



The safety electrical networks at CERN



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Assured network vs. safety network

- The part of the CERN electrical network which is automatically separated from the normal network and supplied by Diesel-generator sets is called

Assured network designation EA

- The part of the assured network which is NOT affected by the general emergency stop system (AUG) is called

Safety network designation ES



Levels of availability of the electrical supply



Types of supply	See mains perturbations ?	Switched off by AUG ?	Back up by Diesel set ?	Downtime ?
Normal EBD	Yes	Yes	No	Yes Mains downtime
Assured EAD	Yes	Yes	Yes	Yes 30s to 90s
Safety ESD	Yes	No	Yes	Yes 30s to 90s
UPS EOD	No	Yes or No	Yes or No	No Battery autonomy : 10min to 2h
48 Vdc ECD	No	No	Yes	No Battery autonomy : 2h to 3h



Back up sources available at CERN

- 1st level of back up, battery sets :

 - UPS, 48 Vdc systems,
No downtime

- 2nd level of back up, alternate source :

 - Auto transfer system between EDF and EOS,
re-supply of the general services network only (max. 60 MVA),
Downtime up to 30 s

- 3rd level of back up, safety source :

 - Diesel-generator sets,
re-supply of the assured network only,
Downtime up to 90 s



Rules and regulations (1/4)

Safety code
C1



Safety Instruction
24



NFC 15-100 (IEC 60364)

Low-voltage electrical installations

- § 35 – Safety Installations
- § 56 – Supply for safety services



Decree N° 88-1056 :

Safety installations =

- Safety lighting
- Installations for the safety of the personnel in case of disaster
- Installations for which the sudden stop or long stop could lead to a risk for the personnel

I.N.B.



LHC, SPS = installations nucléaires de base

- Safety for the personnel
- Safety for the accelerators



NFC 13-200

High-voltage electrical installations

- §56 - Conditions for the protection and installation of Diesel-generator sets



Rules and regulation (2/4)

- What are the safety sources allowed ?
 - Generator sets
 - Uninterruptible power supplies
 - Battery sets

- What is the autonomy required for the safety sources ?
 - Safety lighting : min. 1 hour
 - Other safety equipment : autonomy not specified.
Shall assure the evacuation of the personnel in case of a fire and ease the intervention of the fire brigade.



Rules and regulation (3/4)

The CERN Diesel-generator assured network fulfills two tasks :

⇒ Supply the loads which shall remain in operation for safety and material purposes in all circumstances, **ESD network**

- Safety lighting
- Fire protection
- Lifts for the access pits
- Smoke extraction
- Gas detection
- Emergency stop
- Electrical substation auxiliaries
- Pressurized system for pits
- Transmission level 3 safety alarms
- Access control
- Radiation control
- Fire fighting system
- *ATLAS Heaters and Vacuum system*



Rules and regulation (4/4)

➡ Supply the vital loads which are needed for operational purposes, to maintain a minimum activity in the area, **EAD network**

- Assured lighting
- Computers
- Water pumps
- Compressors for the recuperation of helium



