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Switchgear selection for a Switchboard incomer

PCS 03 Specification Seminar



CRITICAL POWER
POWER CONTROL & SAFETY
EXPERT SERVICES
ENERGY EFFICIENCY

THE GLOBAL COMPACT
WE SUPPORT

ENERGY SPECIALIST
SINCE 1922

Socomec Group – short introduction

Socomec is an independent manufacturer providing specialist solutions for the power industry.

- Founded in 1922
- €470 m turnover
- 3100 people
- Global commercial support - 27 subsidiaries
- Global manufacturing facilities
  - 5 plants in Europe (France and Italy)
  - 1 plant in Tunisia
  - 1 plant in India
  - 2 plants in China









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Socomec Group – short introduction

Our four expertise:

> **High quality power supply**

Ensuring the availability of high-quality power for critical applications

> **Switching and protection**

Managing power and protecting individuals and property

> **Expert Services**

Enabling available, safe and efficient energy

> **Energy performance solutions**

Improving building and facility energy efficiency



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Socomec Group – short introduction

Targeted markets:

> Industry

> Non-critical buildings

> Critical buildings

> Infrastructures

> Integrators

> Renewable energies








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Glossary

- CB: Circuit Breaker
- LBS: Load Break Switch
- O/L: Overload
- S/C: Short circuit
- PnB: Panel Builder
- Tfo: Transformer

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Contents of the seminar

Part 1: Scope

Part 2: The three questions

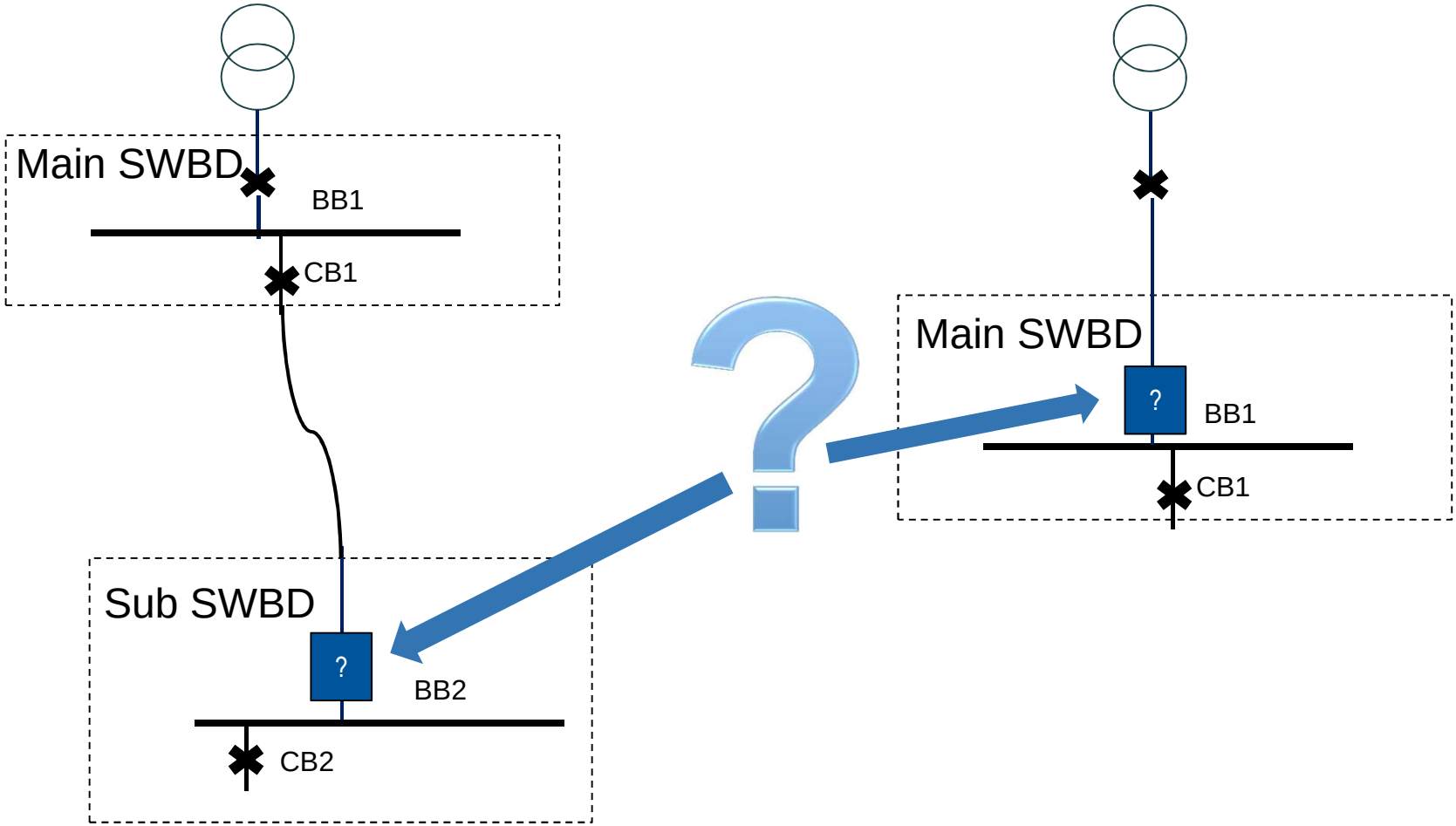
Part 3: Other solutions

Part 4: Synthesis

Appendixes

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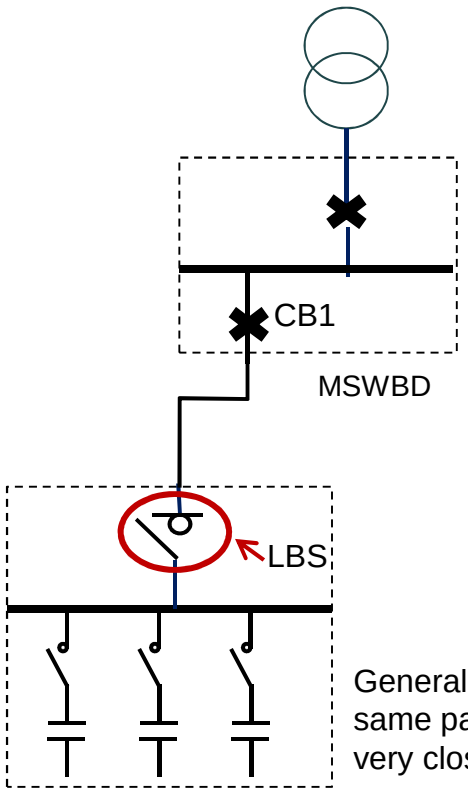
What to put as incomer gear?



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The PFC Capacitor panel GOOD example



- Generally the PFC Capacitor panels, HVAC panels, UPS are equiped with a LBS Disconnector as incomer.
- They are excellent examples of a good design!

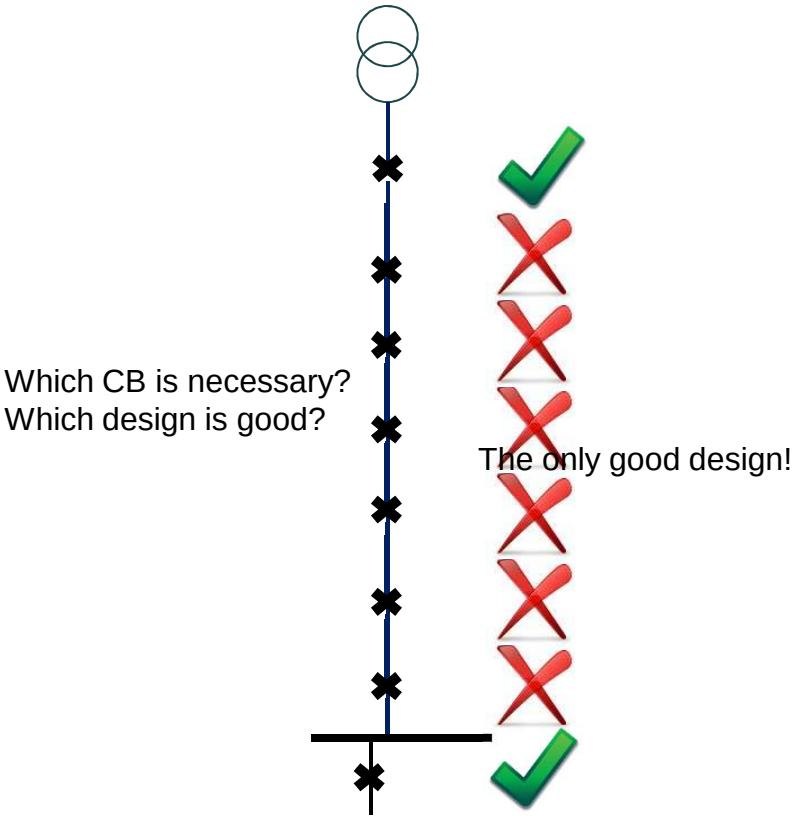




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Protection schemes

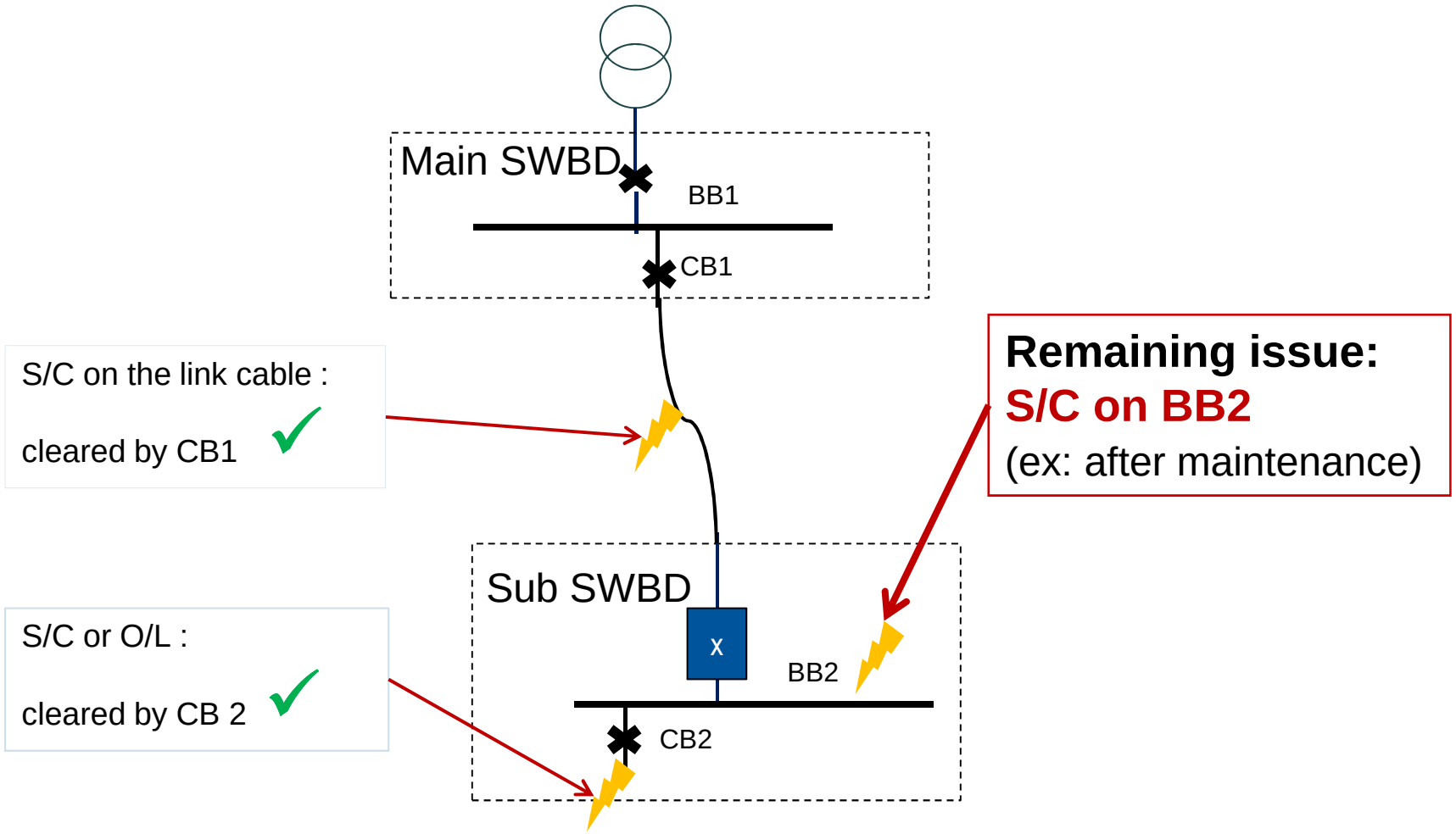


- Starting from a caricature of a bad design we understand the good one.
- This common knowledge is based on sound Standards implementation …

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What is really technically at stake ?

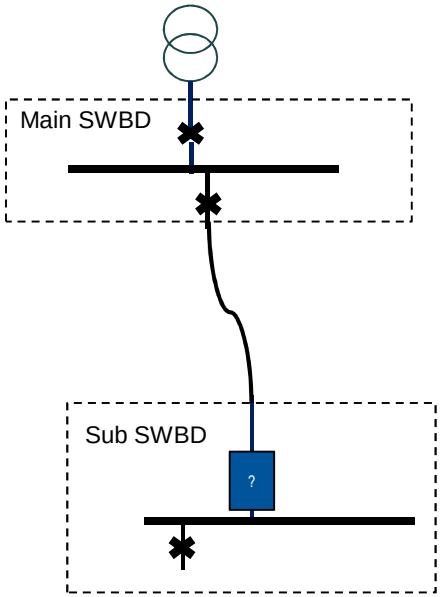


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Just three questions…

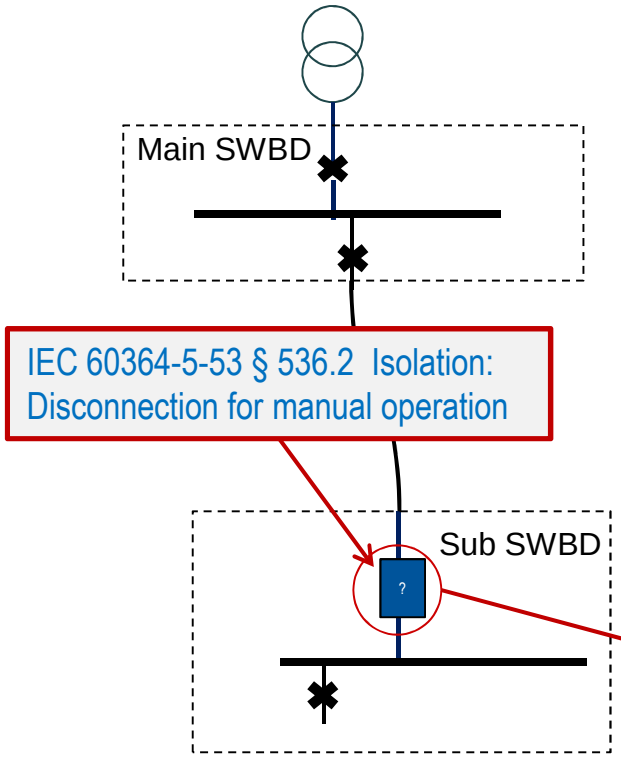
- What is the IEC Standard requirement on a SWBD incomer?
- What is the IEC Standard requirement to add a CB in a circuit?
- What are the consequences if I put 2 CBs of same rating in series?



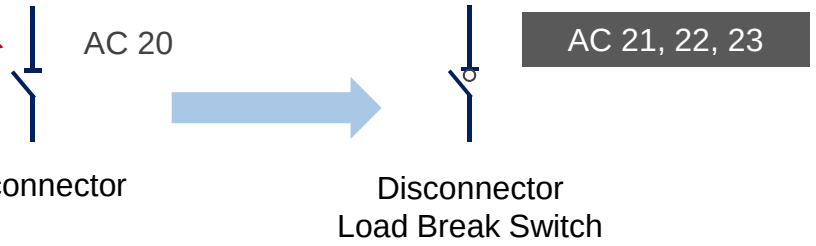
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1) IEC requirement on SWBD incomer: DISCONNECTION

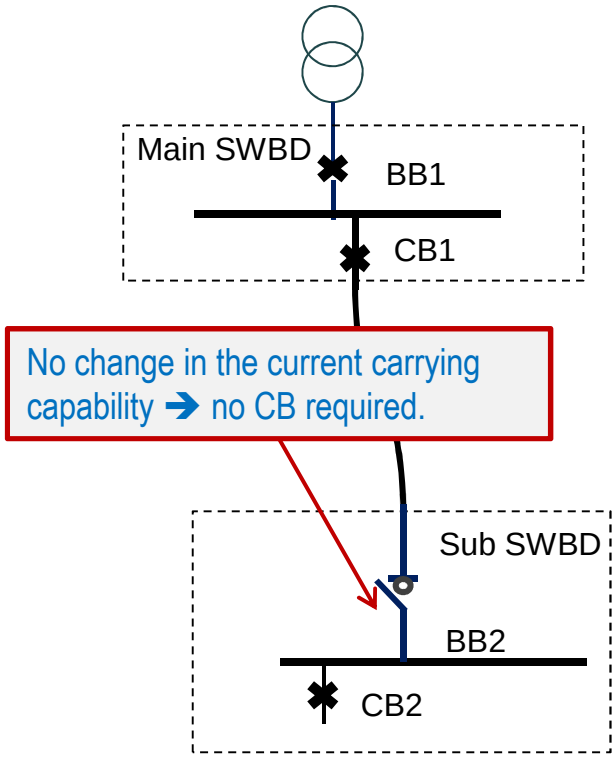


- IEC 60364-5-53 § 536.2 requires a Disconnector for isolation
- Disconnector = IEC 60947-3
  - A LBS or CB can be a Disconnector
- 4 poles in TNS, TNC-S, IT
- A LBS Disconnector is the de facto standard.
  - A Disconnector can't switch ON LOAD.
  - Simple operation ➔ Disconnector can be operated ON LOAD.



