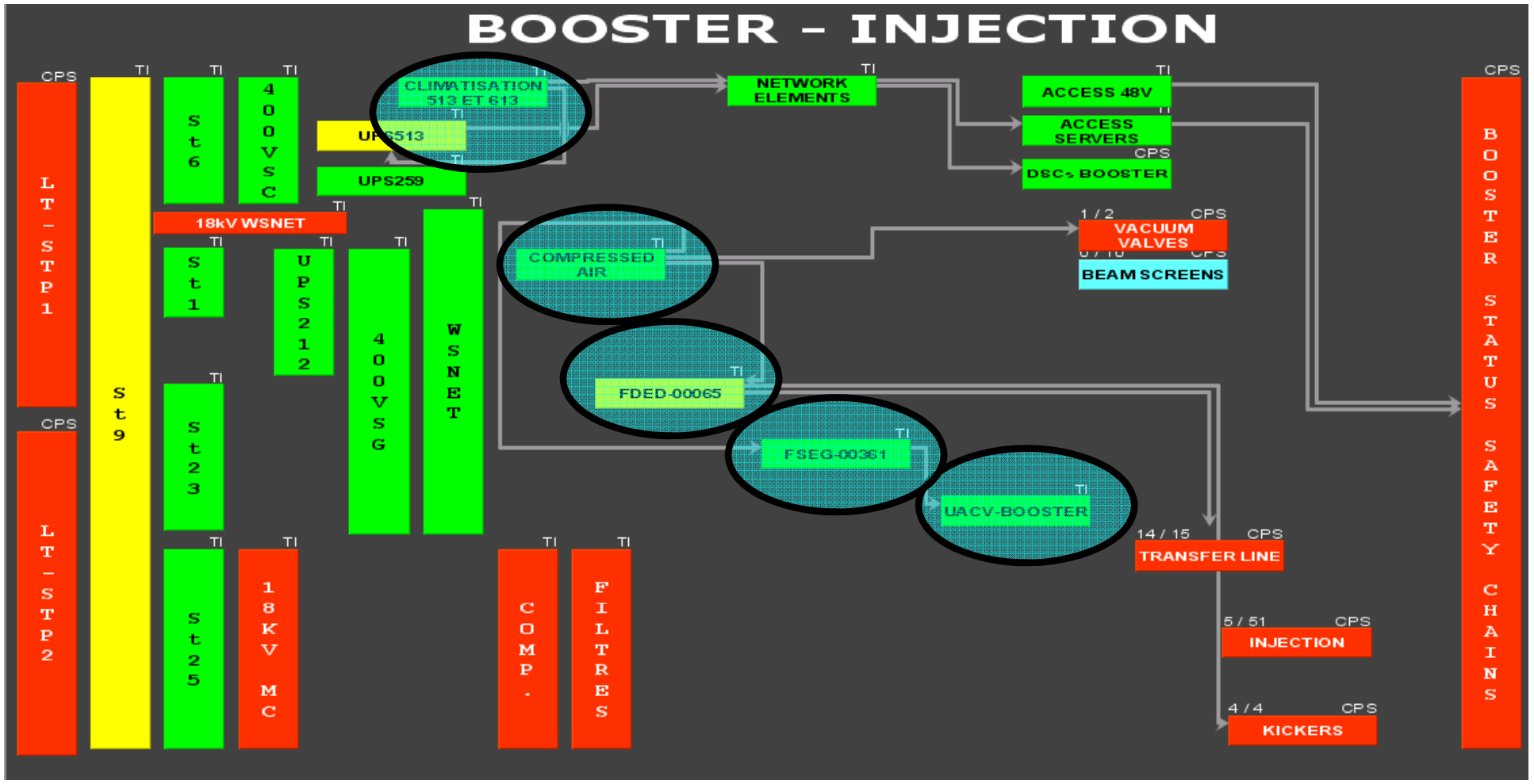
VACUUM VALVES
FDED-00049
FTEF-00216
UACV-LINAC
SOURCE
0 / 6
INJECTION LINE
0 / 67
MAGNETS
8 / 8
RF CAVITIES
5 / 27
TRANSFER LINE
4 / 17
MEASURE LINE
18KVMC
LINAC2 STATUS SAFETY CHAINS