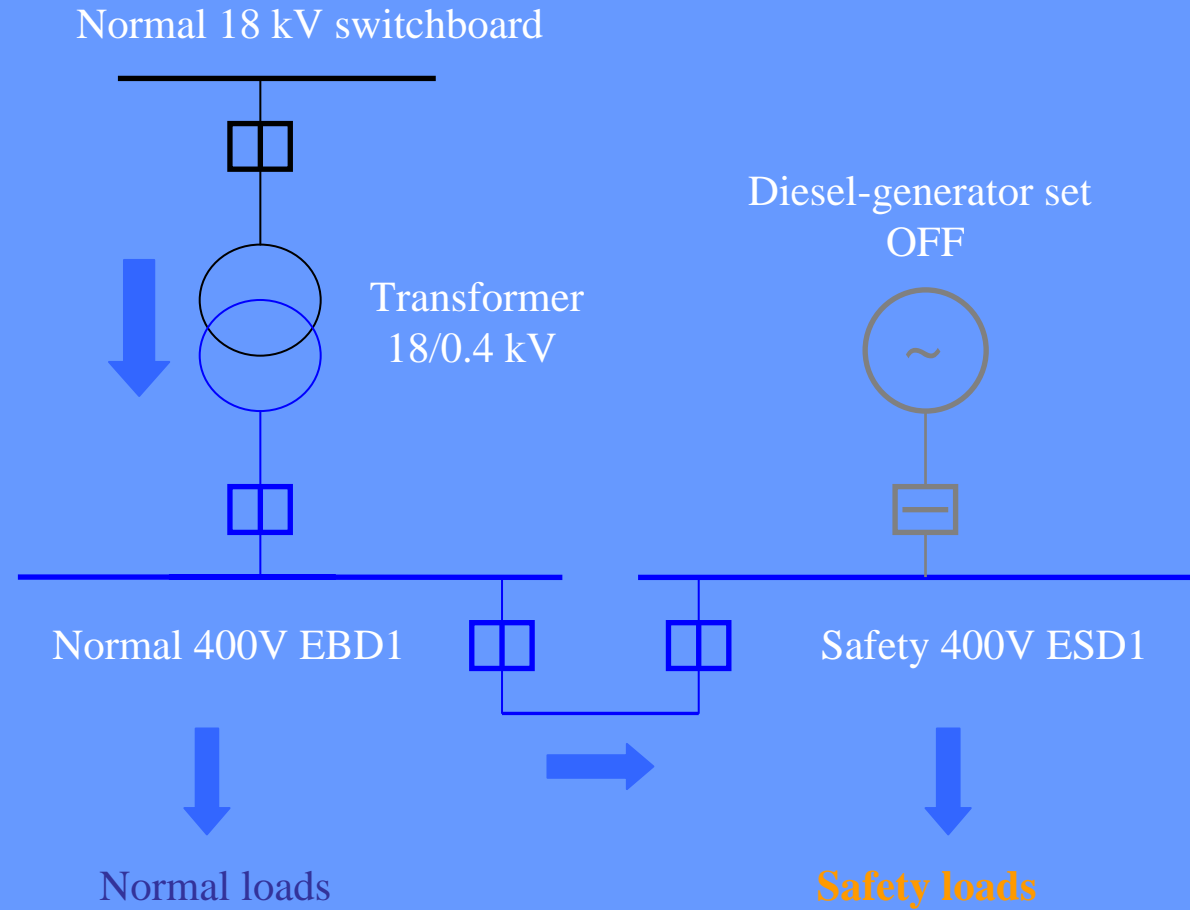
The CERN assured networks

- The assured networks are composed of :
 - ⇒ 14 Diesel-generator sets (6.3 kV, 3.3 kV, 400 V),
total installed power : 17.5 MVA
 - ⇒ 17 PLCs Normal / Safety
 - ⇒ 29 main switchboards (18 kV, 3.3 kV, 400 V)