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2) IEC requirement to add a CB:
a change in the current carrying capability

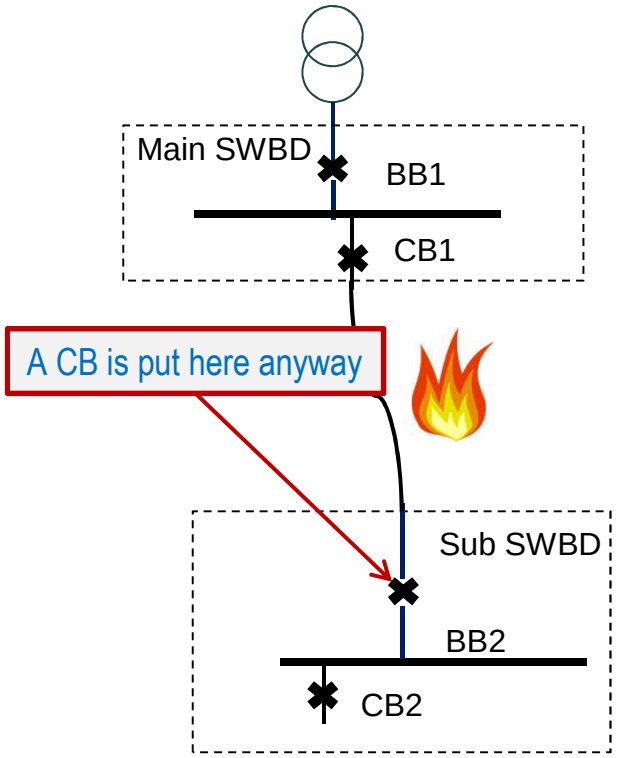


- IEC 60364-4-43
  - O/L § 433.2
  - S/C § 434.2
- New protection device only when there is a change in the current carrying capability
- CB1 & BB2 are of the same rating ➔ No CB required

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3) If 2 CBs are in series: no selectivity, no limitation curves, worse protection against S/C, RISKIER operation



- Anyway, a CB is put on the incomer
- OR a LBS of the same technology than CB1(same contact system)
- Necessarily of the same rating than CB1 (same current).
- Same manufacturer, then same contact system.

WHY

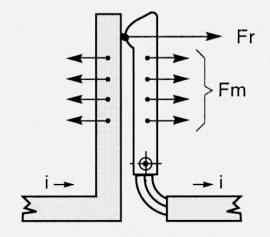
Remember, we are on a S/C issue

- NO selectivity Vs CB1
- NO limitation curves
- Risk of fire: Less protection against S/C.
- Safety in operation is at stake

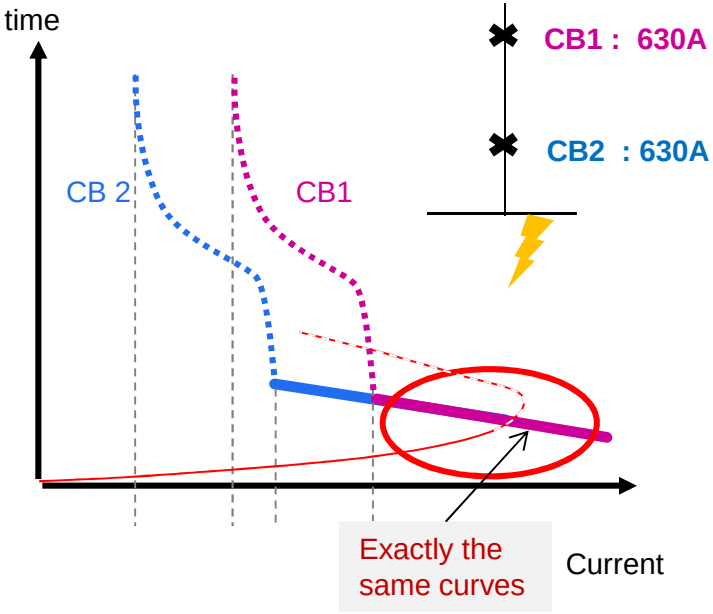
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3) Consequences if 2 CBs are in series: NO selectivity



SAME contact system!



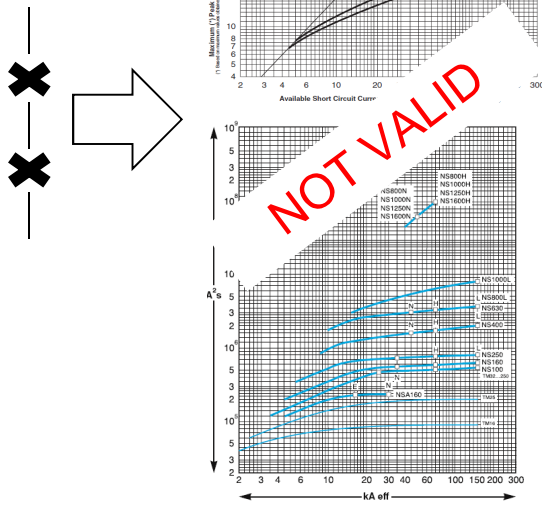
- In case of Short Circuit, we cannot predict which CB will trip first.
  - Both CB curves are strictly identical in the S/C area (same contact system).
- Setting the tripping parameters in case of overload or short delay is useless.
  - As no fault will occur in the region of the settings.

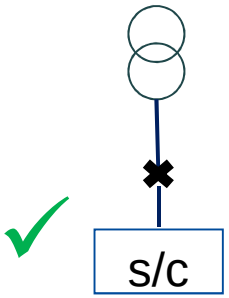
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3) Consequences if 2 CBs are in series: NO limitation curve, worse protection

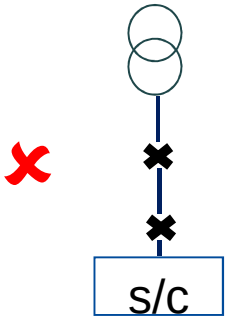
- with 2 CBs or more, the Designer responsibility is at stake: no available limitation curve.





➔Max limitation, min let through energy

➔ Curves are OK



➔ No curve

➔ More energy in the BB

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3) Consequences if 2 CBs are in series: Safety in operation is at risk

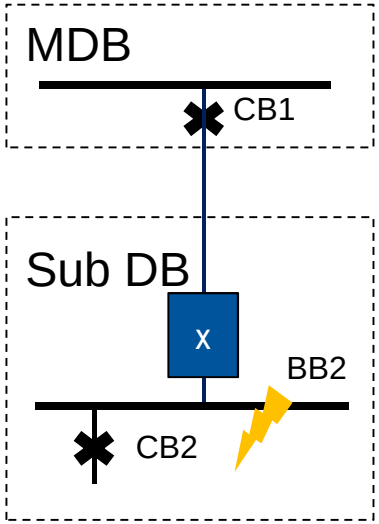
- Closing the incomer on a short circuit (1)
  - Bears lethal consequences with a CB incomer
    - Is absolutely safe with a LBS incomer



400 A S/C clearance



250 A S/C clearance





250 A withstand

CB ✘

LBS ✓

(1) A fault in a panel occurs after maintenance in 80% of the cases

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Part 2

Additional LBS advantages

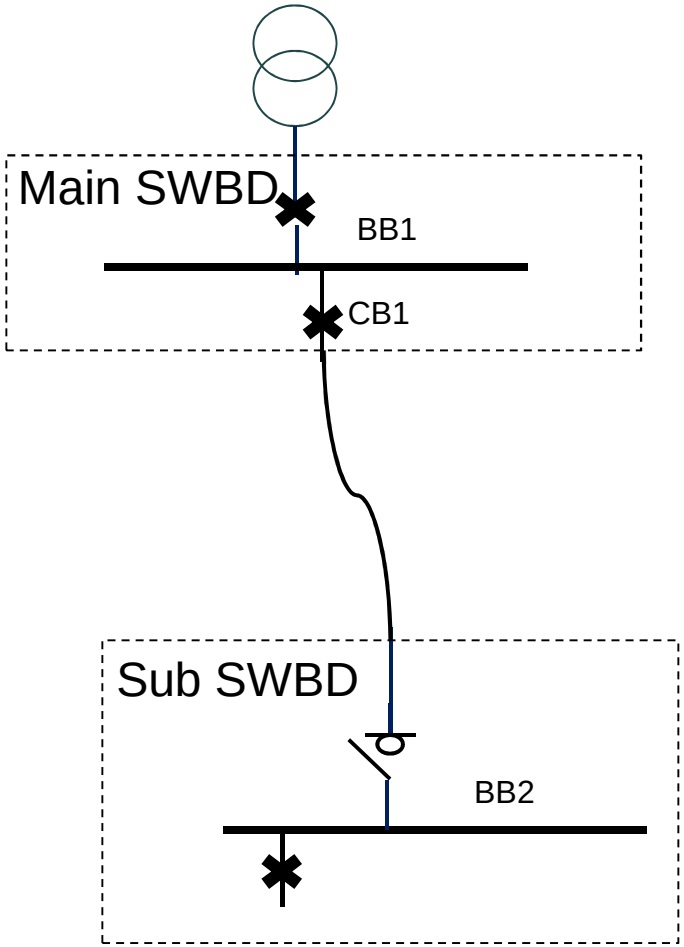
- **Reliability**: Incredibly high LBS MTBF
  - In thousands of years, tens of times the CB ones
- **Maintenance**: No maintenance on LBS, MUST on CB
- **External handle with padlocking**: basic offer on LBS, additional, bulky and less safe accessory on CBs.

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The sound solution from the Standards







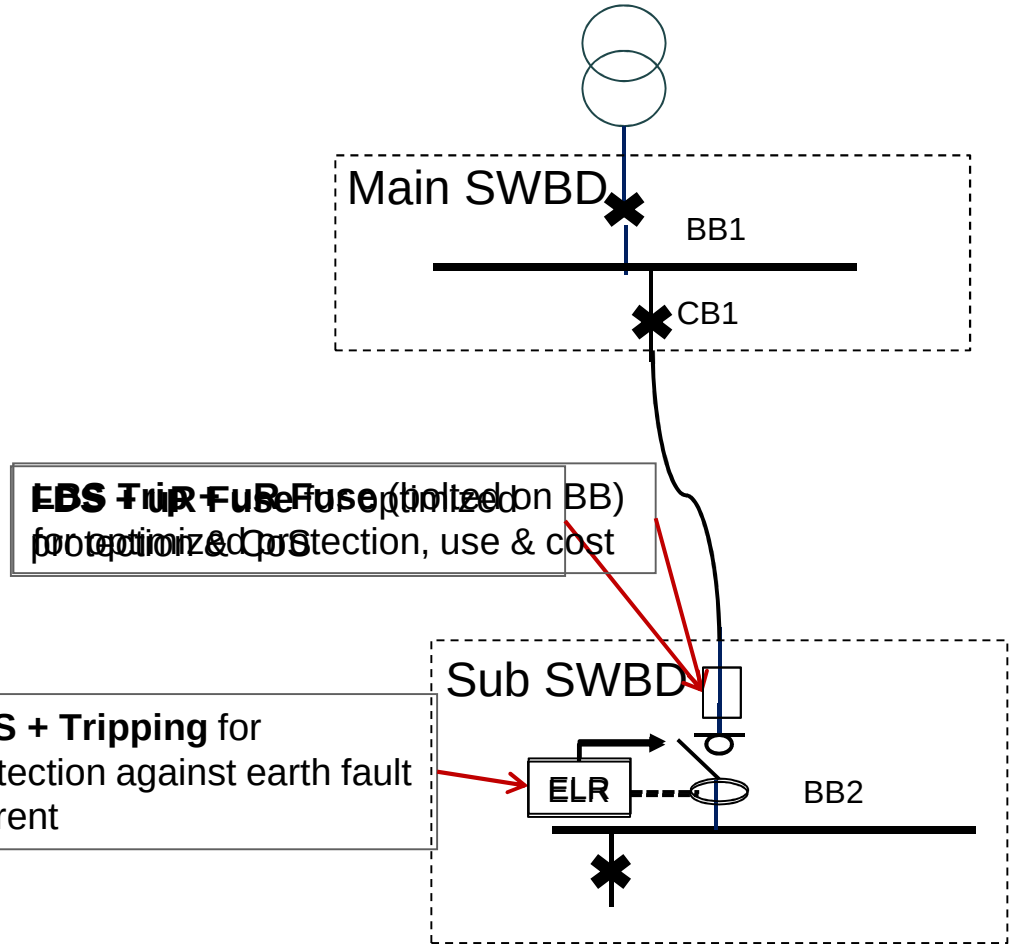
CB ✓ LBS ✗

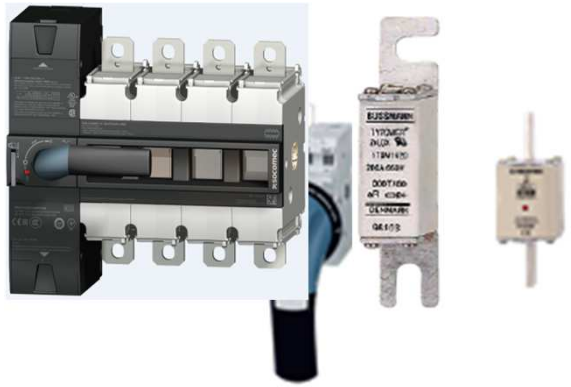
LBS ✓ CB ✗

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Some other solutions





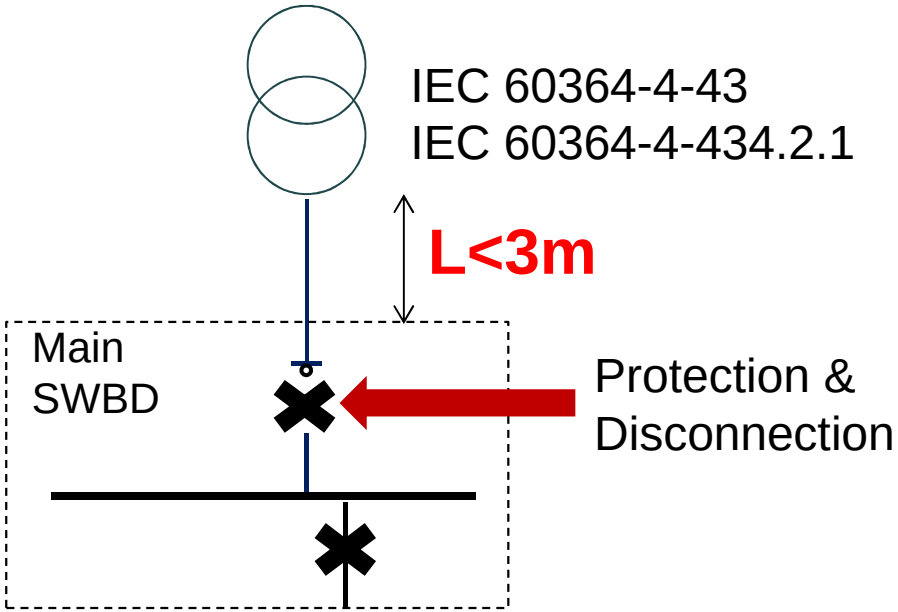
LBS + tripping : for E protection ?

- ❑ earth leakage detected at the panel level. Upper CB doesn't trip.
- ❑ Inosys
- ❑ Inosys + Bolted uR fuse

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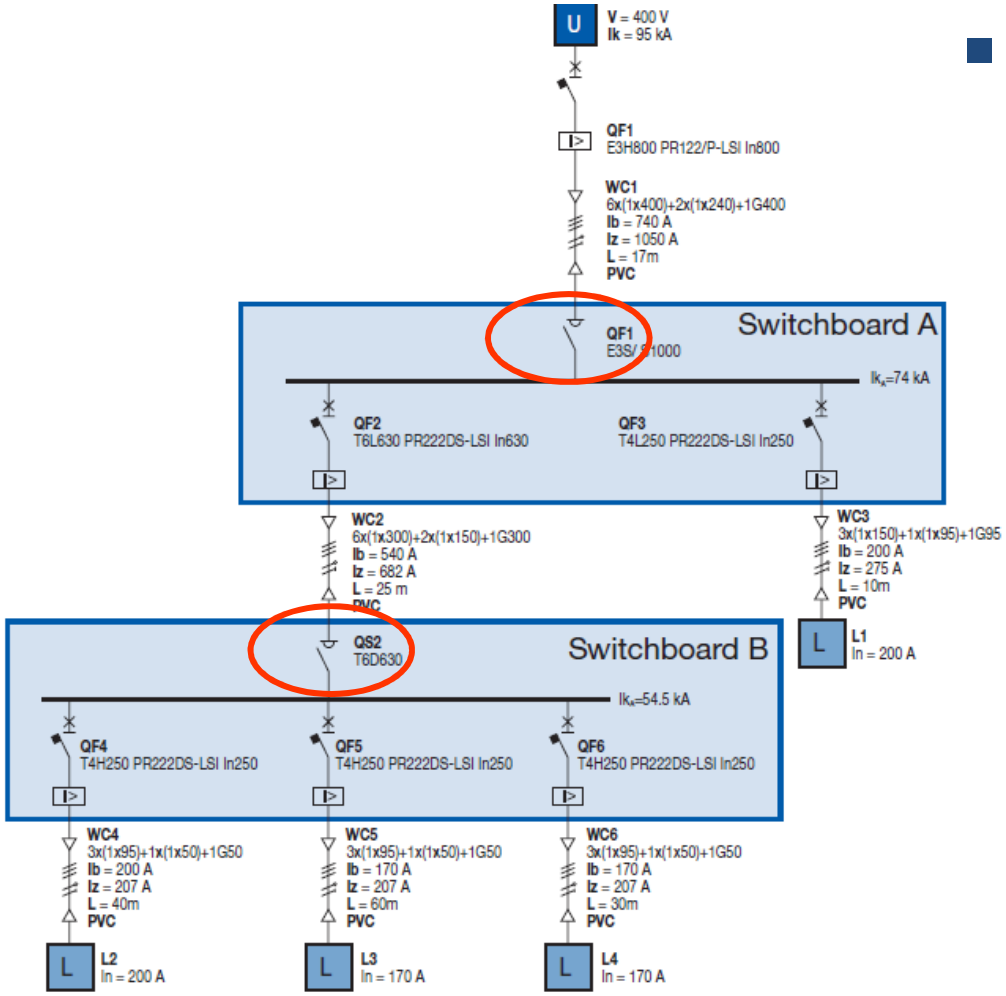
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Exception for the Main incomer



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Other manufacturers promote LBS solution

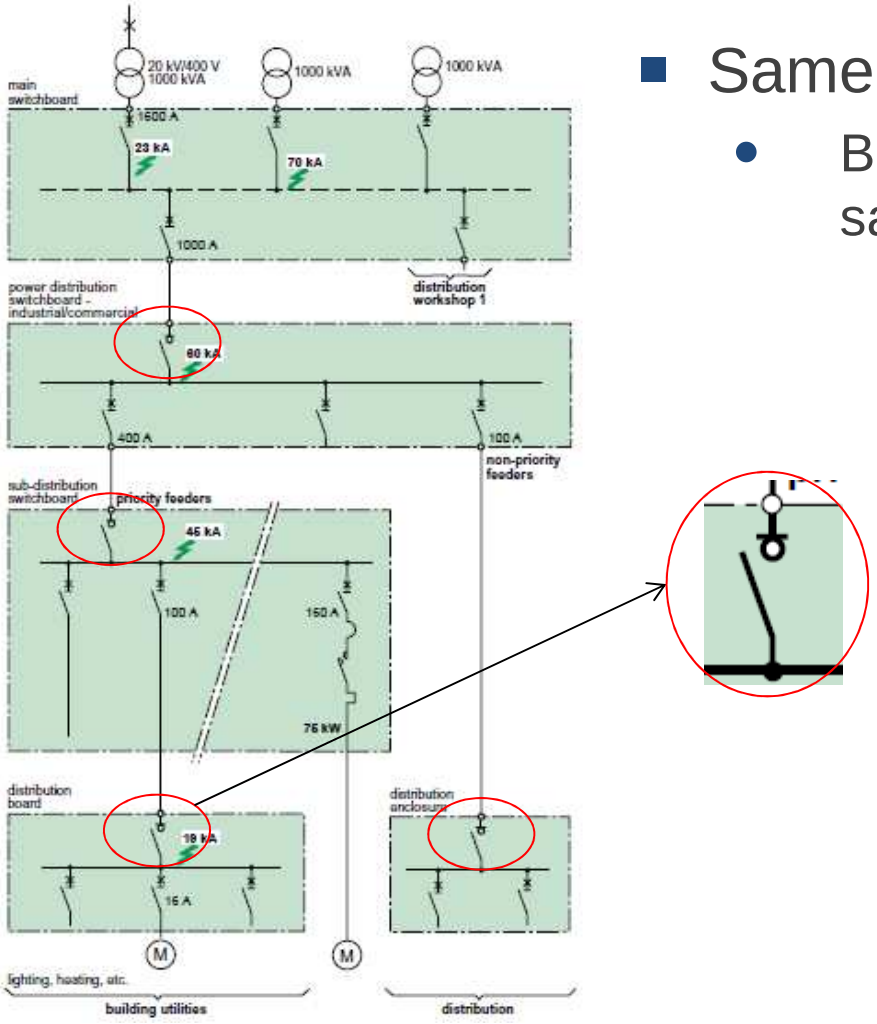


- Example ABB: extract from *ABB LV technical application document*.
  - ABB has a TRUE LBS (OT) of different technology than CB.