BOOSTER – INJECTION
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LT-STP2
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18kV WSNET
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WSNET
18KV MC
CLIMATISATION 513 ET 613
UPS513
UPS259
NETWORK ELEMENTS
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ACCESS SERVERS
DSCs BOOSTER
COMPRESSED AIR
1 / 2
VACUUM VALVES
BEAM SCREENS
FDED-00065
FSEG-00361
UACV-BOOSTER
14 / 15
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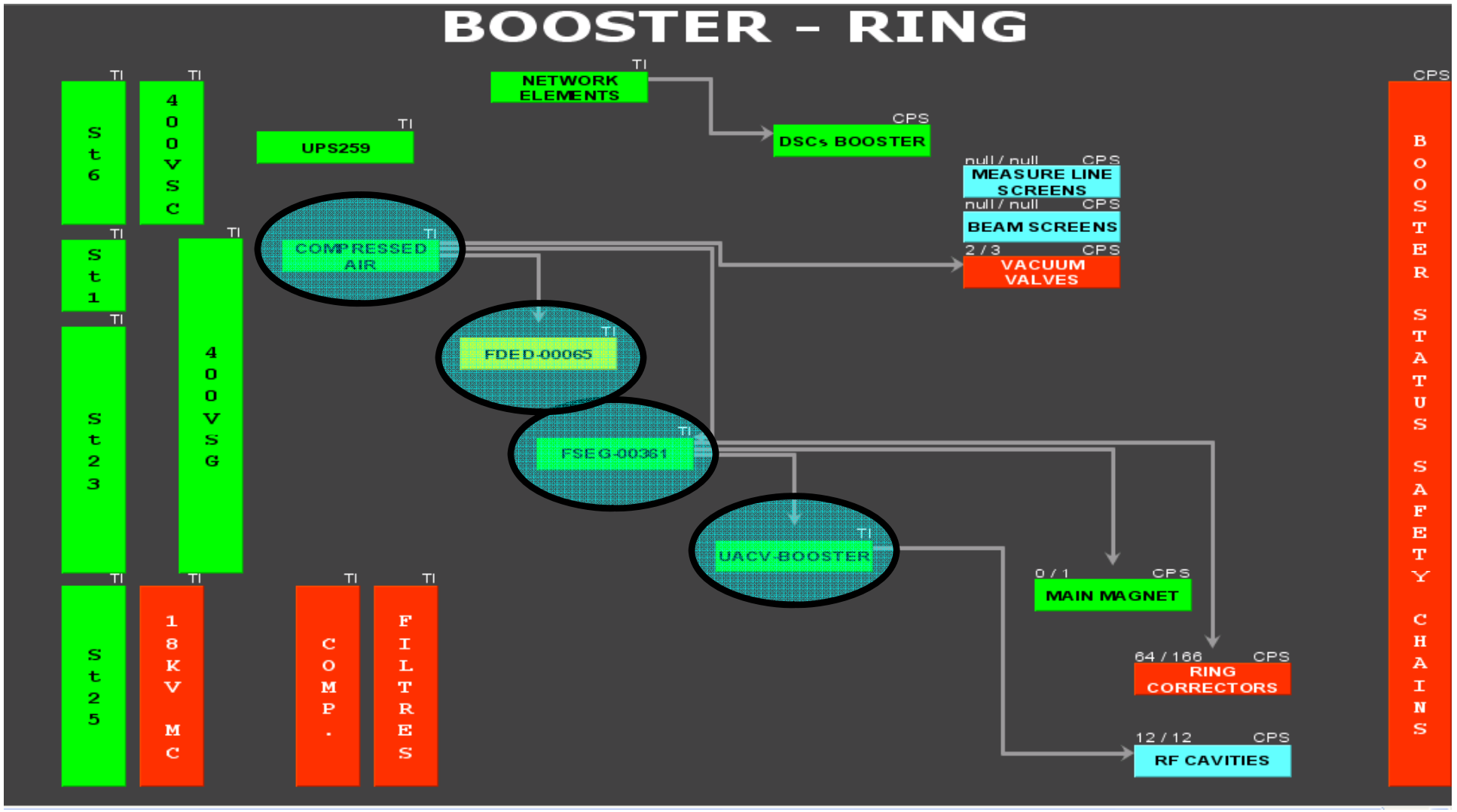
BOOSTER STATUS SAFETY CHAINS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St25
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FILTRES
UPS259
NETWORK ELEMENTS
DSCs BOOSTER
CPS
COMPRESSED AIR
FDED-00065
FSEG-00361
UACV-BOOSTER
null / null
MEASURE LINE SCREENS
BEAM SCREENS
2 / 3
VACUUM VALVES
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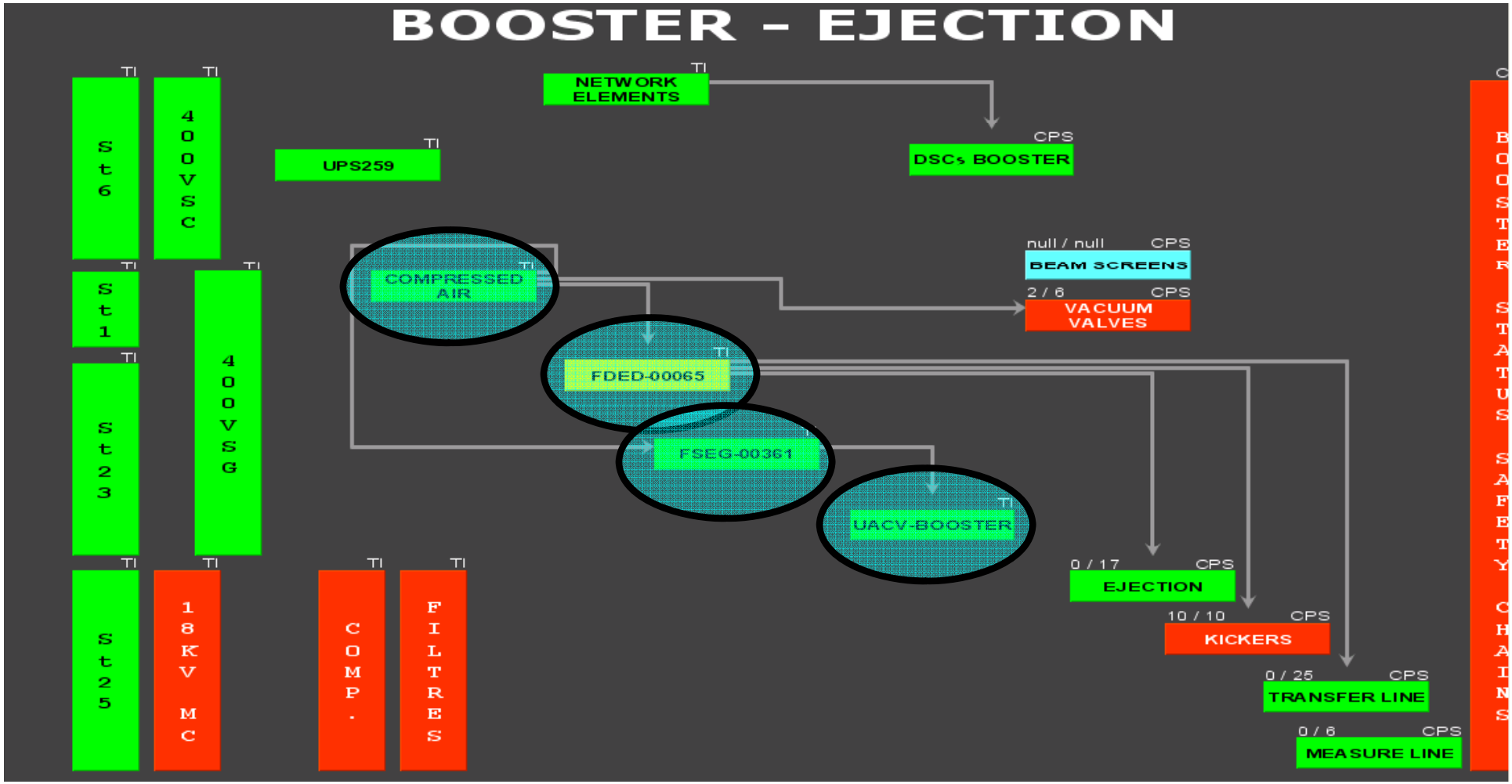
MAIN MAGNET
64 / 166
RING CORRECTORS
12 / 12
RF CAVITIES
BOOSTER STATUS SAFETY CHAINS