Principle of the N/S commutation system

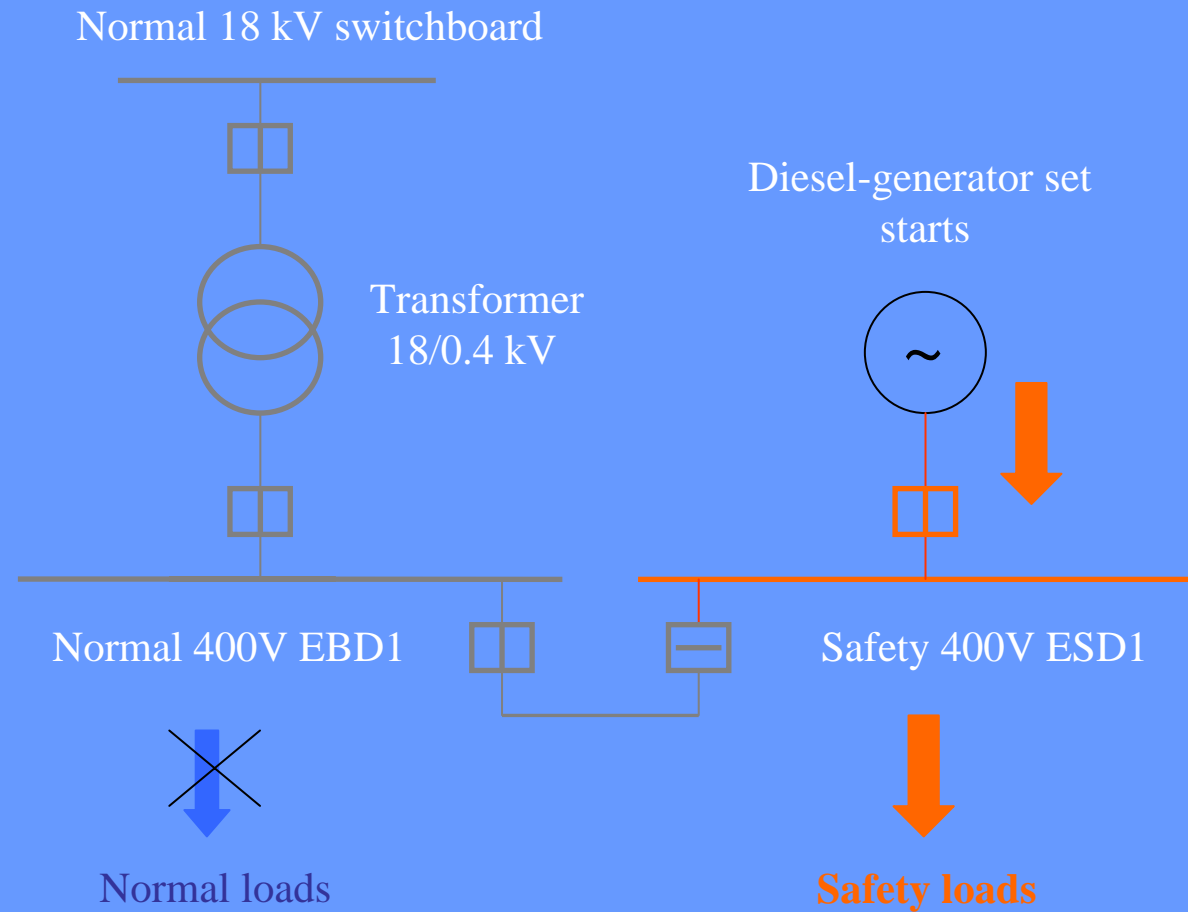
Normal condition





Principle of the N/S commutation system

Diesel back up





The CERN assured networks

- The assured networks are composed of :
 - ⇒ 14 Diesel-generator sets (6.3 kV, 3.3 kV, 400 V), stand-by mode total installed power : 17.5 MVA
 - ⇒ 17 PLCs Normal / Safety
 - ⇒ 29 main switchboards (18 kV, 3.3 kV, 400 V)

- The implementation of the assured network is different for each site :
 - ⇒ Meyrin
 - ⇒ SPS with North Area and CNGS
 - ⇒ LHC



Meyrin Area (1/2)