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Other manufacturers promote LBS solution

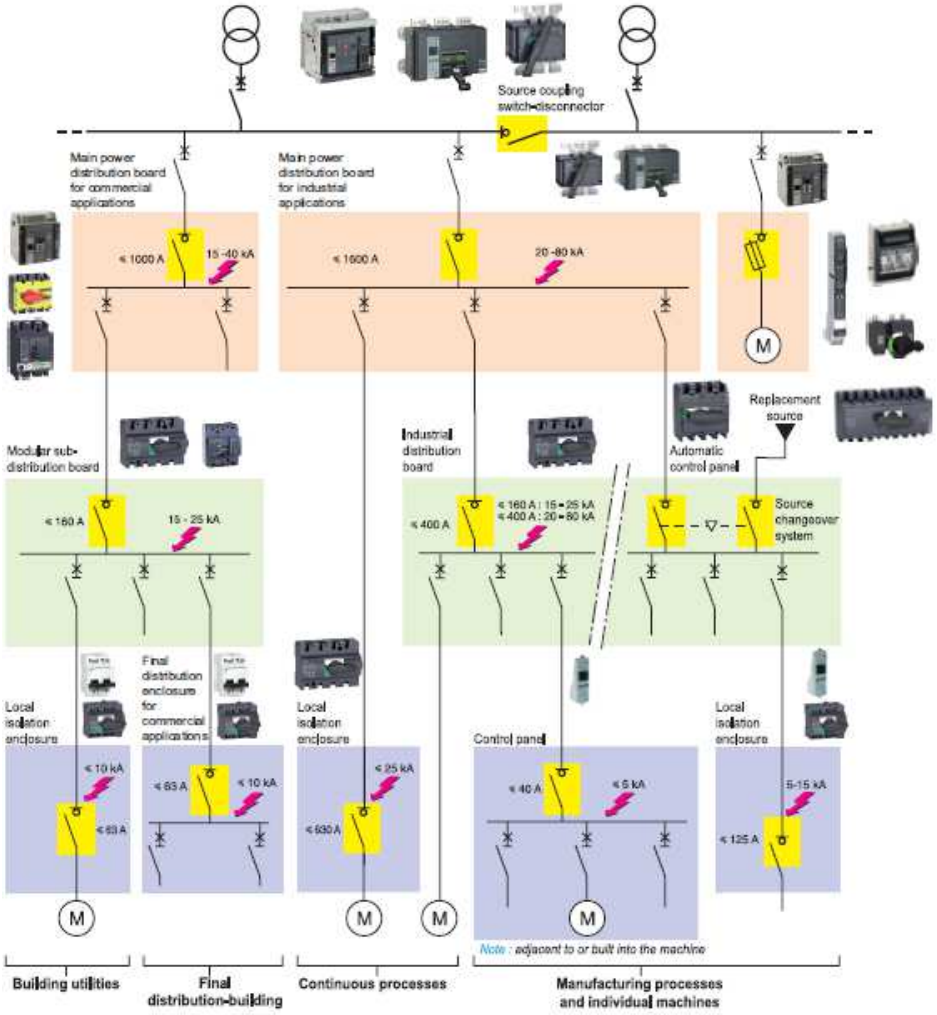


- Same for Schneider electric.
  - But, Compact disconnector: same contact system…

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Other manufacturers promote LBS solution



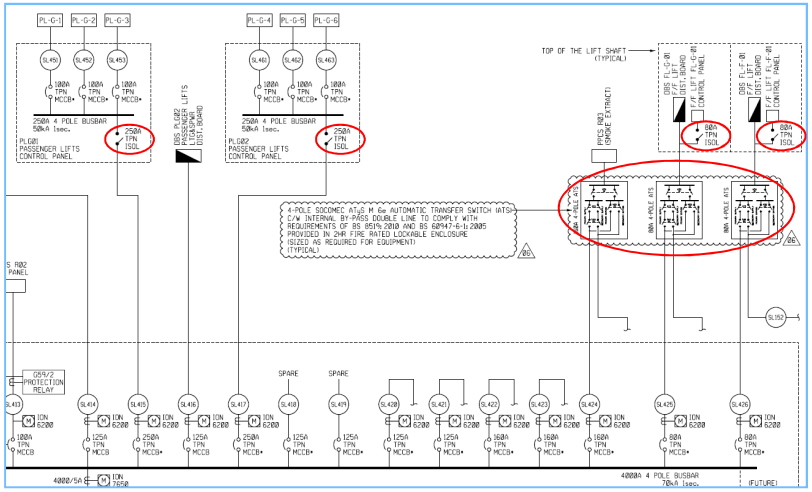
- Schneider electric: In more than one document!
  - Here with a true LBS, with a contact technology of LBS.

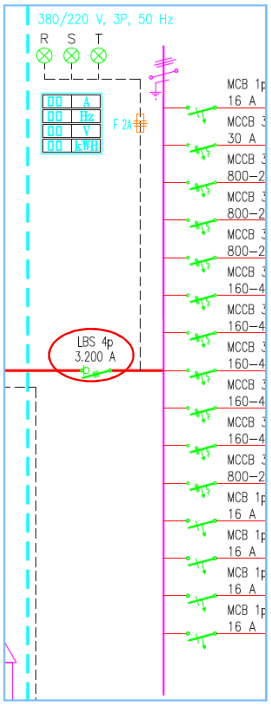
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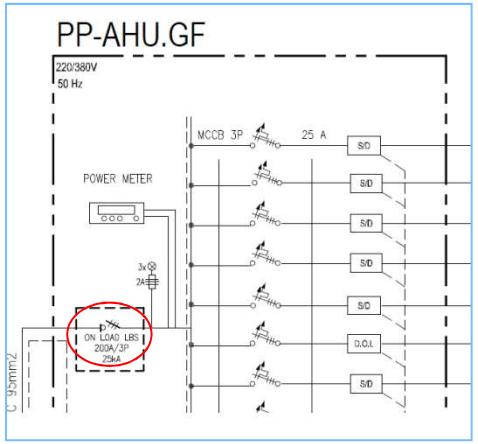
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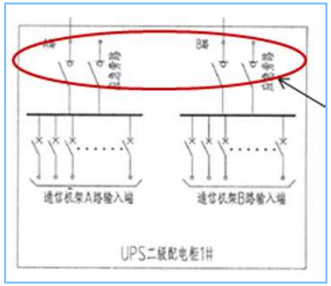
Part 3 Synthesis

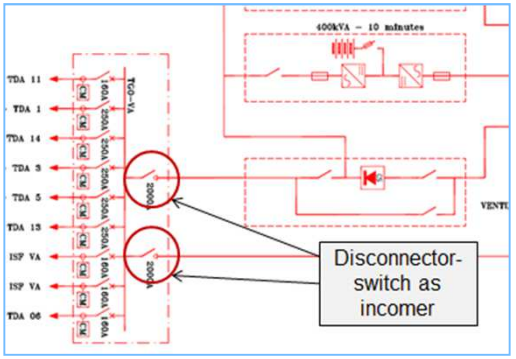
Some real examples from Europe and Asia

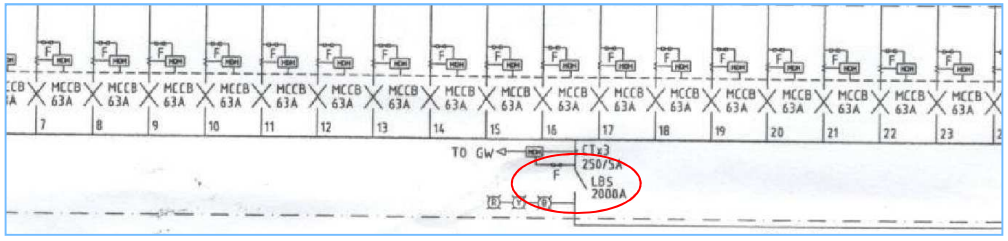










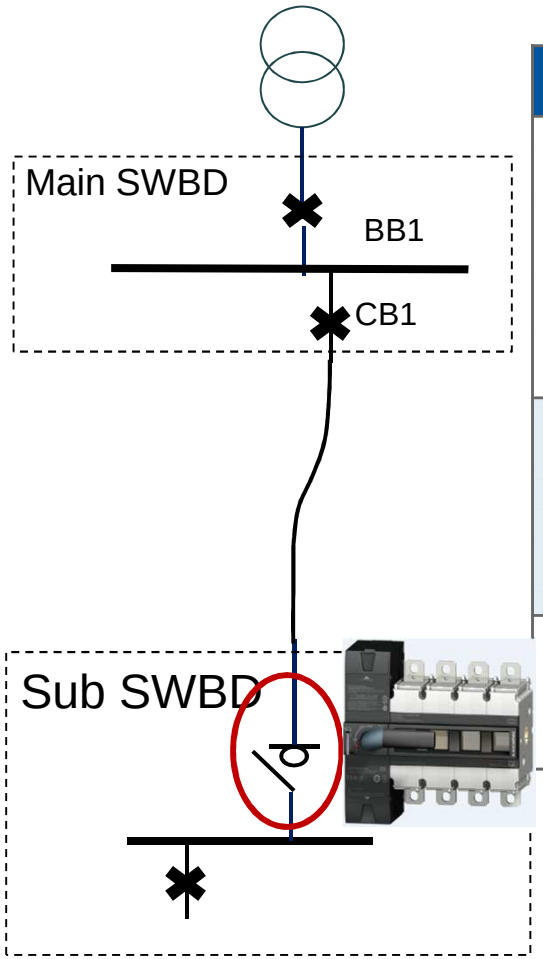


More real examples

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Sub switchboard incomer - Overview



Actor	LBS	FDS + uR fuse	CB
Designer	Consistent with the standard Clean selectivity (less energy)		Can't take responsibility Risk in case of S/C @ BB2
		Better S/C protection	
	Many options on the handle color, lever, IP		
PnB	Lower cost**: cost / up to 4**		Easy ordering process (Same product)
	Aesthetic Mounting with external handle Easier BB design with Ext. Handle		
End User	Easy to operate Higher safety (Door I/L) Higher reliability		Danger for operator in case of closing CB on S/C at 50 cm distance

And this also why ATS switch based are an optimized solution…

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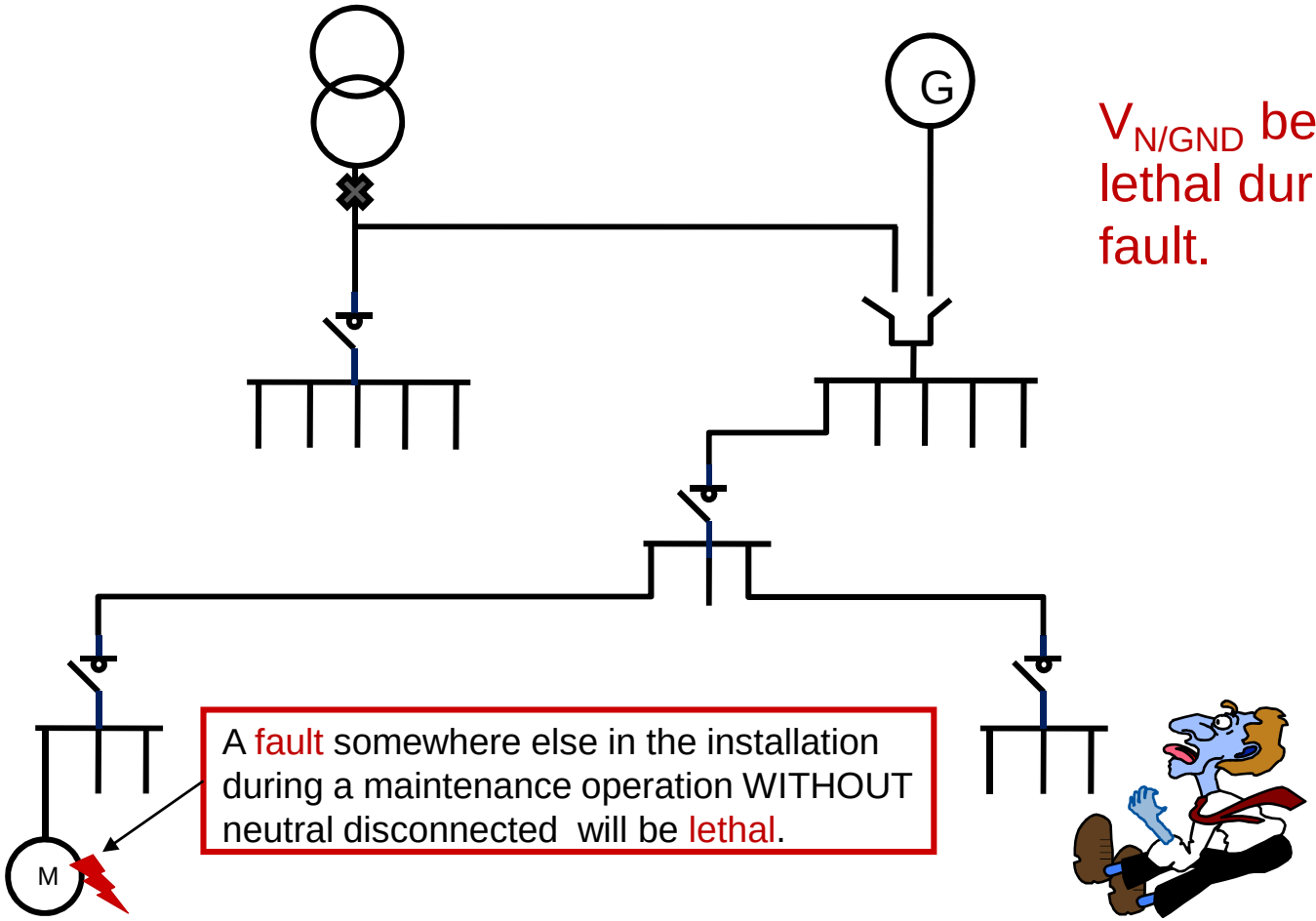


Appendix

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4 poles Disconnectors in TN systems: Neutral can be dangerous



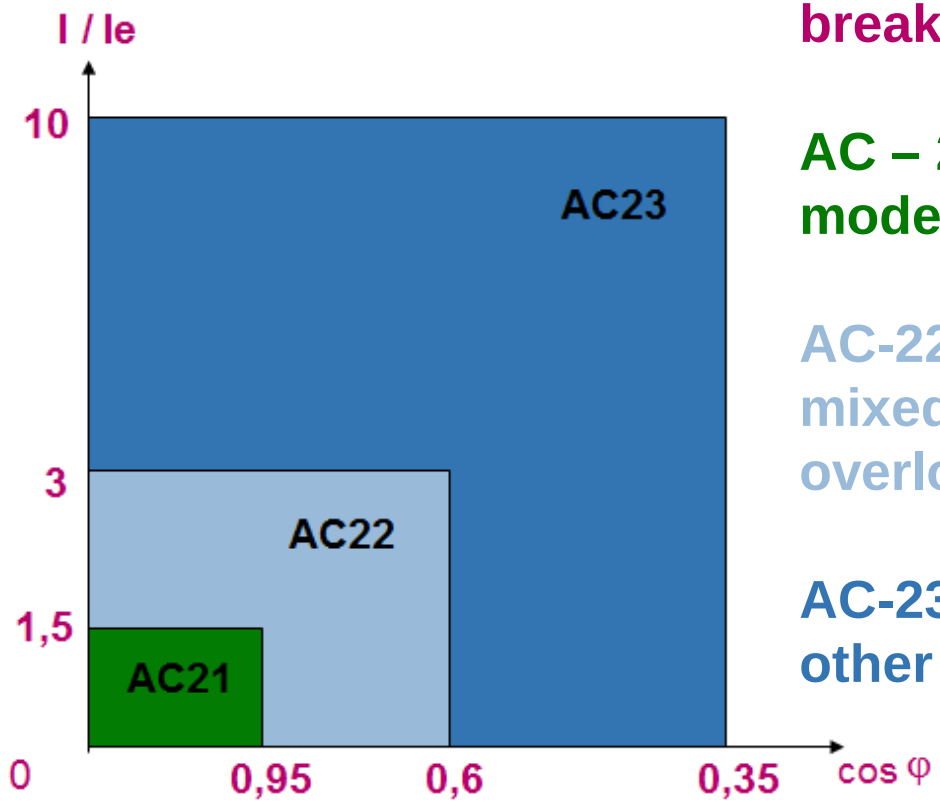
$V_{N/GND}$ becomes lethal during the fault.