BOOSTER - EJECTION
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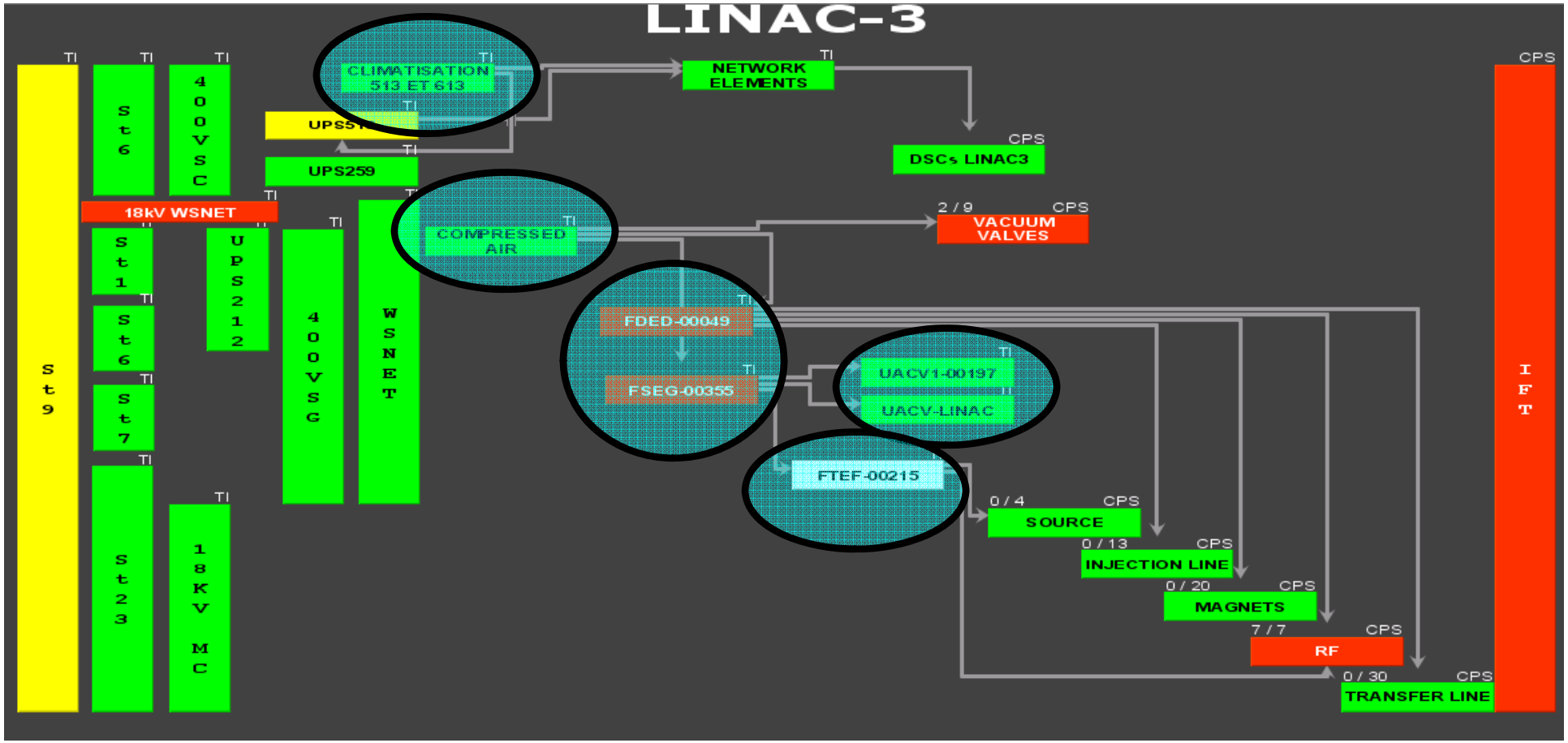
MEASURE LINE
BOOSTER STATUS SAFETY CHAINS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St 7
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WSNET
COMPRESSED AIR
2 / 9
VACUUM VALVES
FDED-00049
FSEG-00355
UACV1-00197
UACV-LINAC
FTEF-00215
18KV MC
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INJECTION LINE
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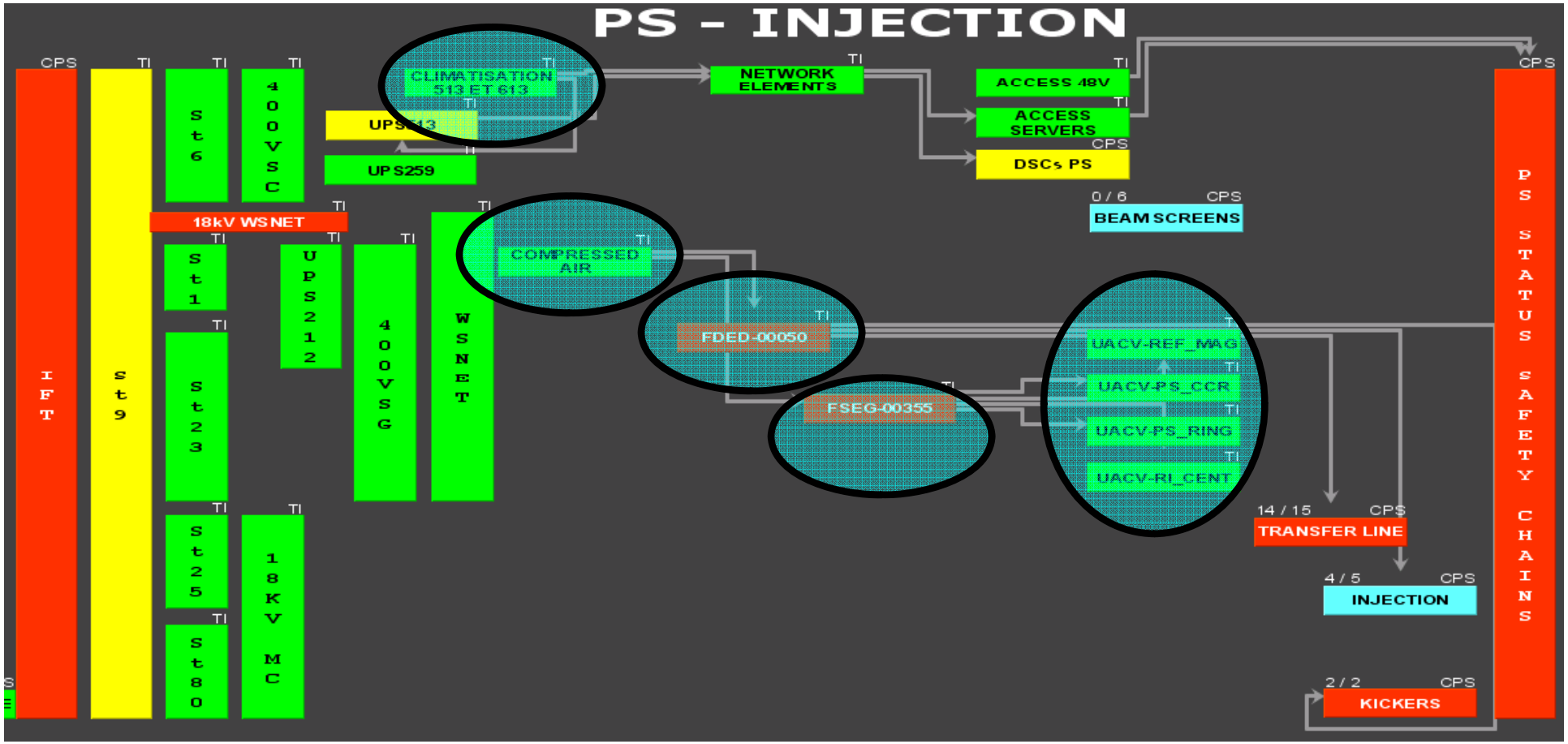
MAGNETS
7 / 7
RF
0 / 30
TRANSFER LINE
IFT