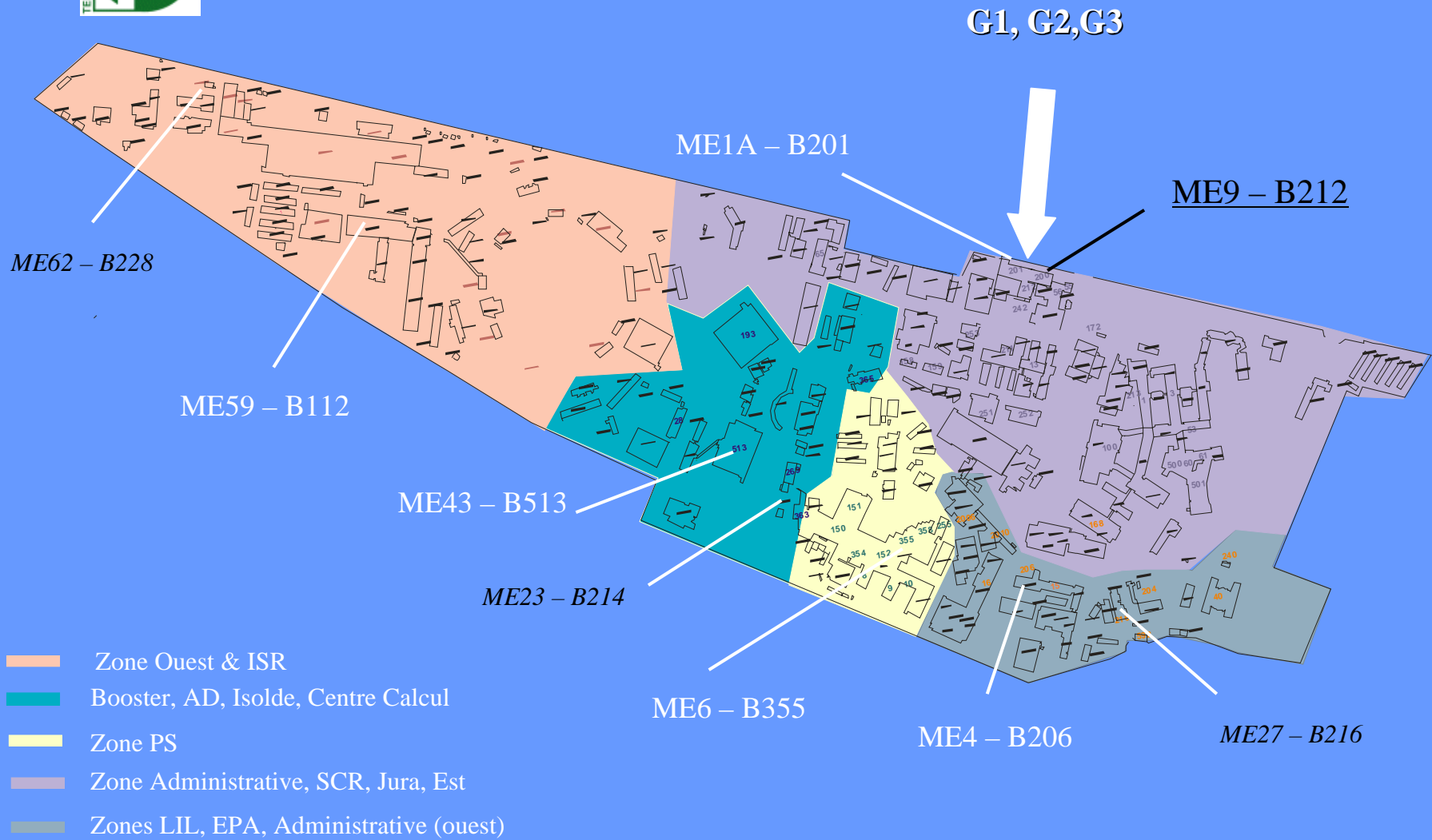
- Centralized Diesel-generator sets 6.3. kV, N+1 redundancy :
 - G1 (1968) 3.2 MVA
 - G2 (1968) 3.2 MVA
 - G3 (1979) 3.5 MVA

- Installations refurbished in 2005 :
 - PLC Normal / Safety
 - Excitation systems
 - Auxiliaries