A fault somewhere else in the installation during a maintenance operation WITHOUT neutral disconnected will be lethal.

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Different categories for different types of load



AC-20 Off-load making and breaking

AC – 21 Resistive loads including moderate overloads

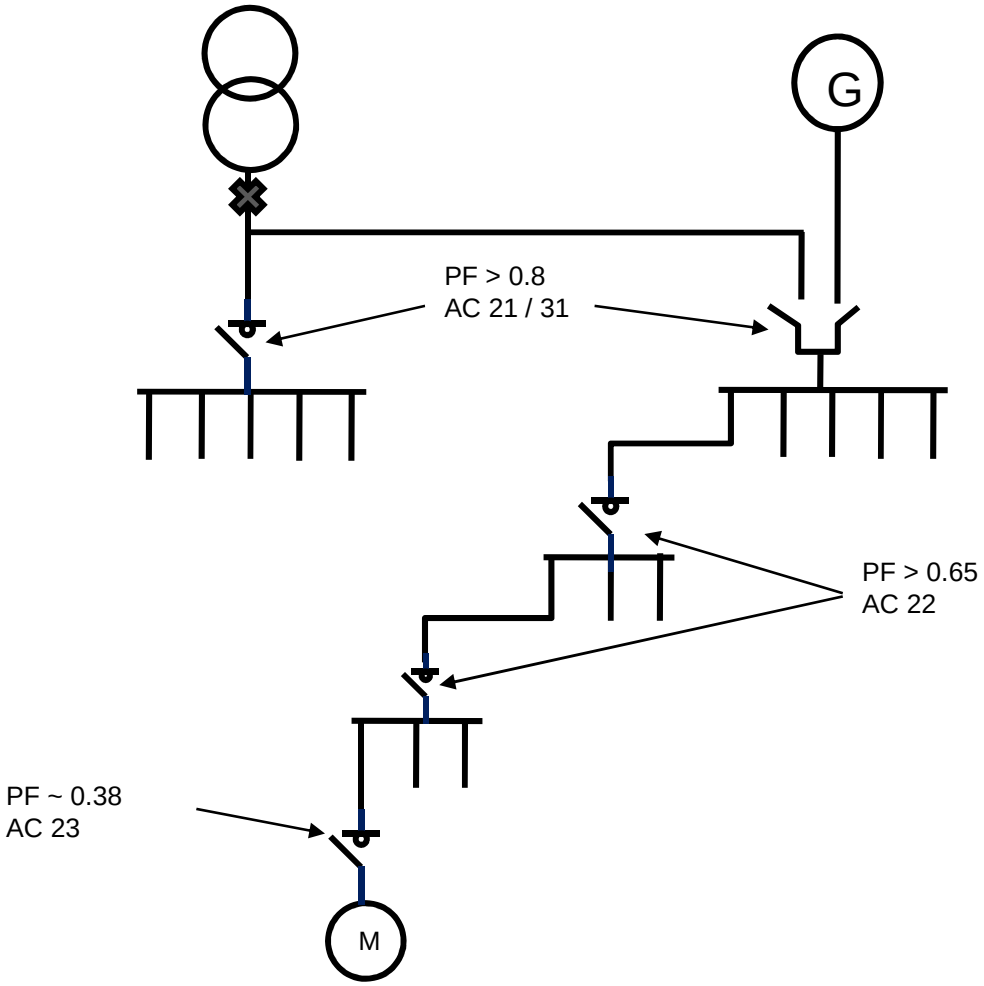
AC-22 Inductive and resistive mixed loads including moderate overloads.

AC-23 Loads made of motors or other highly inductive loads

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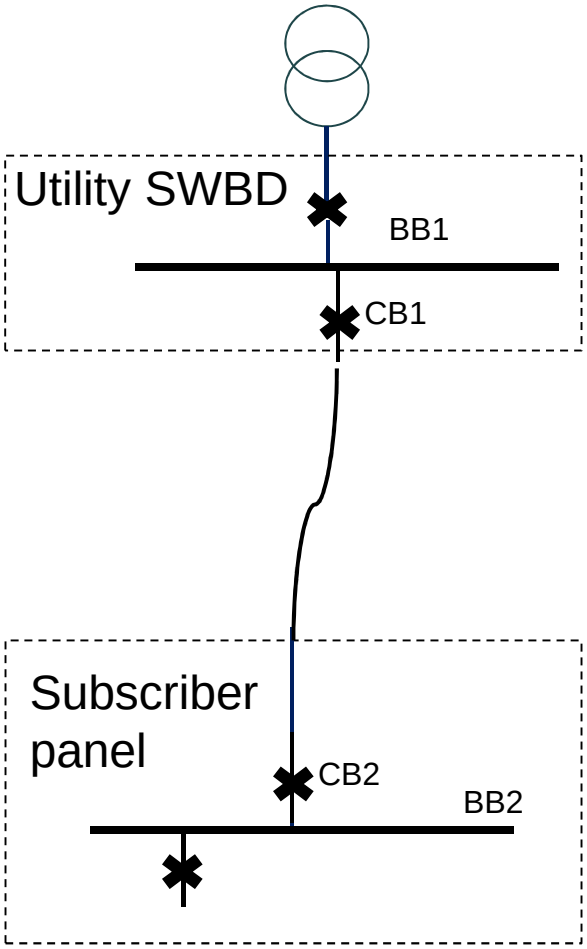
Consequences on SLD: you can optimize.



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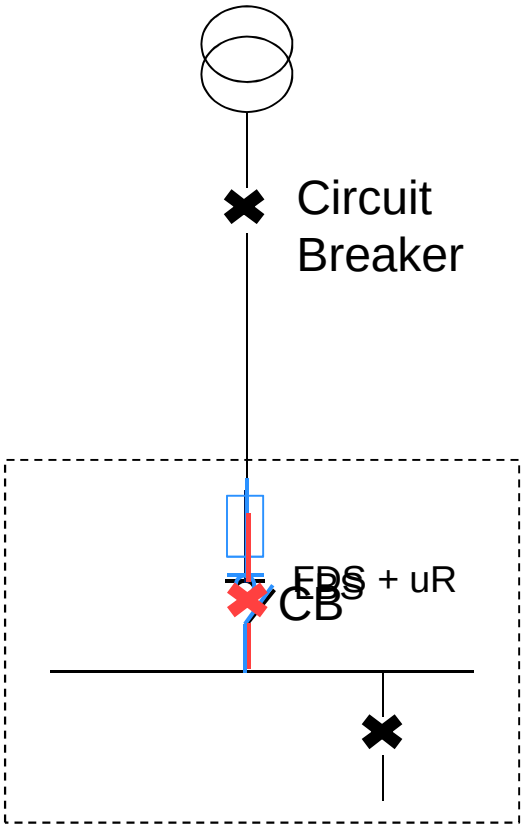
Where this habit comes from ?



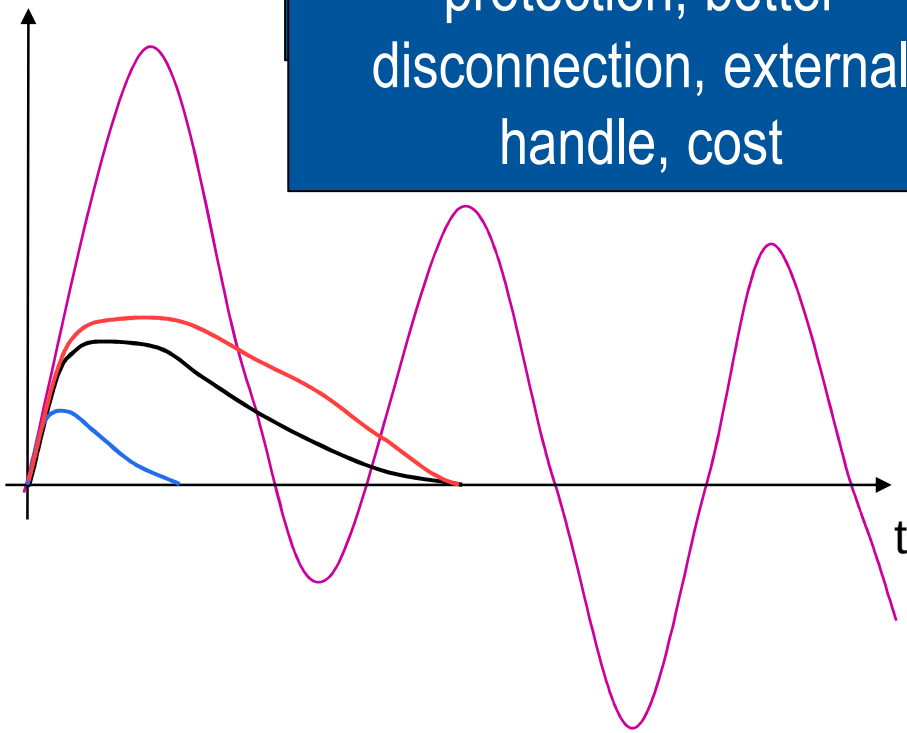
- From the Public Distribution scheme:
  - public distribution local standards ➔ put a CB as incomer of the subscriber panel.
  - FOR CONTRACT MANAGEMENT, not for protection:
    1. to allow a tripping on power above the utility contract.
    2. Or to allow a tripping on earth leakage in the subscriber panel.
  - Those reasons don't apply in private facilities
- From the market habits:
  - Specification push of CBs "947-3 compliant"…
  - One stop shopping for PnB.
  - "not so severe" issue… Not more & not less than any protection issue in a panel. Why ignoring this one?

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Sub Switchboard incomer – PROs & CONs

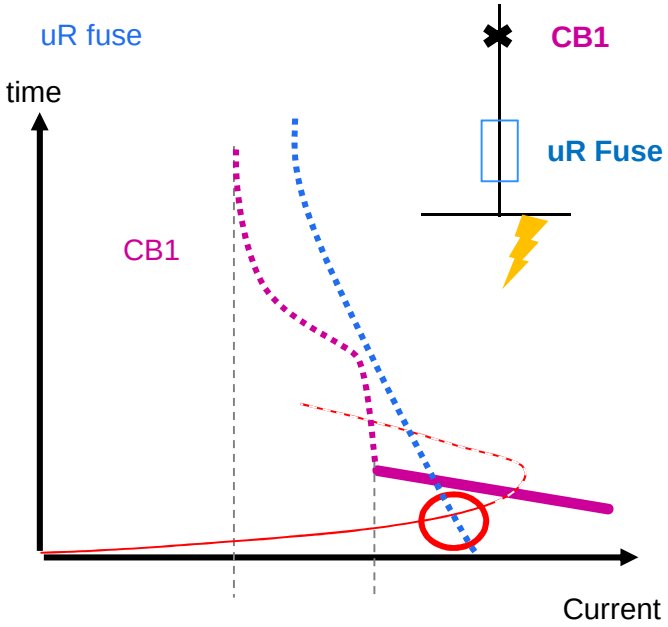


FDS: NO conflict, better protection, better disconnection, external handle, cost



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Consequences if 2 CBs are in series: no selectivity

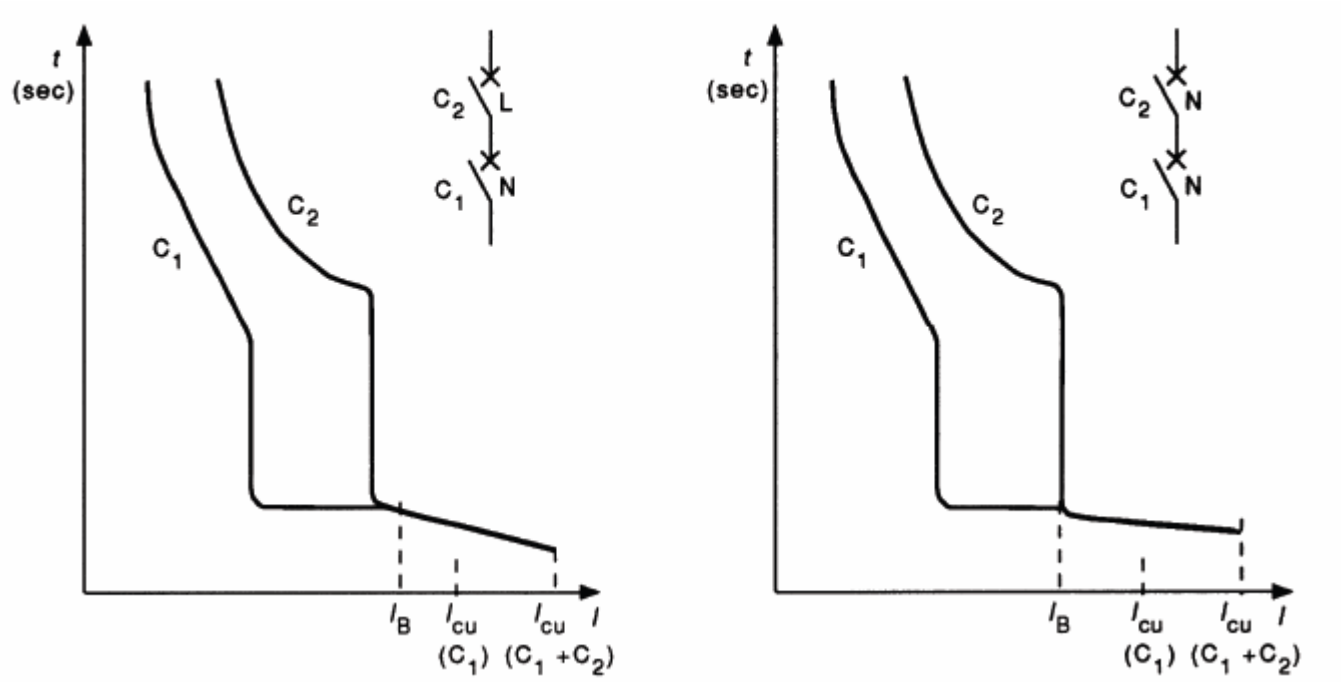


- A CB upstream and a uR fuse downstream are selective.
- The short circuit current will cross the uR curve well before the CB curve.
- The uR fuse will have blown out before the contacts have moved.

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IEC 60947-2 Appendix A - 2 CB N & N

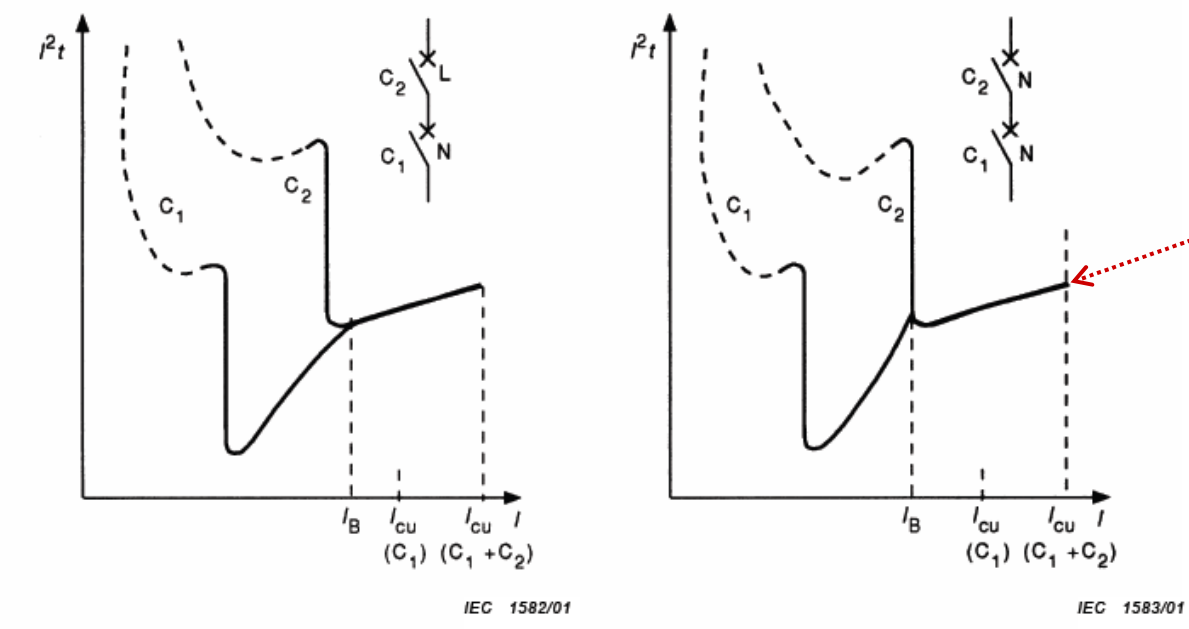
- 2 identical CBs have the same curve beyond IB

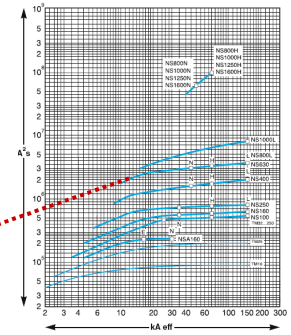


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IEC 60947-2 Appendix A - 2 CB N & N





Tests must be done beyond IB

C_1 = Non current-limiting circuit-breaker (N)

C_2 = Current-limiting circuit breaker (L)

C_1, C_2 = Non current-limiting circuit-breaker (N)

I_B = Take-over current

NOTE 1 Where applicable, restoration of supply by C_2 occurs.

NOTE 2 I_{cu} (C_1 + C_2) ≤ I_{cu} (C_2)

NOTE 3 For values of $I > I_B$, the curve is that of the association (shown in bold) for which data must be obtained by tests.