PS - INJECTION
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400VSG
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COMPRESSED AIR
FDED-00050
FSEG-00355
UACV-REF_MAG
UACV-PS_CCR
UACV-PS_RING
UACV-RI_CENT
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18KV MC
14 / 15
TRANSFER LINE
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INJECTION
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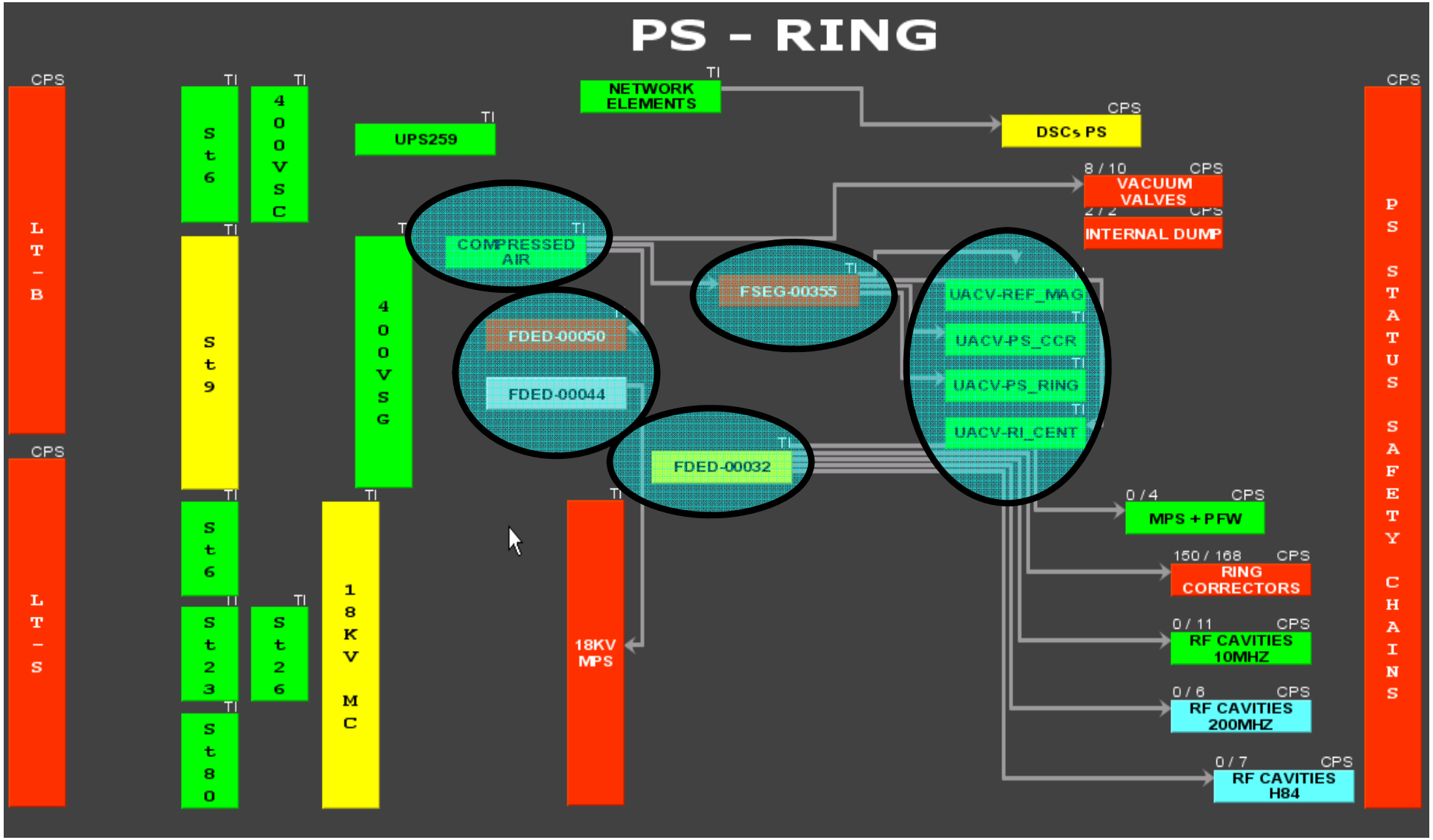
KICKERS
PS STATUS SAFETY CHAINS