- 18 kV assured distribution network : 5 main points of delivery



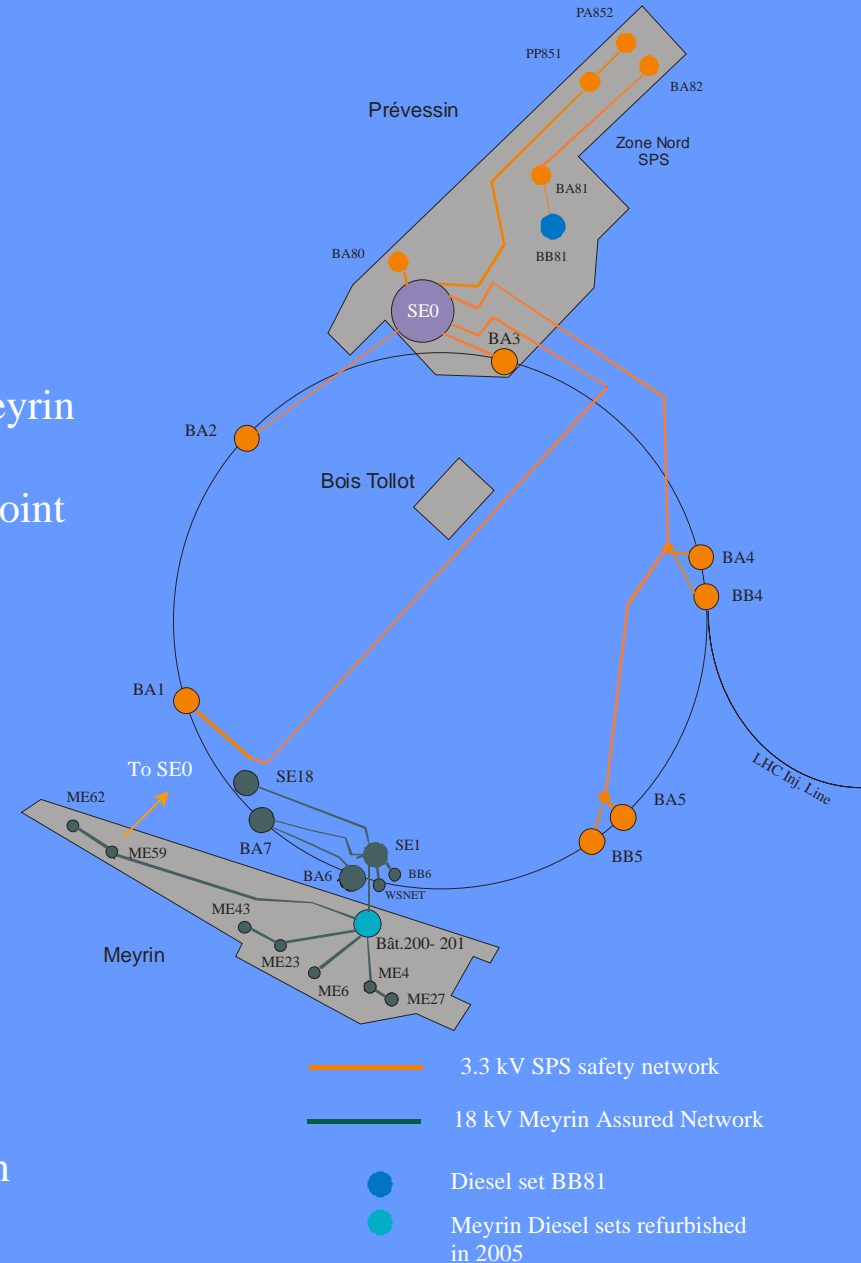
Meyrin Area (2/2)





SPS Areas

- BA1 to BA5, CCC, BA80 :
3.3 kV safety network supplied from the 18 kV Meyrin assured network (800 kVA, 3.3/4 kV transformer in ME59. 4 km link), 250 kVA available on each point
- BA6, BB6 and BA7 :
18 kV distribution supplied from the 18 kV Meyrin assured network
- BA81, BB81, BA82 :
3.3 kV network supplied from the dedicated 1250 kVA, 3.3 kV Diesel-generator set in BB81
- CNGS, TSG4 :
EAD switchboard in TSG4 supplied from the normal network due to the lack of assured power in BA4, BB4