Figure A.4 **Figure A.5**

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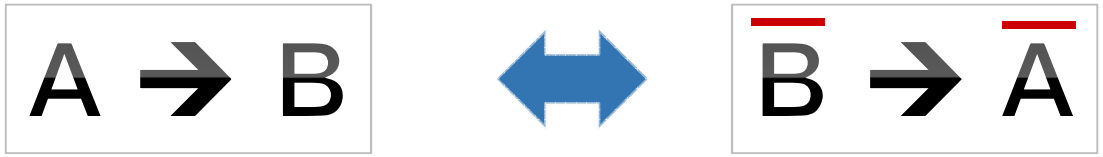
And then more energy in the Bus Bar

1 CB curve is *safer* than the 2 CBs equivalent curve.

A

CAN use the 1 CB curve in a 2 CBs configuration.

B



IEC is used to practice that way. The best example is the IEC 61439, where this principle is widely used.

CANNOT use the 1 CB curve in a 2 CBs configuration.

$\overline{B}$

1 CB curve is **NOT *safer*** than the 2 CBs equivalent curve.

$\overline{A}$

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And then more energy in the Bus Bar

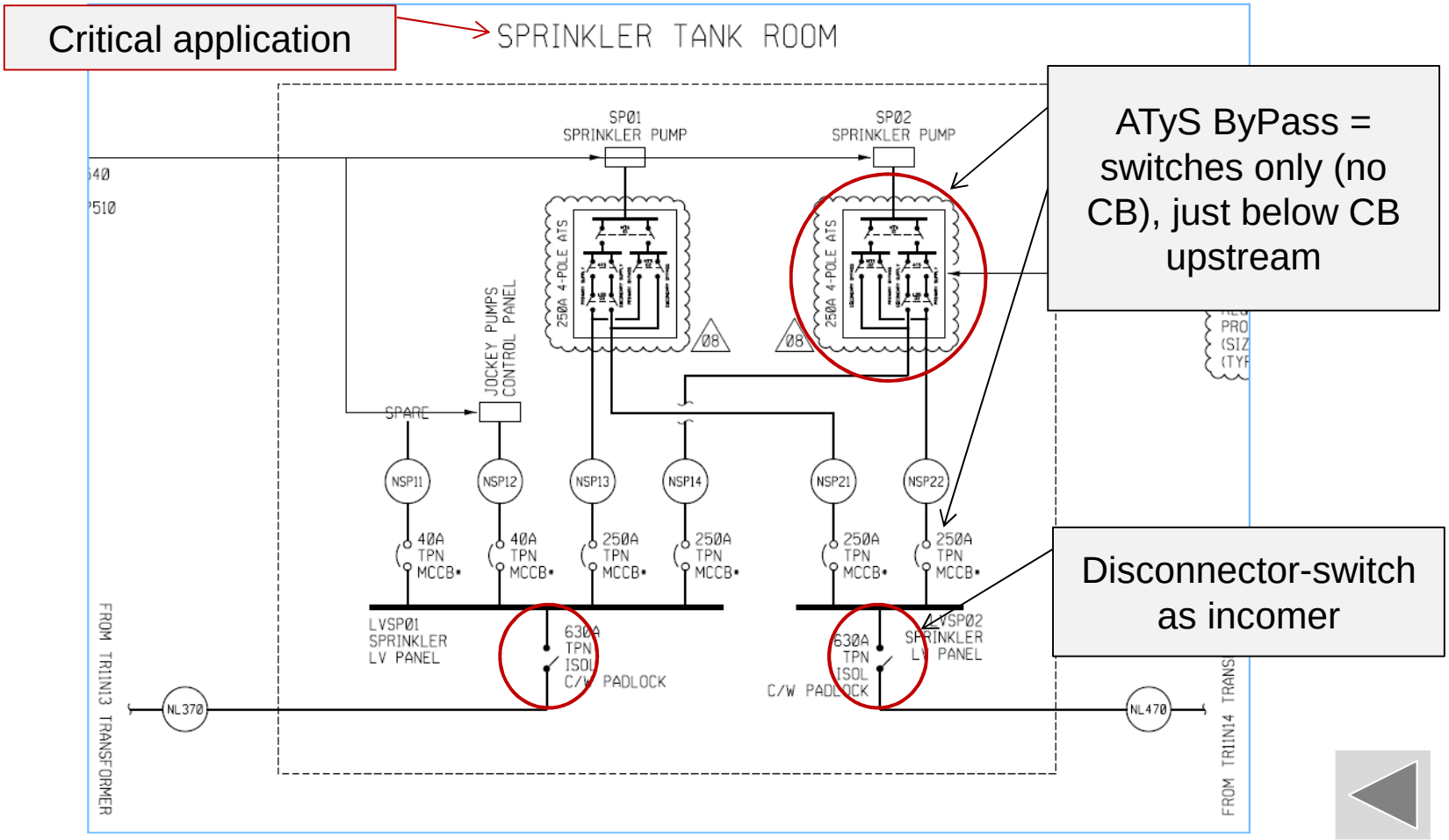
- With 2 CBs in series,
- IF the curve of ONE CB in the circuit is *as safe or safer* than the equivalent curve of TWO CBs
- THEN IEC body would have authorized the use of the “one CB curve”.

A → B ⟺ NON B → NON A

- IEC DOESN’T authorize the use of the “one CB curve”.
- THEN the curve of ONE CB in the circuit is NOT *as safe or safer* than the equivalent curve of TWO CBs.

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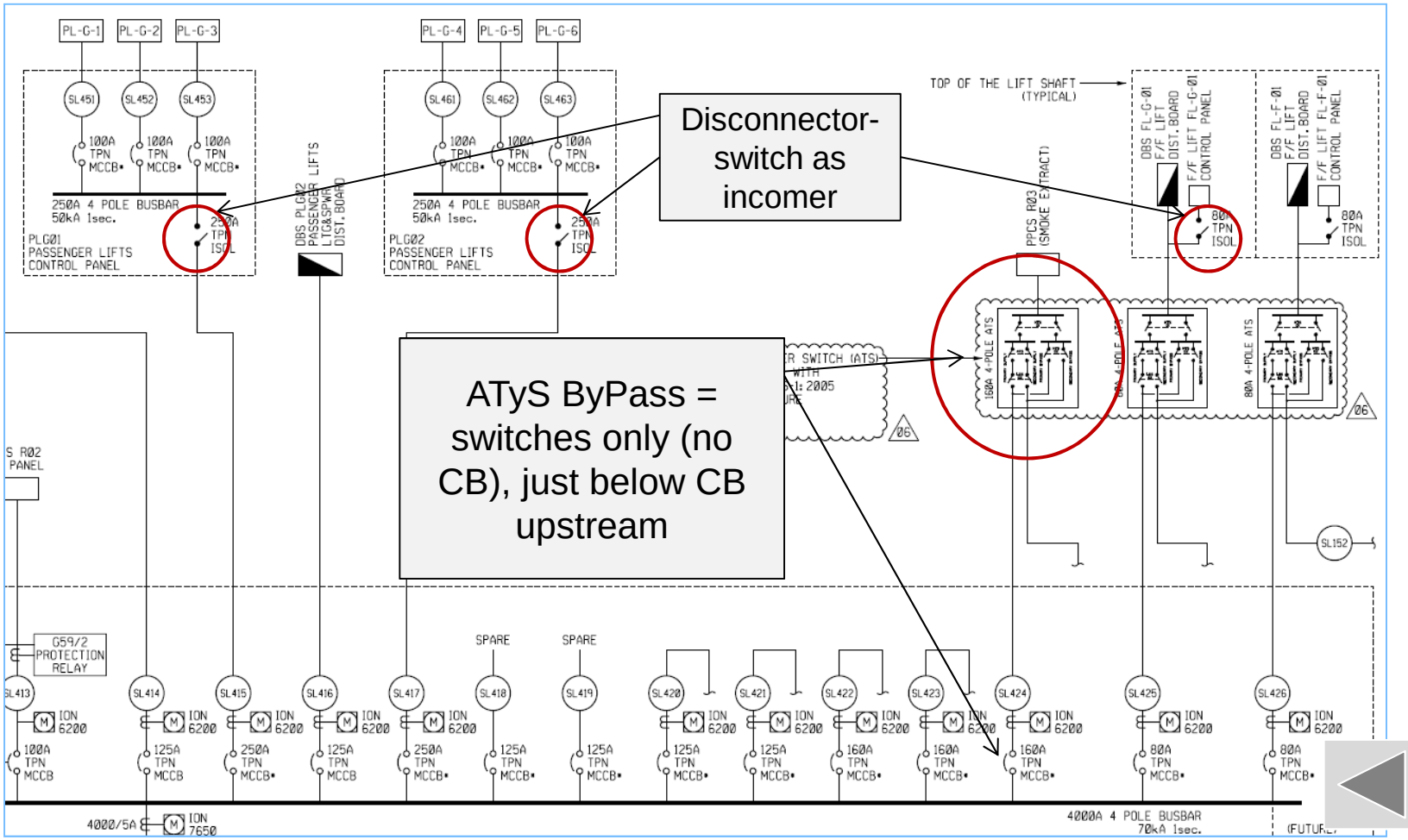
European example of LBS incomer (Retail)



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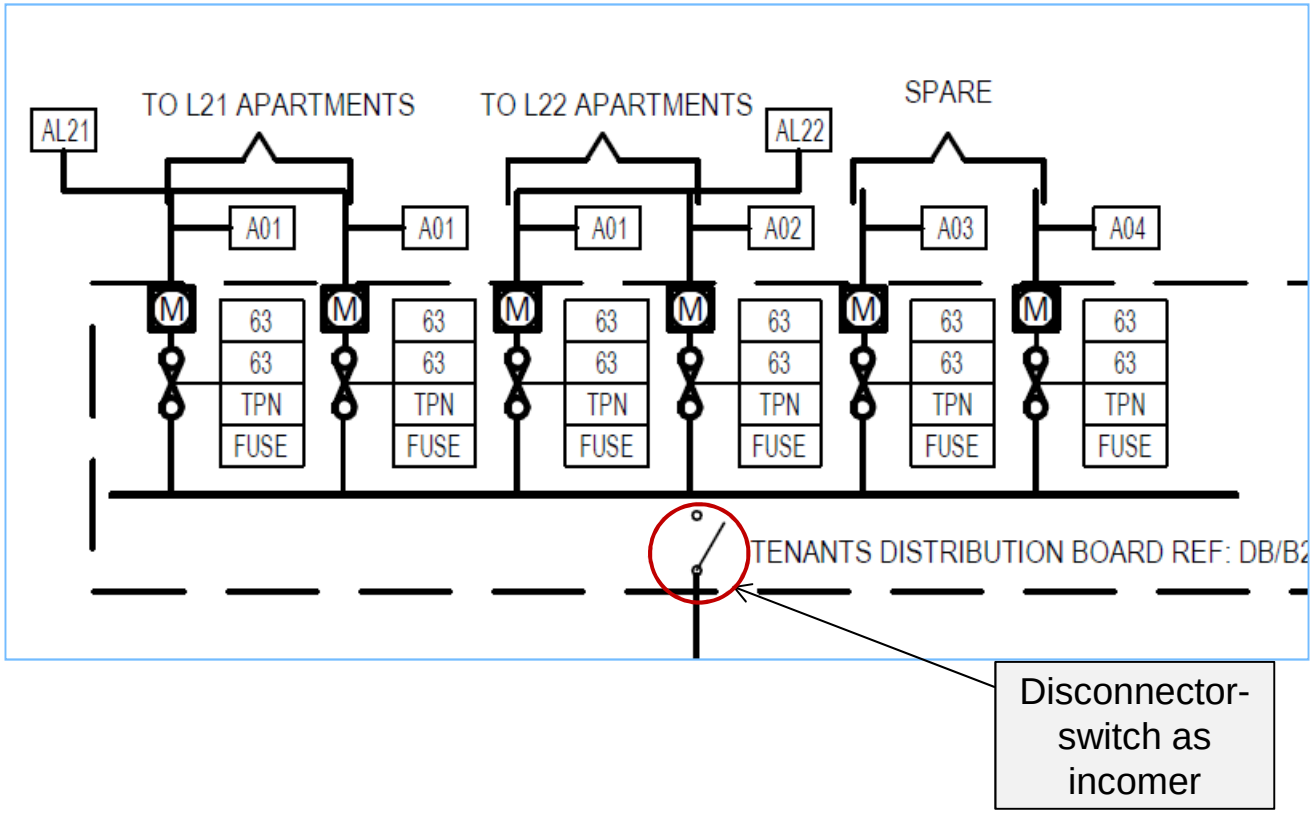
European example of LBS incomer (Retail)



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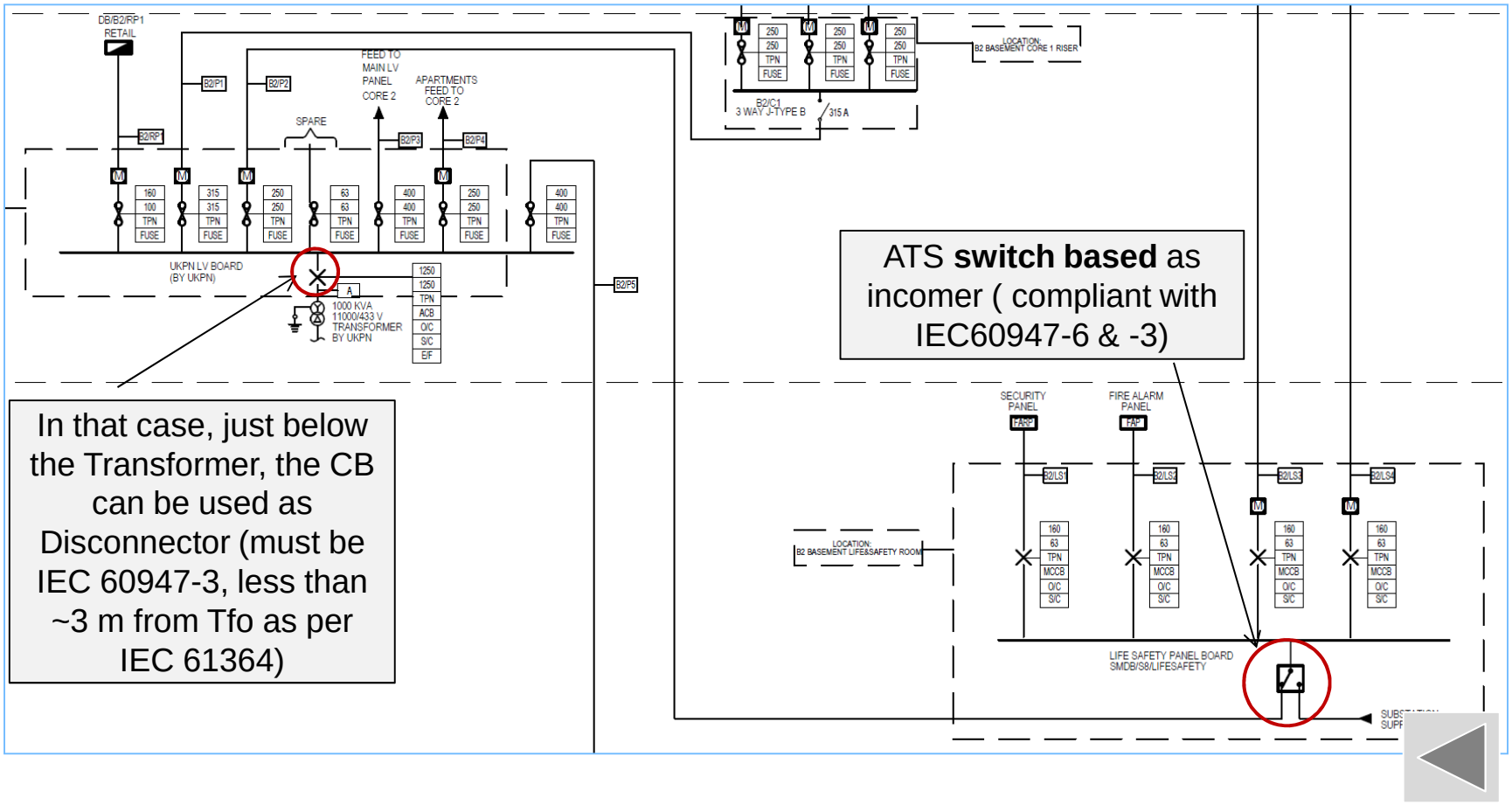
European example of LBS incomer (Building)



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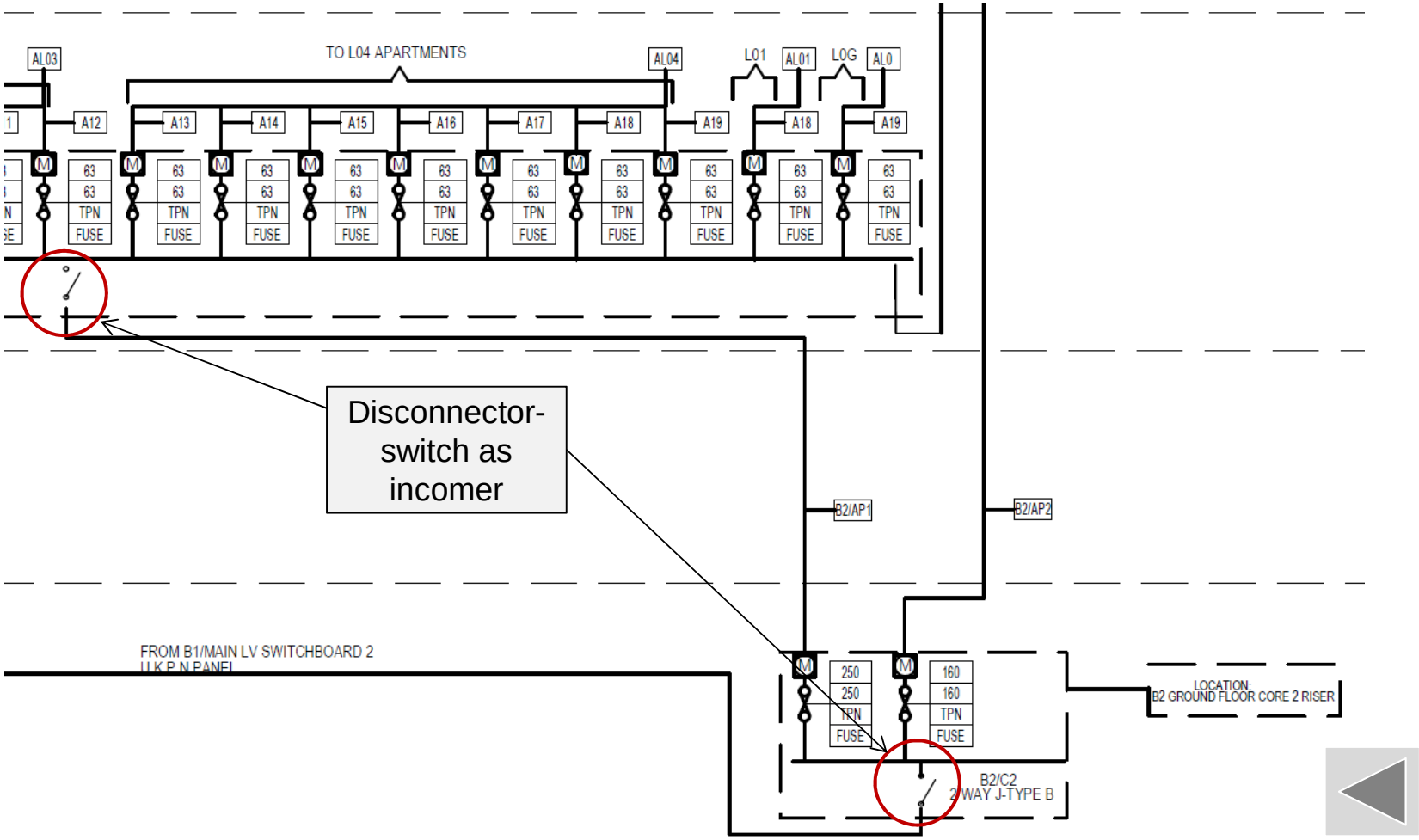
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European example of LBS incomer (Building)