PS - RING
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DSCs PS
CPS
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VACUUM VALVES
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CPS
INTERNAL DUMP
COMPRESSED AIR
St9
400VSG
FDED-00050
FDED-00044
FSEG-00355
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UACV-PS_CCR
UACV-PS_RING
UACV-RI_CENT
FDED-00032
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St80
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18KV MPS
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CPS
MPS + PFW
150 / 168
CPS
RING CORRECTORS
0 / 11
CPS
RF CAVITIES 10MHZ
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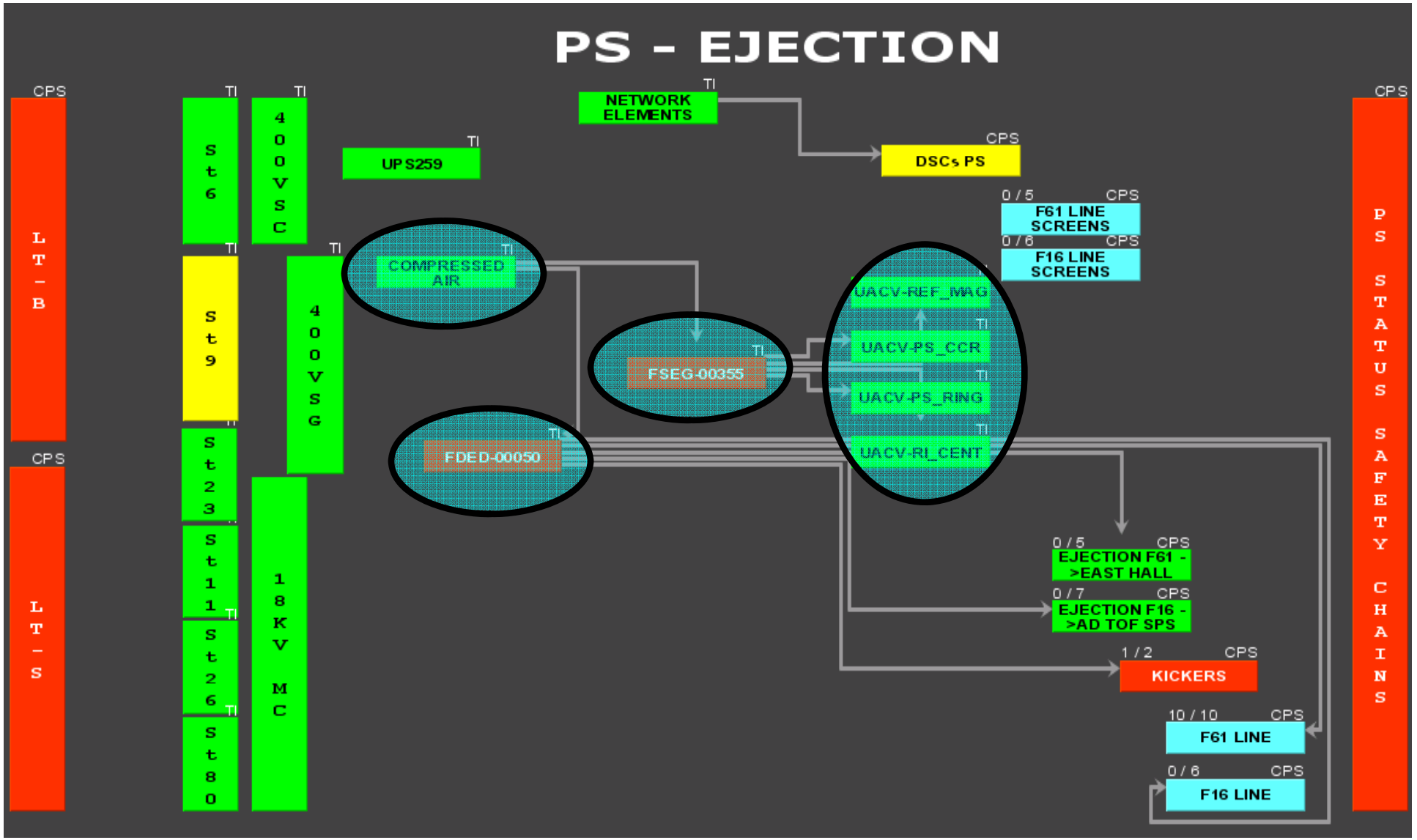
CPS
RF CAVITIES 200MHZ
0 / 7
CPS
RF CAVITIES H84
CPS
PS STATUS SAFETY CHAINS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UPS259
TI
NETWORK ELEMENTS
CPS
DSCs PS
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F61 LINE SCREENS
0 / 6 CPS
F16 LINE SCREENS
TI
COMPRESSED AIR
TI
FSEG-00355
TI
FDED-00050
TI
UACV-REF_MAG
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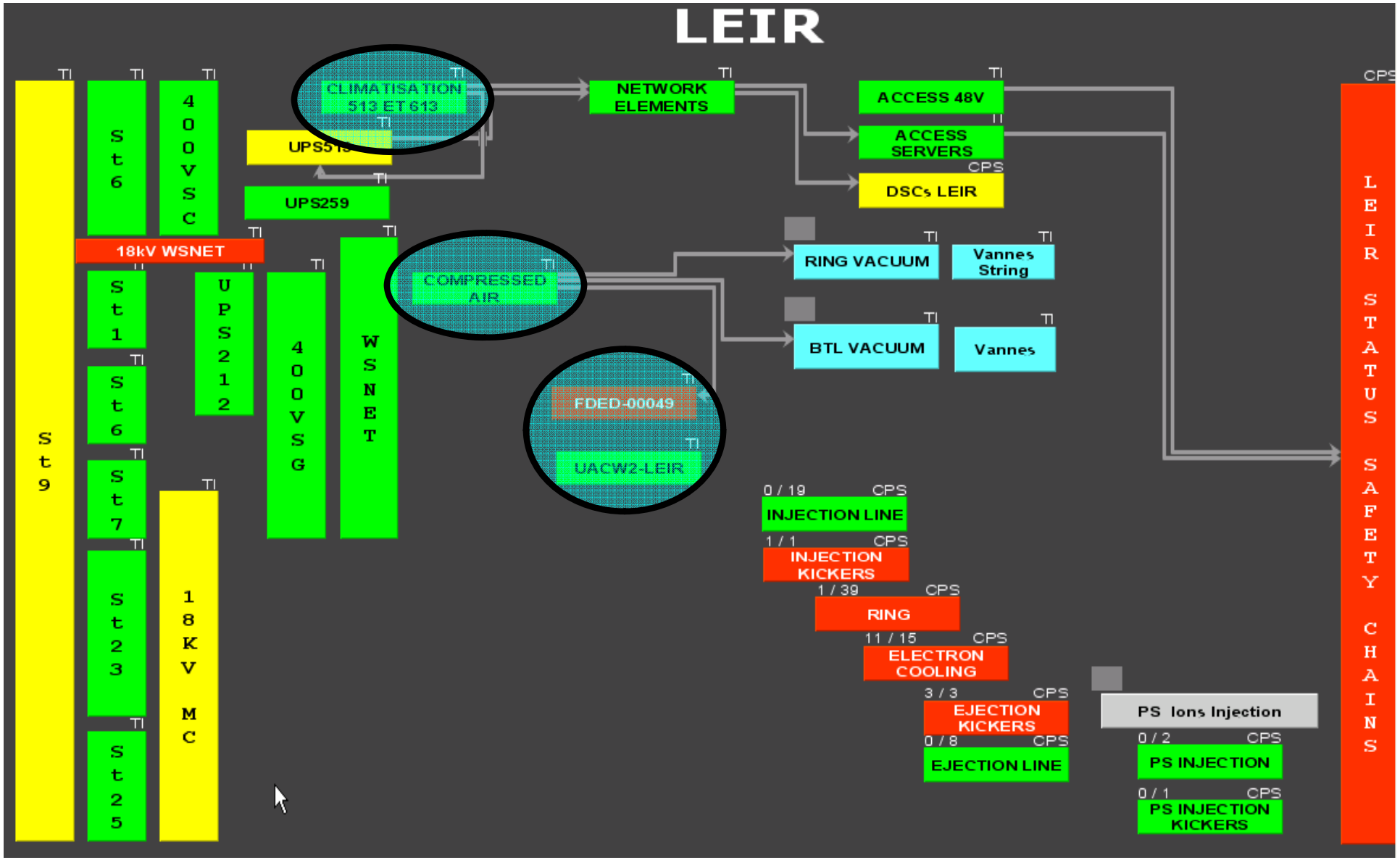
UACV-PS_CCR
TI
UACV-PS_RING
TI
UACV-RI_CENT
0 / 5 CPS
EJECTION F61 ->EAST HALL
0 / 7 CPS
EJECTION F16 ->AD TOF SPS
1 / 2 CPS
KICKERS
10 / 10 CPS
F61 LINE
0 / 6 CPS
F16 LINE
CPS
PS STATUS SAFETY CHAINS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18kV WSNET
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St25
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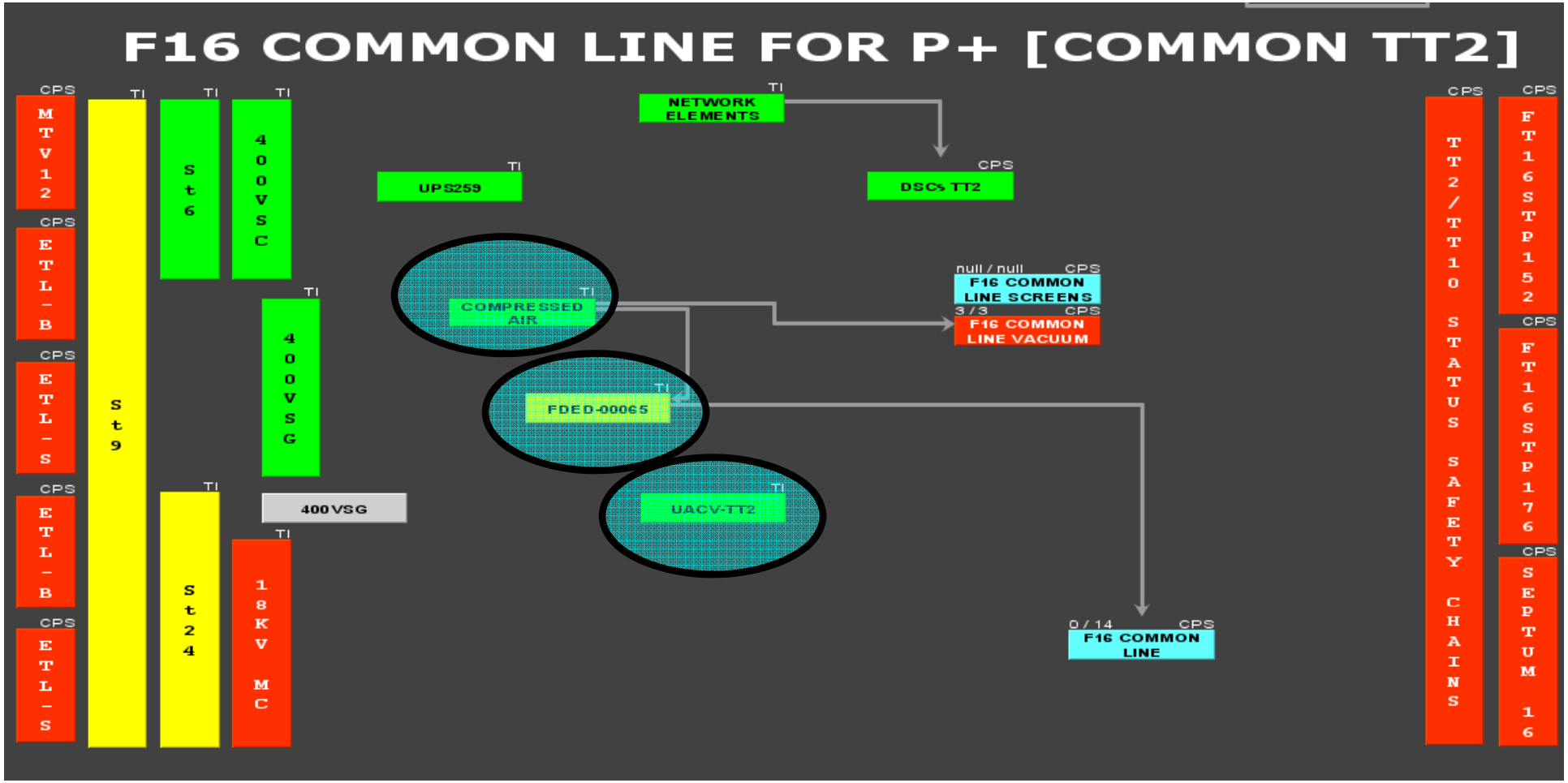
18KV MC
CLIMATISATION 513 ET 613
UPS513
UPS259
COMPRESSED AIR
FDED-00049
UACW2-LEIR
NETWORK ELEMENTS
ACCESS 48V
ACCESS SERVERS
DSCs LEIR
RING VACUUM
Vannes String
BTL VACUUM
Vannes
0 / 19 CPS
INJECTION LINE
1 / 1 CPS
INJECTION KICKERS
1 / 39 CPS
RING
11 / 15 CPS
ELECTRON COOLING
3 / 3 CPS
EJECTION KICKERS
0 / 8 CPS
EJECTION LINE
PS Ions Injection
0 / 2 CPS
PS INJECTION
0 / 1 CPS
PS INJECTION KICKERS
CPS
LEIR STATUS SAFETY CHAINS