LHC Areas



Diesel-generator set 750 kVA, P.A.2

- Decentralized production : no redundancy
one 400 V Diesel-generator set per point,
except for LHC1
- Rated installed power :
 - 275 kVA odd points
 - 750 kVA even points
- 400 V distribution network : safety
of personnel and safety of the accelerator
(I.N.B.)
- LHC1 supplied from the Meyrin Diesel-
generator sets and the 18kV assured
network
- Critical systems of ATLAS detector :
supplied by two dedicated Diesel sets
(910 kVA @ 400 V, 1 MVA @ 3.3 kV)



Power balances on the assured networks

■ Meyrin Diesel-generator sets :

	P, kW	Q, kVAr	S, kVA
Estimated consumption (max)	3490	2210	4130
Max power available with 2 Diesel-generator sets	4100	2500	4800

- Margin : 15 % of the rated power of 2 Diesel-generator sets

- Autonomy at rated power : 5 days

■ LHC Diesel-generator sets :

- Load (4th December test) : 15 % (LHC8) to 40 % (LHC3) of the rated power

- Autonomy at rated power : 2 to 3 hours daily tank, 1 to 4 days external tanks



Regular maintenance and tests

- Preventive maintenance of each subsystems of the assured network done via a general maintenance contract (E065) or constructor maintenance contracts (E067, E076, E077, E078...):
 - Maintenance plan set up for each equipment
 - Traceability of all maintenance activities done in D7i



*Diesel sets of LHC not available once a year during 1 day to 1 week
Back up sources : auto transfer system (automatic) or 20 kV EDF (manual)*

- Functional test of the whole system, twice a year :
 - During the annual assured network test
 - During the AUG tests
- Each subsystem is remotely monitored, except for LHC underground (implementation underway)



Results of the 4th December test (1/2)

- Check of the automatic re-supply of the assured networks by their Diesel-generator sets, with the corrections done after the 29th of July major event
 - ✓ *the 14 sets did operate correctly*

- Check of the correct function of the PLCs Normal/Safety, modified after the 29th of July major event
 - ✓ *16 systems did operate correctly*
 - ✗ *1 system did not operate correctly due to a wrong setting in two SEPAM*



Results of the 4th December test (2/2)

- Power balance of the assured networks
 - ✓ *Results similar to 2005 for Meyrin Diesel-generator sets*
- Check of the dynamic behavior of the Meyrin Diesel-generator sets on real and significant loads (pumping station BB6)
 - ✓ *Done*
- Check if all equipment is connected on the adequate network
 - ✗ *No feedback given by the users*



What needs to be done ? (1/2)

■ CNGS

⇒ BA4 : transfer of the EAD switchboard in TSG4 to the assured network.
For the time being : supplied from the normal network due to the lack of assured power. Not funded, not planned.

■ TI2, TI8

⇒ BA7, BA4 : transfer of the smoke extraction systems to the safety network.
For the time being : supplied from the normal network due to the lack of assured power. Not funded, not planned.

■ 3.3 kV safety network of SPS

⇒ Power balance to establish in the worst case



What needs to be done ? (2/2)

■ LHC

- ⇒ LHC5 : replacement of the 275 kVA Diesel-generator set installed for LEP by a more powerful set (750 kVA).
Funded and planned during 2007.
- ⇒ Inventory of the electrical supply of the safety loads : underway for the star points. **Type of supply and autonomy required to be specified by the users. Not funded.**
- ⇒ Replacement of the Cd-Ni battery sets of the 48 Vdc systems (balisage): autonomy available reduced to 70 % of the specified one.
Consolidation budget. To plan.



What could be done ?

- 3.3 kV safety network of SPS

- ⇒ install a dedicated Diesel-generator set in 3.3 kV in SE0 or dedicated 400 V Diesel-generator sets in SE0, BA1, BA2, BA4, BA5.
- ⇒ Upgrade of the low-voltage safety substation in BA4

Study to launch. Project not funded.

- SPS North Area

- ⇒ create safety substations for BA80, BA81, BA82 like done for the BA of SPS in 1999-2000. See SL-PS Technical note N° 15 (O. Bayard, May 1997). **Not funded.**



Questions ?

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