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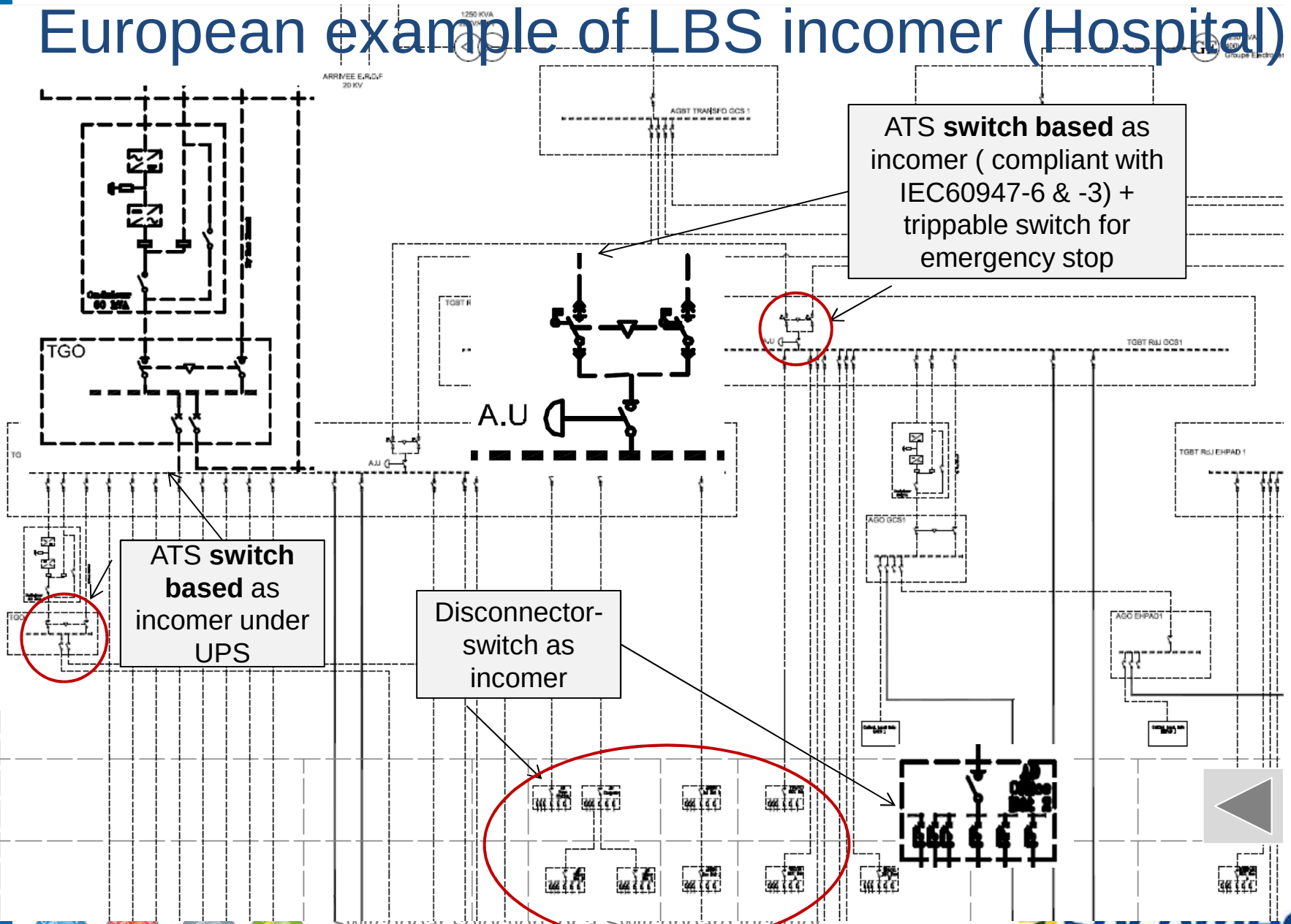
European example of LBS incomer (Building)



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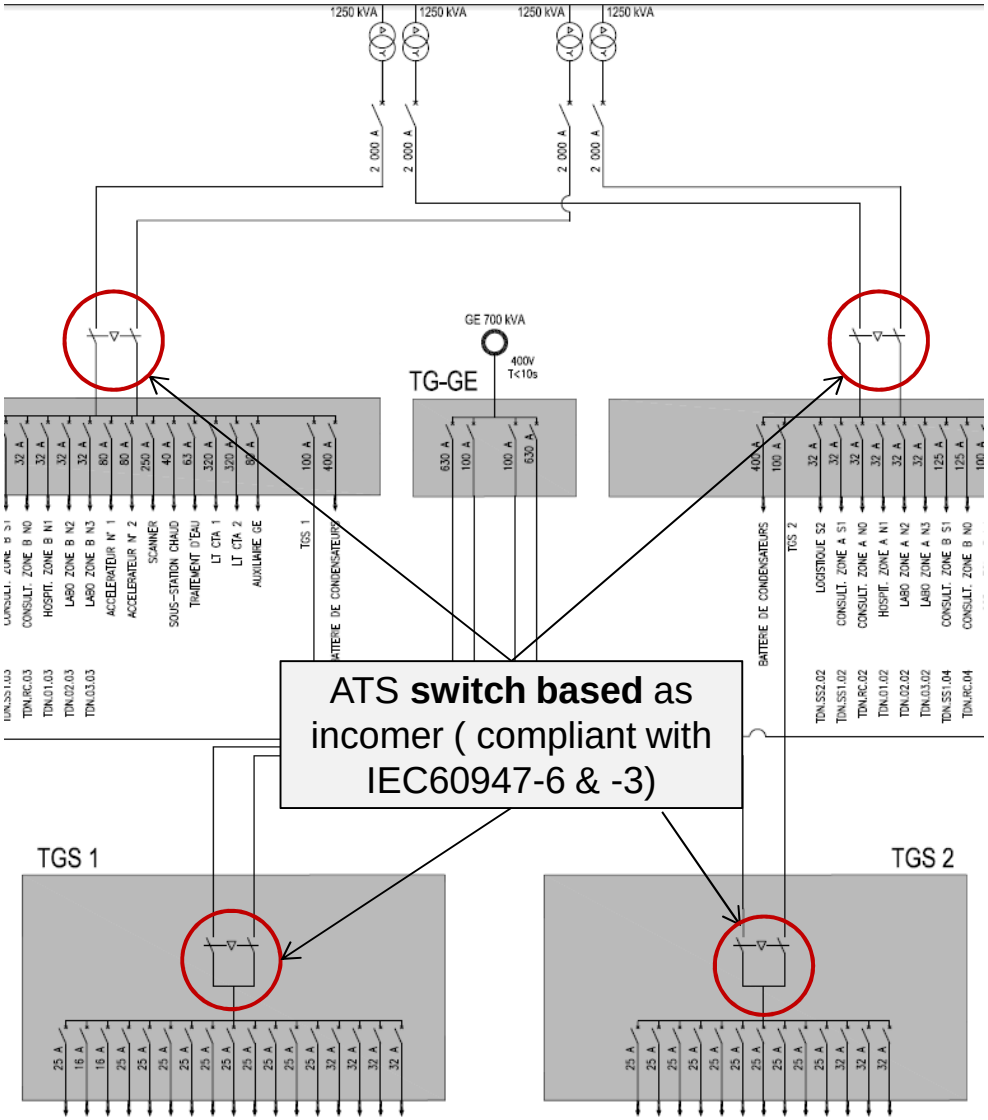
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European example of LBS incomer (Hospital)



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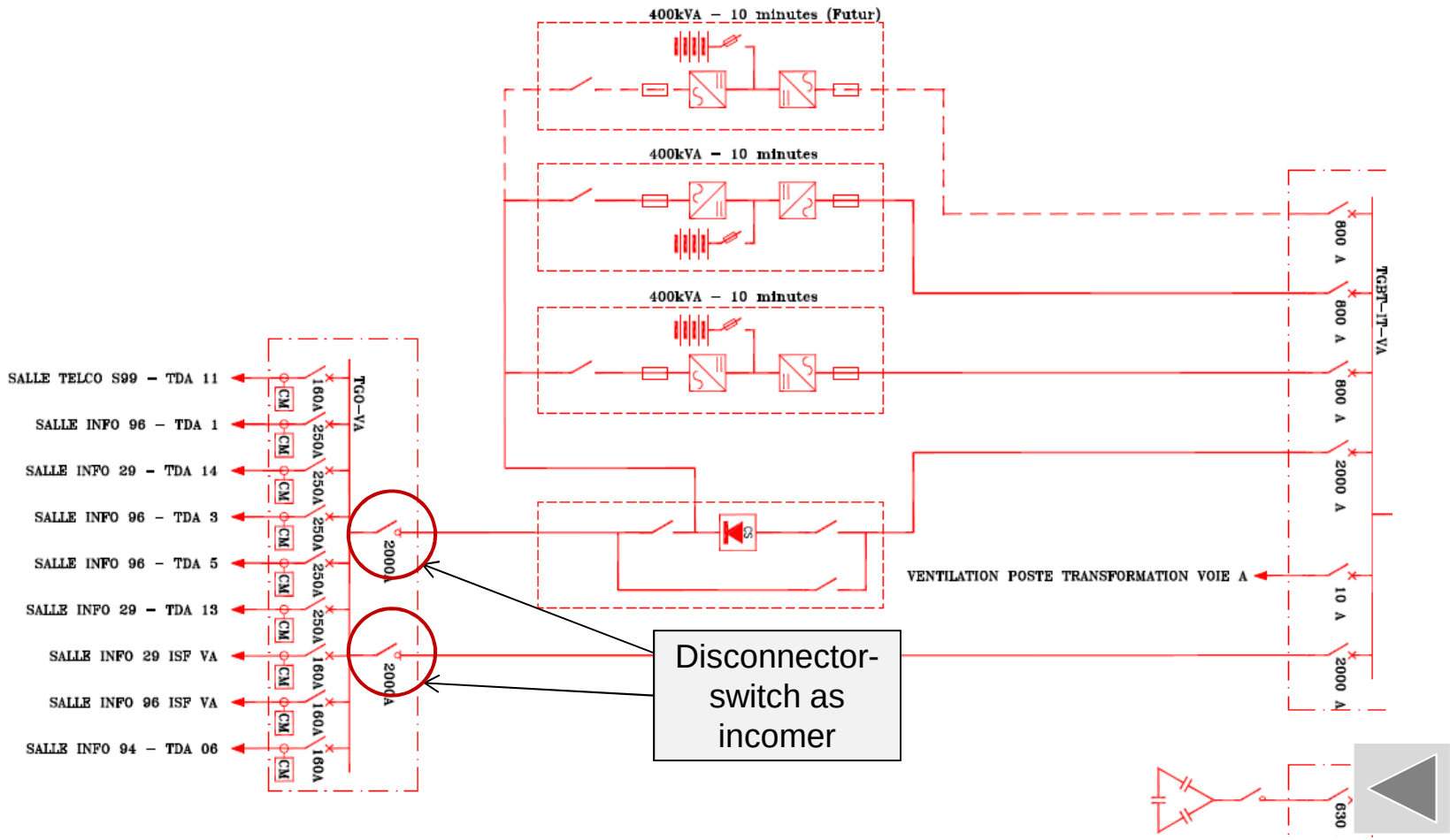
European example of LBS incomer (Hospital)



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European example of LBS incomer (DTC)



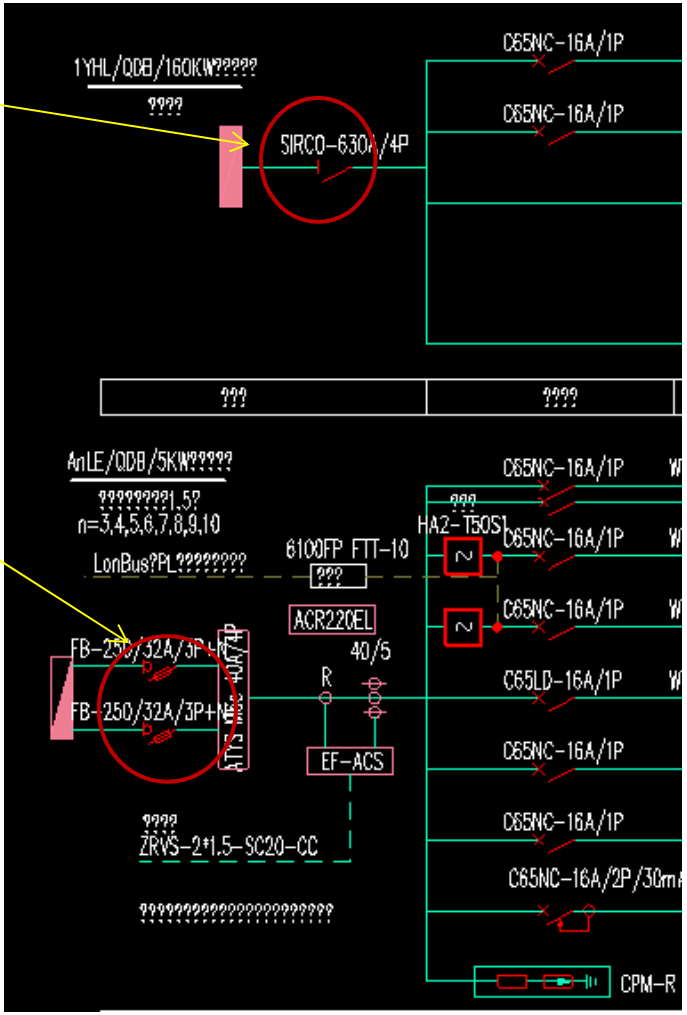
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Chinese example of LBS incomer (Telecom DTC)

Disconnector-switch as incomer

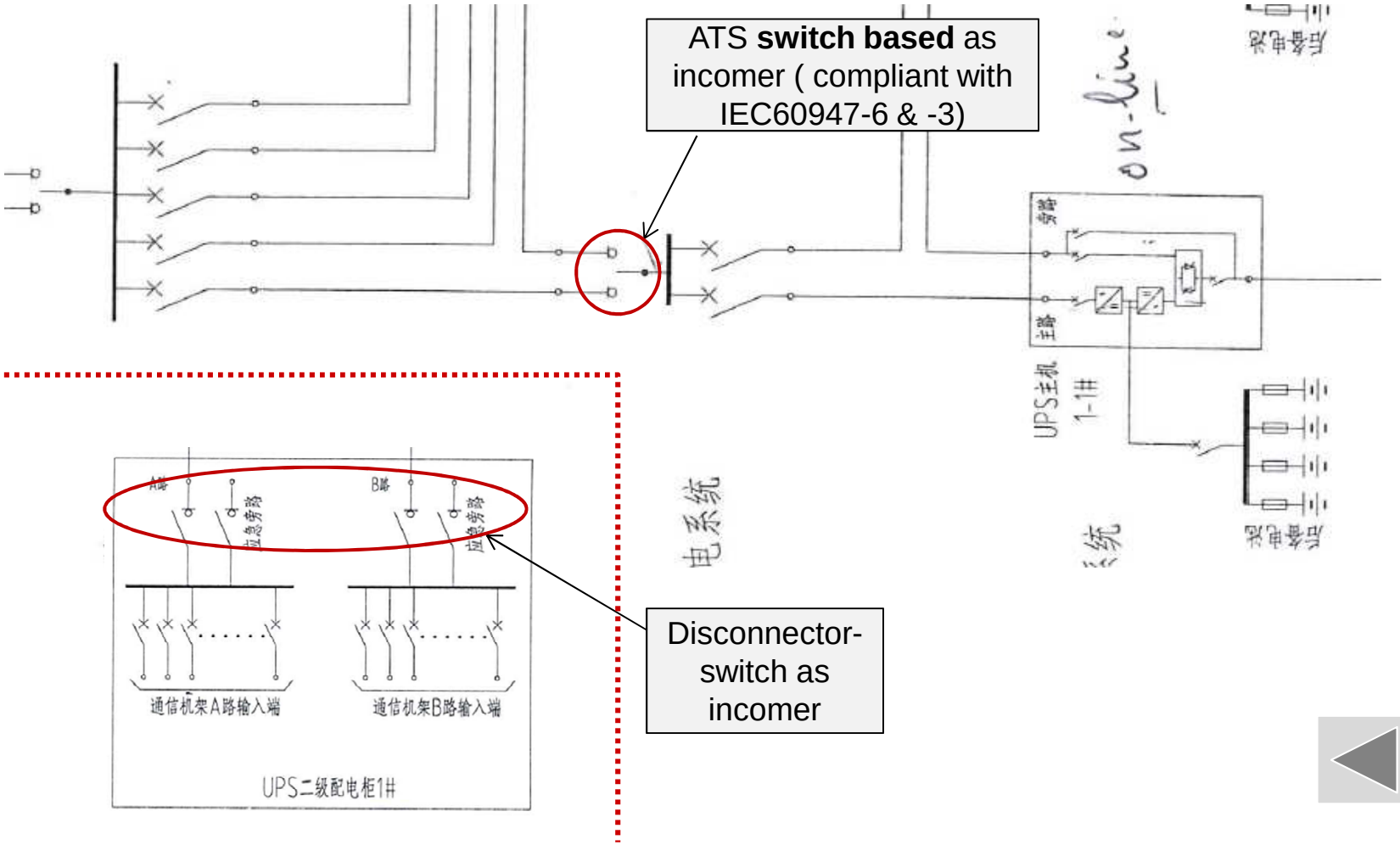
Fuse-Disconnector-switch as incomer



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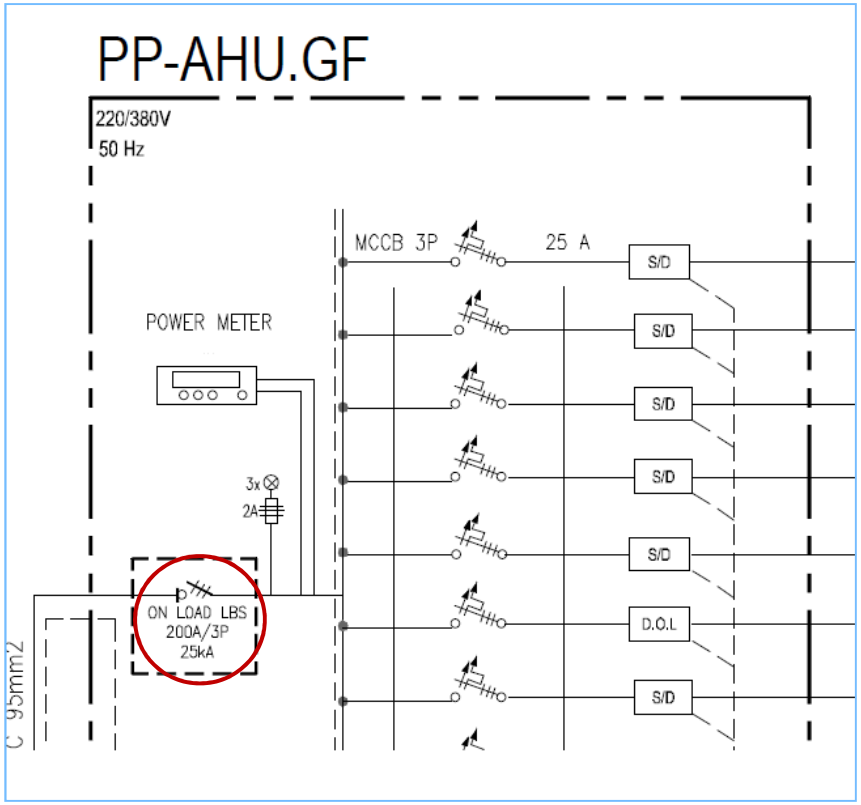
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Chinese example of LBS incomer (Telecom DTC)