F16 COMMON LINE FOR P+ [COMMON TT2]
CPS
MTV12
CPS
ETL-B
CPS
ETL-S
CPS
ETL-B
CPS
ETL-S
TI
St 9
TI
St 24
TI
St 6
TI
400VSC
TI
400VSG
400VSG
TI
18KV MC
TI
NETWORK ELEMENTS
TI
UPS259
CPS
DSCs TT2
TI
COMPRESSED AIR
TI
FDED-00065
TI
UACV-TT2
null / null CPS
F16 COMMON LINE SCREENS
3 / 3 CPS
F16 COMMON LINE VACUUM
0 / 14 CPS
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CPS
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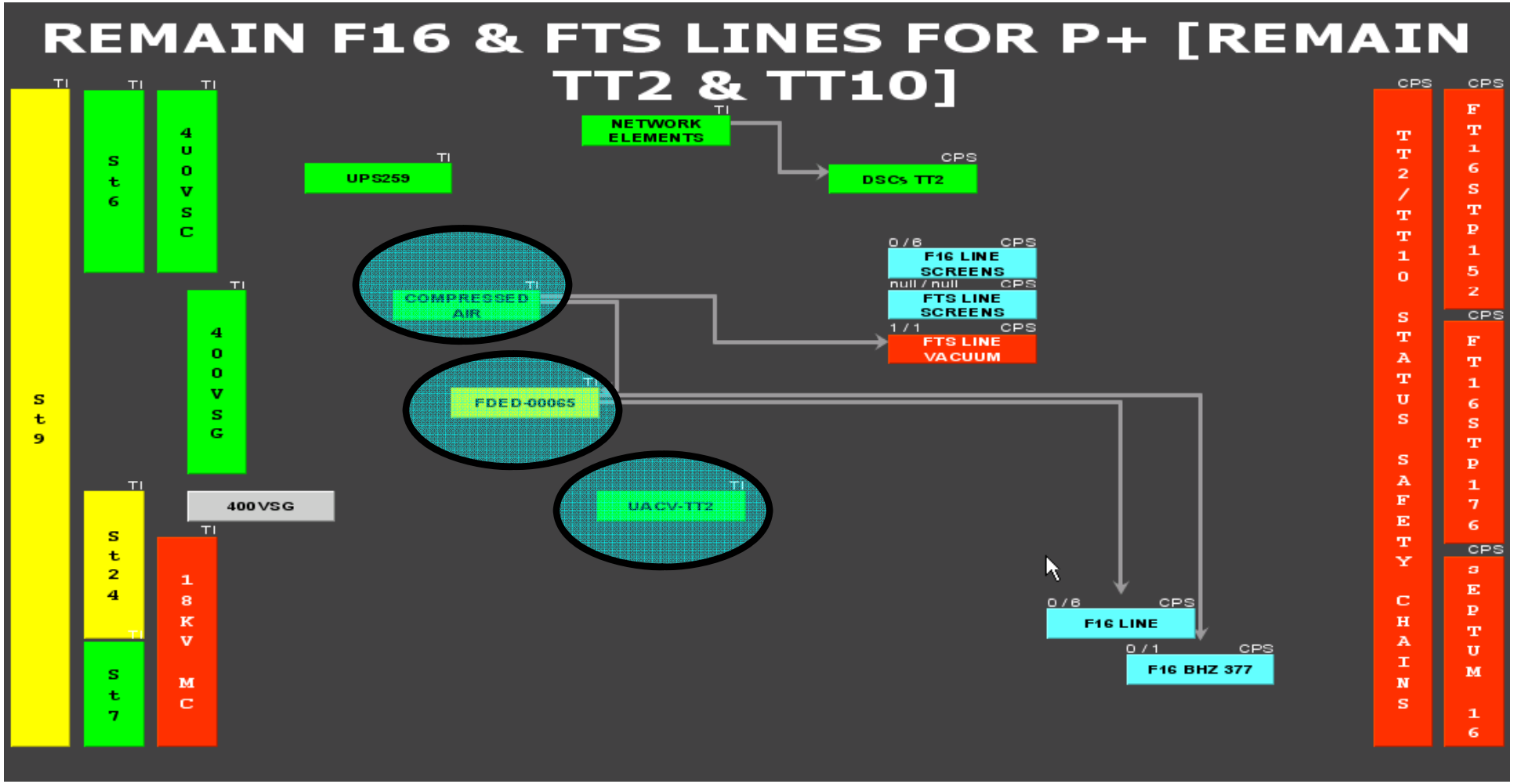
SEPTUM 16