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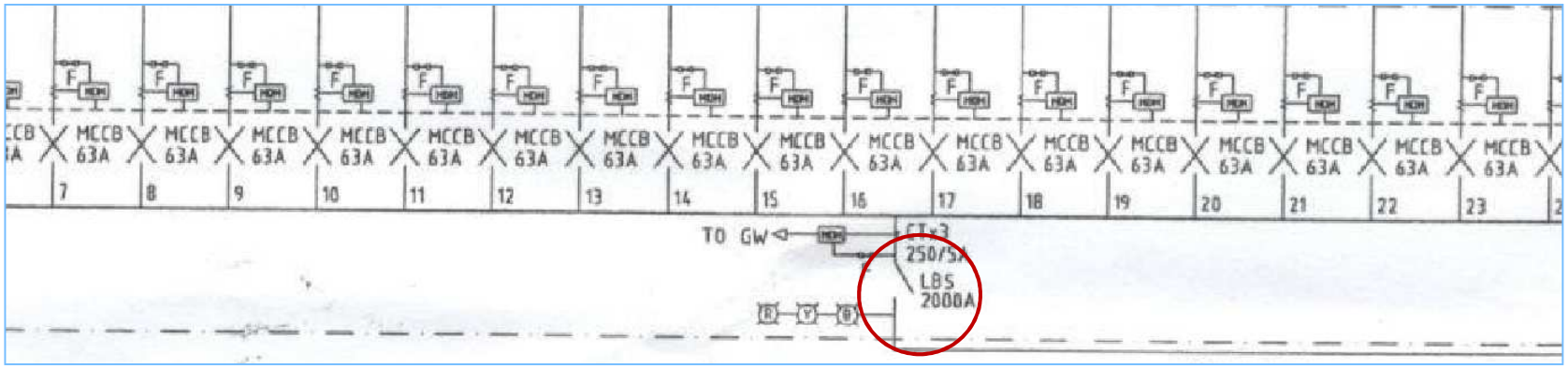
Indonesian example (Retail supermarket)



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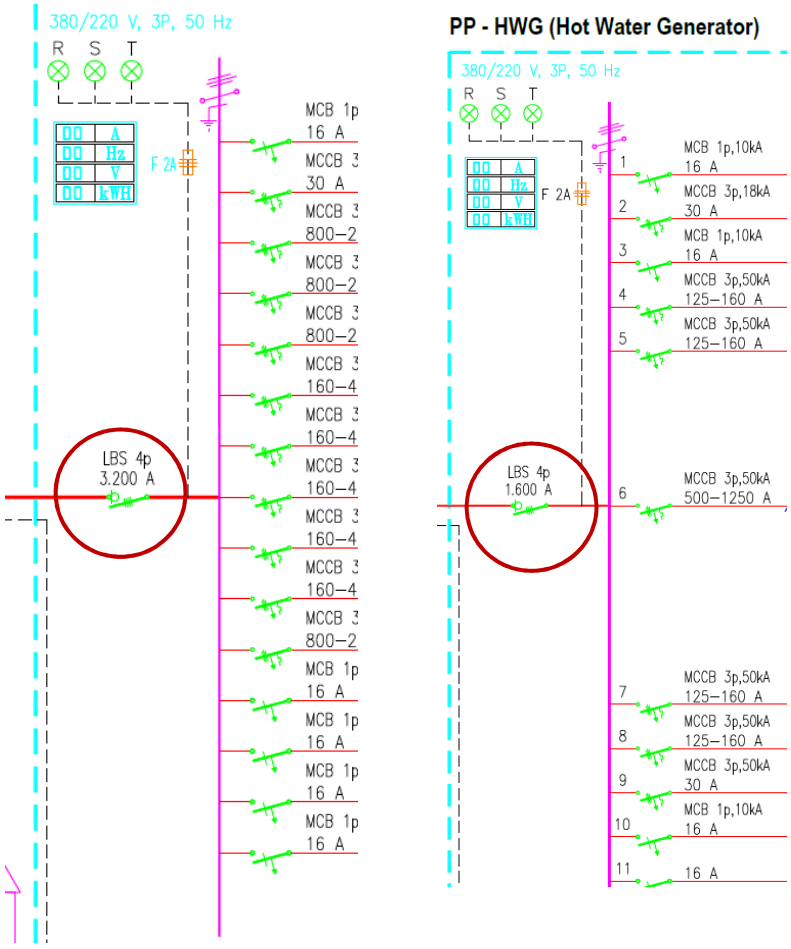
Indonesian example (F&B)



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Indonesian example (Pharma)



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LBS can reach 55 000 years MTBF, tens of times more than CB

- CB average MTBF: 100 to 150 y
  - but unpublished by manufacturer
- LBS MTBF: Thousands of years
  - published by Socomec

125A : MTBF(=MTTF) ≥ 1500 years	160A : MTBF(=MTTF) ≥ 55 000 years
200A : MTBF(=MTTF) ≥ 8 000 years	250A : MTBF(=MTTF) ≥ 20 000 years
315A and 1600A : MTBF(=MTTF) ≥ 7 500 years	400A and 1250A : MTBF(=MTTF) ≥ 2 000 years
500A : MTBF(=MTTF) ≥ 850 years	630A : MTBF(=MTTF) ≥ 1 000 years
800A : MTBF(=MTTF) ≥ 2 500 years	1000A : MTBF(=MTTF) ≥ 8 500 years
1800A : MTBF(=MTTF) ≥ 800 years	4000A : MTBF(=MTTF) ≥ 200 years



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67235 BENFELD
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ATTESTATION OF PERFORMANCE No AP 13397 CPR
Following specifications :
Manufacturer-operational reliability based on the data of the year 2012

TESTED MATERIAL

Designation :	Switch-disconnectors
Type :	SIRCO
Rating :	125A to 4000A
Reference :	2600 xxxx ; 2601 xxxx ; 2605 xxxx (x= 0 to 9)
Manufacturer :	SOCOMEC S.A. 67235 BENFELD France

Rated characteristics :
The above-mentioned product satisfies to the following characteristics:

125A : MTBF(=MTTF) ≥ 1500 years	160A : MTBF(=MTTF) ≥ 55 000 years
200A : MTBF(=MTTF) ≥ 8 000 years	250A : MTBF(=MTTF) ≥ 20 000 years
315A and 1600A : MTBF(=MTTF) ≥ 7 500 years	400A and 1250A : MTBF(=MTTF) ≥ 2 000 years
500A : MTBF(=MTTF) ≥ 850 years	630A : MTBF(=MTTF) ≥ 1 000 years
800A : MTBF(=MTTF) ≥ 2 500 years	1000A : MTBF(=MTTF) ≥ 8 500 years
1800A : MTBF(=MTTF) ≥ 800 years	4000A : MTBF(=MTTF) ≥ 200 years

Date : 2013/10/29

The Writer — **Adrien DECKER**

LABORATOIRE D'ESSAIS ELECTRIQUES Pierre SIAT 67235 BENFELD cedex - FRANCE

Test and Certification Manager — **Dominique MARBACH**

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Siège social : 1, rue de Westhouse - boîte postale 60010 - F-67235 Benfeld Cedex - tél. 03 88 57 41 41 - fax 03 88 57 78 78

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There is no such maintenance on LBS as on CB

Recommended maintenance program

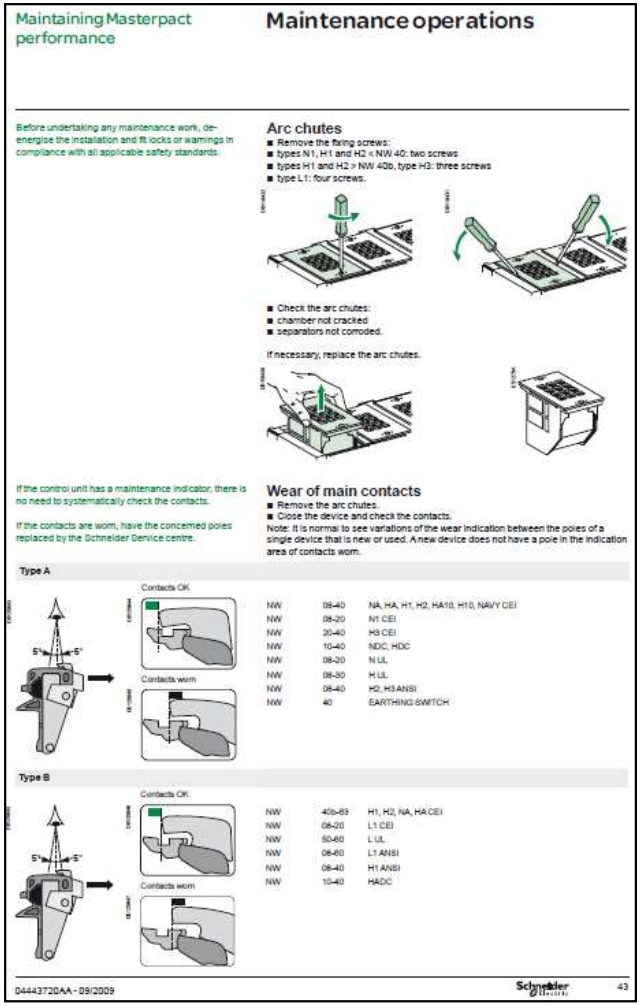
Periodic inspections required

Interval	Operations	Procedure
Each year	■ Open and close the device locally and remotely, successively using the various auxiliaries	□ see pages 10 and 11.
	■ Test the operating sequences	□ see page 8.
	■ Test the control unit using the mini test kit.	□ see the user manual of the control unit.
Every two years or when the control-unit maintenance indicator reaches 100	■ Check the arc chutes	□ see page 43
	■ Check the main contacts	□ see page 43
	■ Check the tightness of connections	□ see the device installation manual
	■ Check the disconnecting-contact clusters	□ see page 44

Parts requiring replacement, depending on the number of operating cycles.

The following parts must be replaced periodically to lengthen the service life of the device (maximum number of operating cycles).

Part	Intervening entity	Description or procedure
Arc chutes	■ User.	□ see page 43.
Main contacts	■ Inspection: user ■ Replacement: Schneider After Sales Support.	□ see page 43.
MCH gear motor	■ User.	□ see page 9.
Mechanical interlocks	■ User.	
Connecting-rod springs	■ Schneider After Sales Support.	
MX/MN/XF	■ User.	□ see page 10, 11.



Maintaining Masterpact performance

Maintenance operations

Before undertaking any maintenance work, de-energise the installation and fit locks or warnings in compliance with all applicable safety standards.

Arc chutes

■ Remove the fixing screws:
■ types N1, H1 and H2 ≤ NW 40: two screws
■ types H1 and H2 ≥ NW 40b, type H3: three screws
■ type L1: four screws.

■ Check the arc chutes:
■ chamber not cracked
■ separators not corroded.

If necessary, replace the arc chutes.

If the control unit has a maintenance indicator, there is no need to systematically check the contacts.

If the contacts are worn, have the concerned poles replaced by the Schneider Service centre.

Wear of main contacts

■ Remove the arc chutes.
■ Close the device and check the contacts.

Note: It is normal to see variations of the wear indication between the poles of a single device that is new or used. A new device does not have a pole in the indication area of contacts worn.

Type A

Contacts OK

Contacts worn

NW	08-40	NA, HA, H1, H2, HA10, H10, NAVY CEI
NW	08-20	N1 CEI
NW	20-40	H3 CEI
NW	10-40	NDC, HDC
NW	08-20	N UL
NW	08-30	H UL
NW	08-40	H2, H3 ANSI
NW	40	EARTHING SWITCH

Type B

Contacts OK

Contacts worn

NW	40b-63	H1, H2, NA, HA CEI
NW	08-20	L1 CEI
NW	50-60	L UL
NW	08-60	L1 ANSI
NW	08-40	H1 ANSI
NW	10-40	HADC

04443720AA - 09/2009

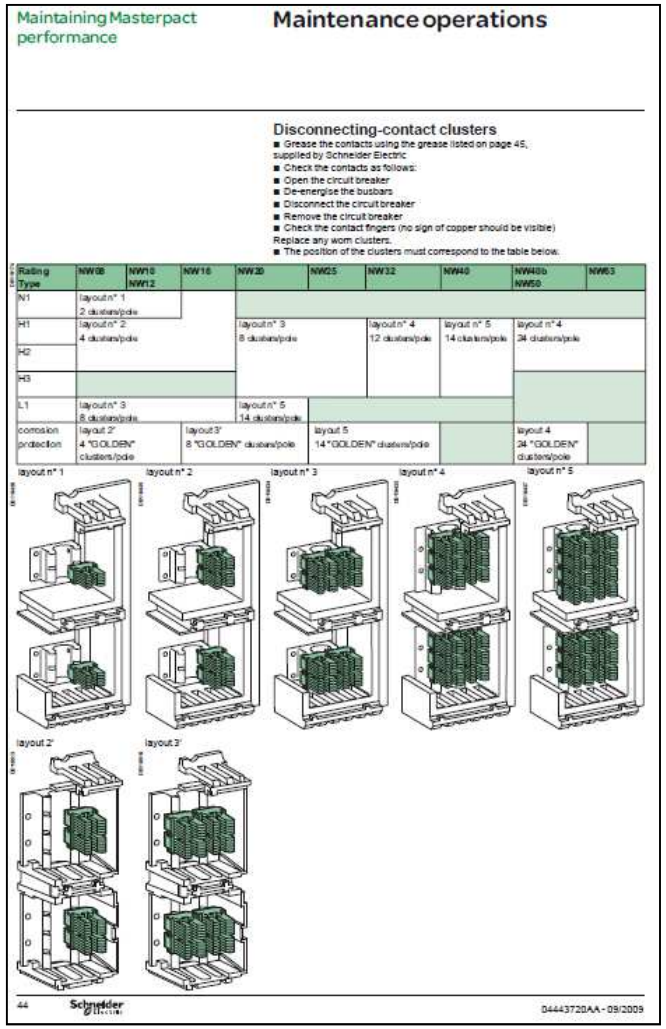
Schneider Electric

43

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There is no such maintenance on LBS as on CB



Maintaining Masterpact performance

Maintenance operations

Disconnecting-contact clusters

- Grease the contacts using the grease listed on page 45, supplied by Schneider Electric
- Check the contacts as follows:
- Open the circuit breaker
- De-energise the busbars
- Disconnect the circuit breaker
- Remove the circuit breaker
- Check the contact fingers (no sign of copper should be visible)

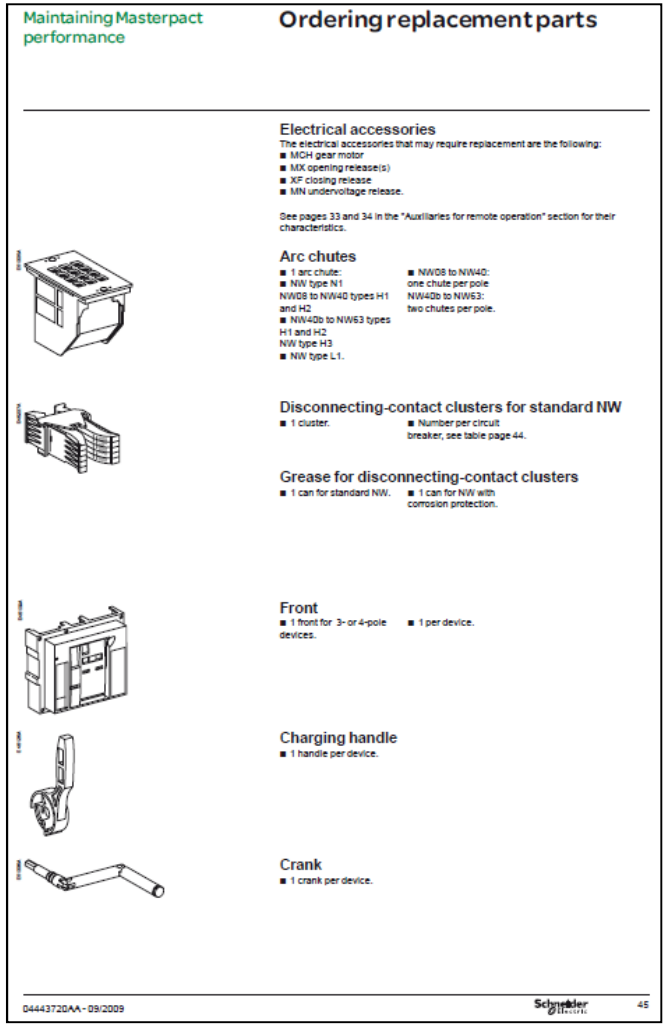
Replace any worn clusters.