REMAIN F16 & FTS LINES FOR P+ [REMAIN TT2 & TT10]
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St 9
St 6
400VSC
UPS259
NETWORK ELEMENTS
CPS
DSCs TT2
400VSG
COMPRESSED AIR
0 / 6
F16 LINE SCREENS
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FTS LINE SCREENS
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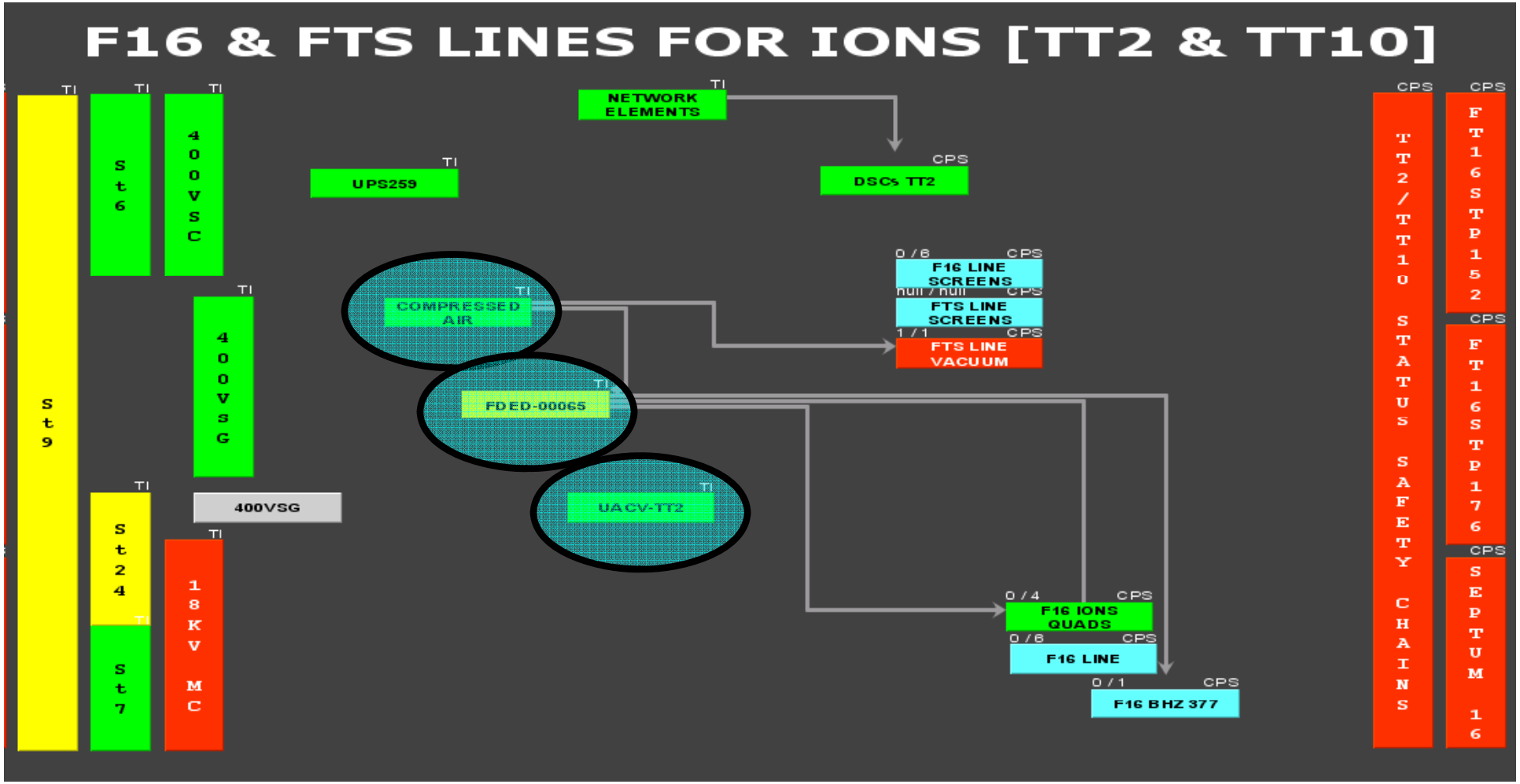
FDED-00065
UACV-TT2
St 24
St 7
18KV MC
0 / 8
F16 LINE
0 / 1
F16 BHZ 377
TT2/TT10 STATUS SAFETY CHAINS
FT16STP152
FT16STP176
SEPTUM 16


F16 & FTS LINES FOR IONS [TT2 & TT10]
St 9
St 6
400VSC
UPS259
NETWORK ELEMENTS
DSCs TT2
400VSG
COMPRESSED AIR
FDED-00065
UACV-TT2
F16 LINE SCREENS
FTS LINE SCREENS
FTS LINE VACUUM
400VSG
St 24
St 7
18KV MC
F16 IONS QUADS
F16 LINE
F16 BHZ 377
TT2/TT10 STATUS SAFETY CHAINS
FT16STP152
FT16STP176
SEPTUM 16

LINAC-2

CLIM 513, 613

CA->FDED-00049, FTEF-00216

UACV-LINAC

BOOSTER-INJECTION

CLIM 513, 613

CA->FDED-00065, CA->FSEG-00361->UACV-BOOSTER

BOOSTER-RING

CA->FDED-00065, CA->FSEG-00361->UACV-BOOSTER

BOOSTER-EJECT

CA->FDED-00065, CA->FSEG-00361->UACV-BOOSTER

LINAC3

CLIM 513, 613
CA-> FDED-00049
CA-> FSEG-00355-> FTEF-00215
UACV1-00197, UACV-LINAC

PS-INJECTION

CLIM 513, 613
CA->FSEG-00355
CA->FDED-00050

PS-RING

CA->FSEG-00355->UACV-REF_MAG + UACV-PS_CCR
->UACV-PS_RING + UACV-RI_CENT
CA->FDED-00050
FDED-00044
FDED-00032

PS-EJECTION

CA->FSEG-00355->UACV-REF_MAG + UACV-PS_CCR
->UACV-PS_RING + UACV-RI_CENT
CA->FDED-00050

LEIR
CA->FDED-00049
UACW2

F16 COMMON LINE FOR P+ (COMMON TT2)
CA->FDED-00065
UACV-TT2

REMAIN F16 & FTS LINES FOR P+ (REMAIN TT2&TT10)
CA->FDED-00065
UACV-TT2

REMAIN F16 & FTS LINES FOR IONS (TT2&TT10)
CA->FDED-00065
UACV-TT2

CRITICAL CV INSTALLATIONS IN THE INJECTOR CHAIN (MEYRIN)

- General compressed air bldg. 200 and 201
- CLIM 513
- FDED 32, 44, 49, 50, 54, 65
- FTEF 215, 216
- FSEG 355, 361
- UACV BOOSTER, 197, LINAC, REF_MAG, PS_CCR, PS_RING, RI_CENT, TT2

COMPRESSED AIR PRODUCTION (MEYRIN)

Identification	Critical element	Remedy
Meyrin compressors (200 and 201):	1 spare but 4 beyond estimated useful life	Replace air compressors. Call for tender under preparation
Meyrin compressors (200 and 201):	One cell EL feeds 2 compressors	See with EL for their problem

FDED: DEMINERALISED WATER STATIONS (MEYRIN)

Identification	Critical element	Remedy
All circuits	Electrical/Control cubicle	
All circuits	Regulation valves (3 way). Servomotor	Keep servomotor in stock
FDED-32, 49 and 65	Cooling towers (no spare cell)	Keep motor, gear box and pale of ventilator in stock
FDED-32, 50 and 65	No by-pass in demineralised water circuits	Add by-pass or have a spare filter to change rapidly
FDED-49	2 pumps but only one equipped with VFD	Add one VFD
FDED-50	One pump in chilled water tertiary circuit (P8)	Install warm stand-by

FTEF: RAW WATER STATIONS (MEYRIN)

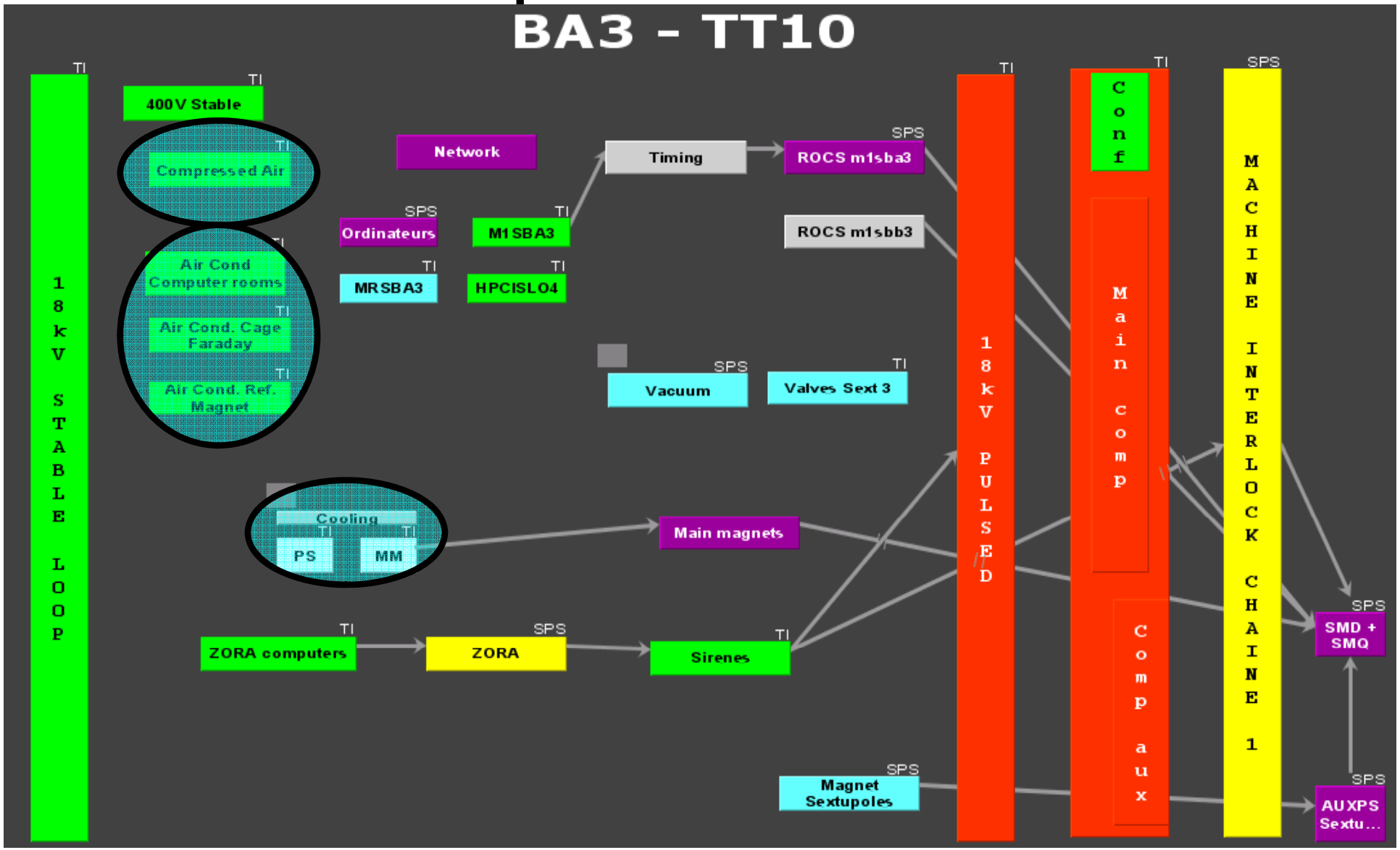
Identification	Critical element	Remedy
All circuits	Electrical/Control cubicle	
All circuits	Regulation valves (3 way). Servomotor	Keep servomotor in store
FTEF-215	Motorised valve at the outtake of the pumps and another for by-pass	Keep servomotors in store
FTEF-216	Sectorisation valve in service tunnel	Keep servomotor in store (check access constraints)
FTEF-216	No by-pass in demineralised water circuits	Install by-pass

CRITICAL INSTALLATIONS OUTSIDE THE INJECTOR CHAIN (MEYRIN)

- FDED-00030, 31, 48, 52, 53, 68
- UHF1-00101, 120, AD
- UNF6-00107, UNF3-00613
- UACV-AD, UACW2-00021

SPS

SPS Example


BA3 - TT10
TI
18kV STABLE LOOP
400V Stable
Compressed Air
Air Cond Computer rooms
Air Cond. Cage Faraday
Air Cond. Ref. Magnet
Network
Timing
SPS
ROCS m1sba3
ROCS m1sbb3
Ordinateurs
M1SBA3
MRSBA3
HPCISLO4
Vacuum
Valves Sext 3
Cooling
PS
MM
Main magnets
ZORA computers
ZORA
Sirenes
Magnet Sextupoles
18kV PULSED
Conf
Main comp
Comp aux
MACHINE INTERLOCK CHAINE 1
SMD + SMQ
AUXPS Sextu...

CRITICAL INSTALLATIONS IN THE INJECTOR CHAIN (SPS)

- General compressed air bldg. 860 and BA3 and BA5
- Cooling towers BA6 and SF1
- BA Secondary cooling stations

SPS CRITICAL ELEMENTS

Identification	Critical element	Remedy
BA3 and BA5 compressed air production	Not enough back-up	Add a compressor in parallel
Filter in demineralised water circuits without by-pass	Motorised valve at the outtake of the pumps and another for by-pass	Keep servomotors in store
BA2 demineralised water	Common expansion vessel: a leak in TT20 circuit would stop SPS	Add a expansion vessel separated for that circuit

V- RECUPERATION AFTER MAJOR FAILURE

Major Failures

- **All three stand-by teams called, together with the team leaders, if required**
- **In case of very large number of interventions, all those piquet members available will be called by CCC at the request of CV team leader**
- **CERN-wide priorities handled by TI. TS/CV team leader coordinates the different teams on the field (N.B. GTPM LHC does not yet exist)**
- **Best ever time to recover, when everything prepared in advance during tests, around 6 hours. In case of unforeseen incidents could take up to a few days; all safety related and high priority systems should be operational within the first day (excluding material breakages!). Second priority systems followed-up in subsequent day(s)**
- **Potential problems:**
  - IT
    - Recuperation of technical network (supervision needed to restart systems)
    - Availability of IT piquet for the restart of Star-points
  - TI
    - Avalanches of alarms may keep some important ones from being detected
  - SIG
    - Very efficient piquet in past years
  - Priorities in case of massive failure?
    - See P. Collier's presentation

VI- CONCLUSIONS

Conclusions

- The analysis of the major events shows that there is little repeatability in the breakdowns. Around 1/3 of breakdowns with Physics loss is linked to equipment, rest of stops due to accidental or unauthorised manipulation of the CV systems. Headroom here
- A comparison between the major events and the numbers of calls from CCC shows that most of the breakdowns and events do not stop the accelerators
- Major effort done to improve the TS/CV policy to reduce MTTR mainly through stand-by duty preparation and D7i documentation improvement (in the past and coming years)
- The spare part management cannot be underestimated, for rapid reaction in interventions. and the identification of critical elements is underway. However…
- Past and recent experience indicate, as shown by the MERI examples available, that spares play a limited role in the reduction of MTTR as a vast majority of stand-by actions consist in troubleshooting, helped by the N+1 warm stand-by policy. Repairs of equipment is performed in hidden time.
- Improvements will be necessary by consolidation programs