- The position of the clusters must correspond to the table below.

Rating / Type	NW08	NW10 NW12	NW16	NW20	NW25	NW32	NW40	NW40b NW50	NW63
N1	layout n° 1 2 clusters/pole								
H1	layout n° 2 4 clusters/pole			layout n° 3 8 clusters/pole		layout n° 4 12 clusters/pole	layout n° 5 14 clusters/pole	layout n° 4 24 clusters/pole	
H2									
H3									
L1	layout n° 3 8 clusters/pole			layout n° 5 14 clusters/pole					
corrosion protection	layout 2' 4 "GOLDEN" clusters/pole		layout 3' 8 "GOLDEN" clusters/pole		layout 5 14 "GOLDEN" clusters/pole			layout 4 24 "GOLDEN" clusters/pole	

layout n° 1 layout n° 2 layout n° 3 layout n° 4 layout n° 5

layout 2' layout 3'



Maintaining Masterpact performance

Ordering replacement parts

Electrical accessories

The electrical accessories that may require replacement are the following:

- MCH gear motor
- MX opening release(s)
- XF closing release
- MN undervoltage release.

See pages 33 and 34 in the "Auxiliaries for remote operation" section for their characteristics.

Arc chutes

- 1 arc chute:
  - NW type N1 NW08 to NW40 types H1 and H2
  - NW40b to NW63 types H1 and H2 NW type H3
  - NW type L1.
- NW08 to NW40: one chute per pole
- NW40b to NW63: two chutes per pole.

Disconnecting-contact clusters for standard NW

- 1 cluster.
- Number per circuit breaker, see table page 44.

Grease for disconnecting-contact clusters

- 1 can for standard NW.
- 1 can for NW with corrosion protection.

Front

- 1 front for 3- or 4-pole devices.
- 1 per device.

Charging handle

- 1 handle per device.

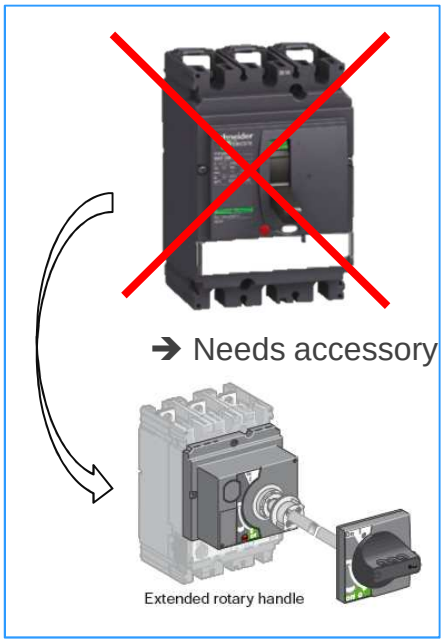
Crank

- 1 crank per device.

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External handle & padlocking is SAFER with LBS



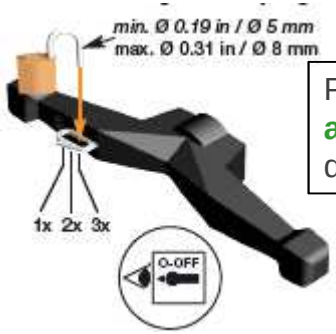
External handle requires additional accessory on the CB.
Converting the “arc type” movement of the CB into a rotary movement is made through a complex mechanism
➔ **Reduces the Reliability.**



Padlocking CBs requires often additional accessories which can be lost ➔ **Reduces the Safety.**

External handle on LBS is an intrinsic feature. No additional mechanism
➔ **No impact on the Reliability.**

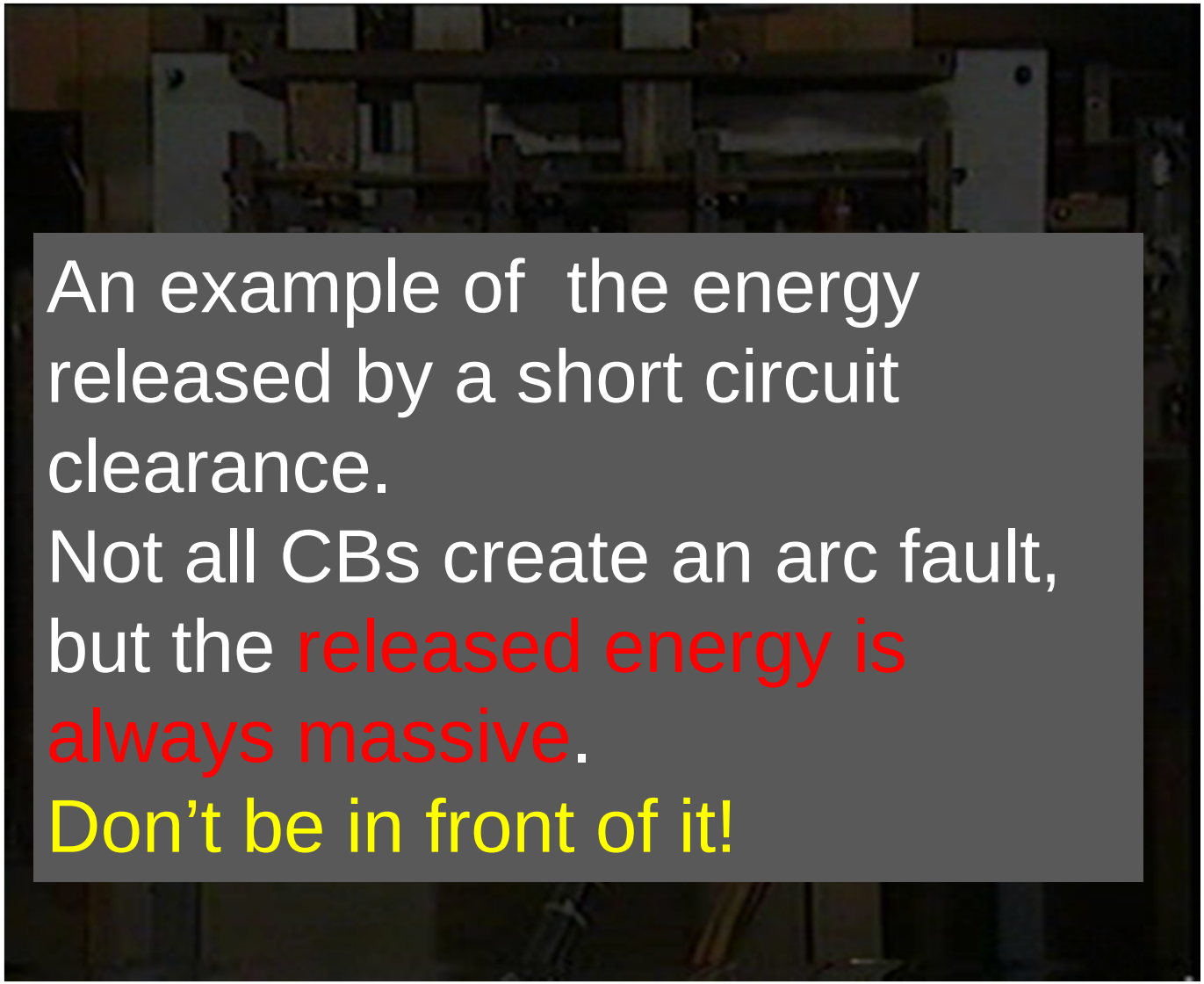




Padlocking is **readily available on LBS**, even on direct handles.

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400 A Short circuit clearance & arc fault



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A 250 A Short circuit clearance

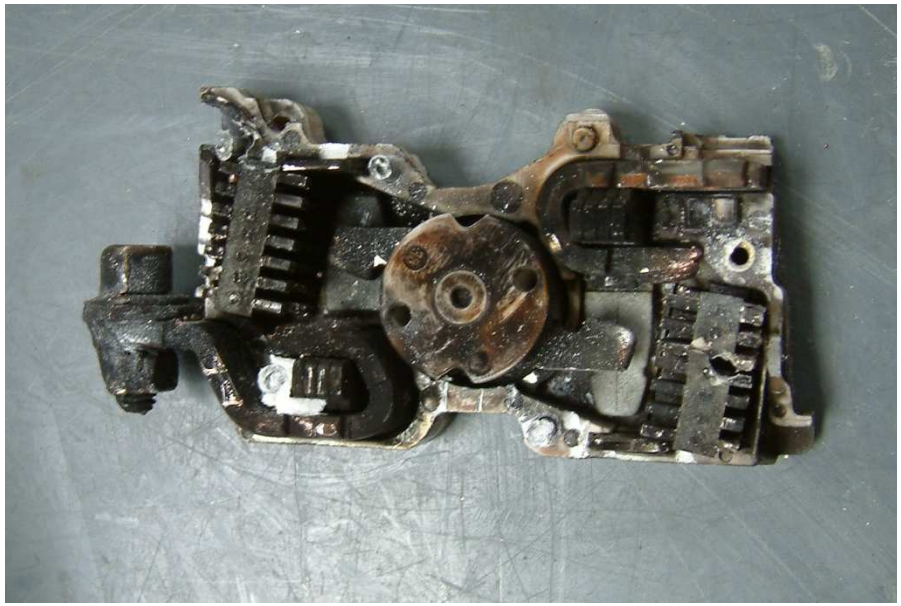


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A 250 A Short circuit clearance

- Damages on the breaker…





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LBS doesn’t explode under short-circuit



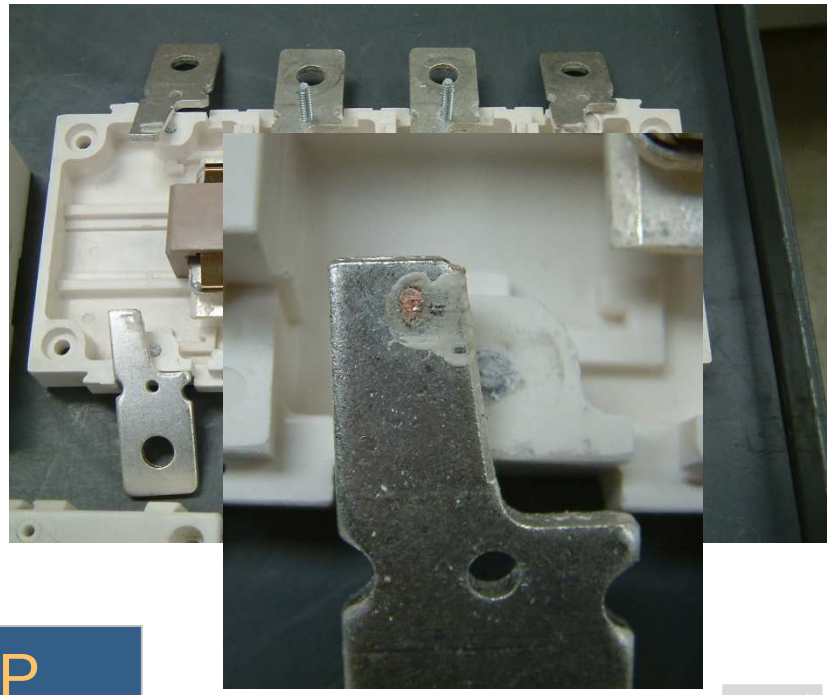
Same conditions than 250 A CB, no protection.

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LBS doesn’t explode and stays clean

- After the 250 A S/C



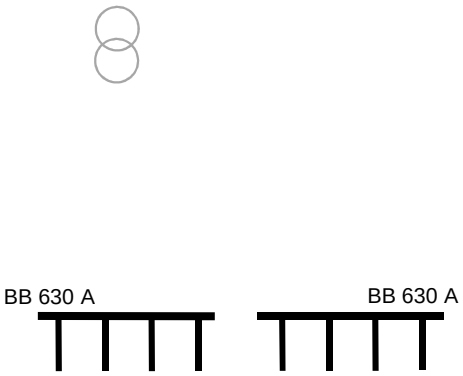


A CB IS DESIGNED TO TRIP
A LBS IS DESIGNED TO HOLD

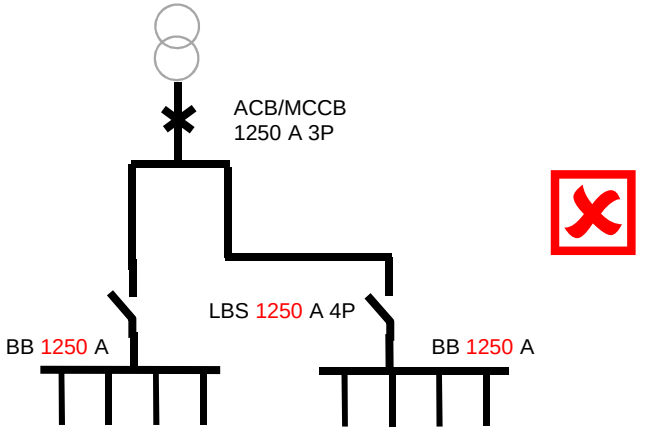
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Optimization: From LBS to ATS …

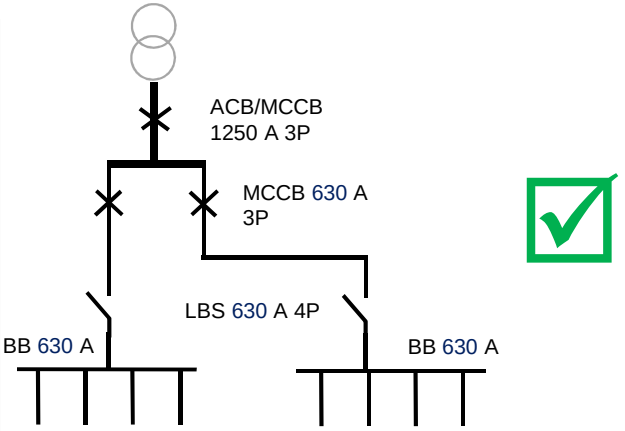
Need: 1 Tfo,
2 « Load centers »



Which SLD?



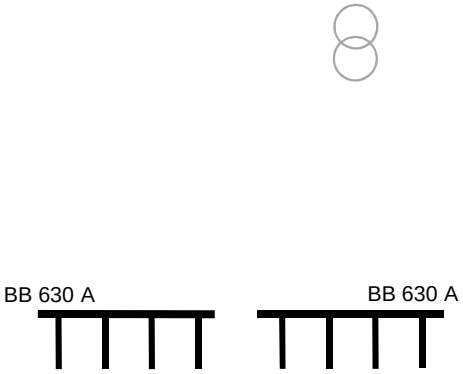
Discrimination
Limitation
Selectivity
➔
Copper &
Panel reduction
➔
Cost & CoS efficient



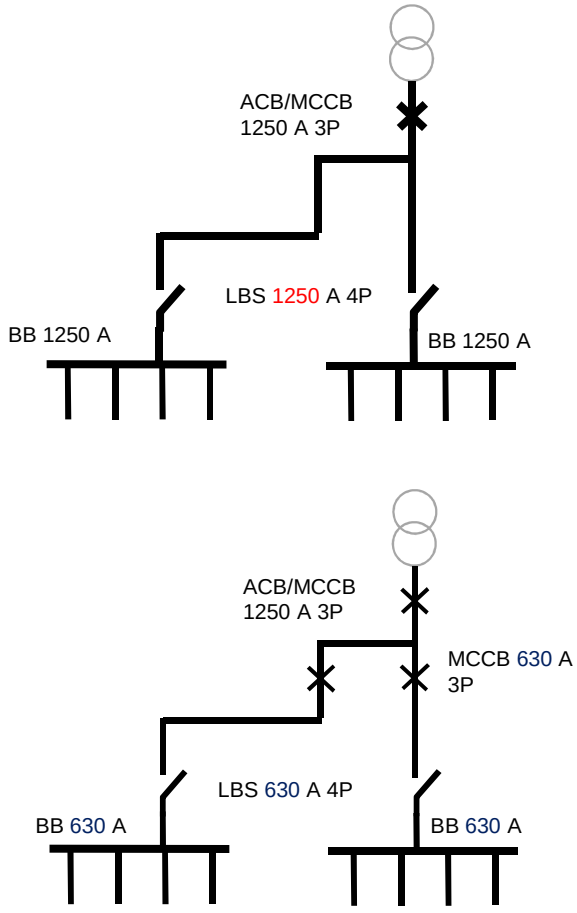
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Optimization: From LBS to ATS …

Need: 1 Tfo,
2 « Load centers »

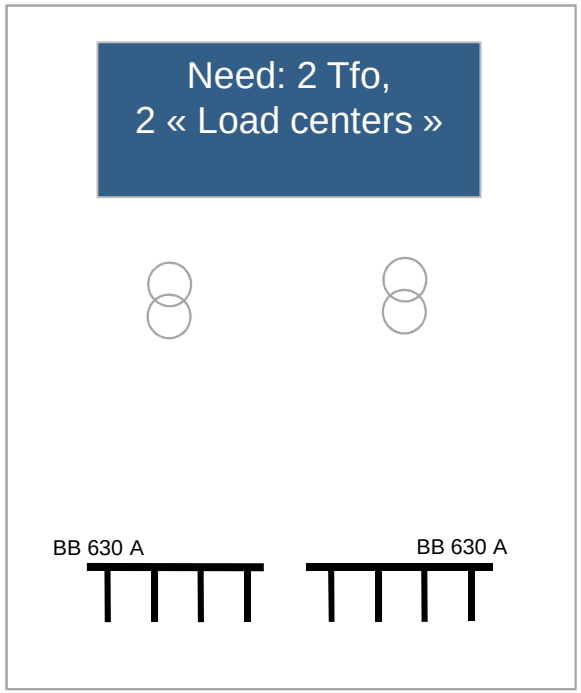


Same story!

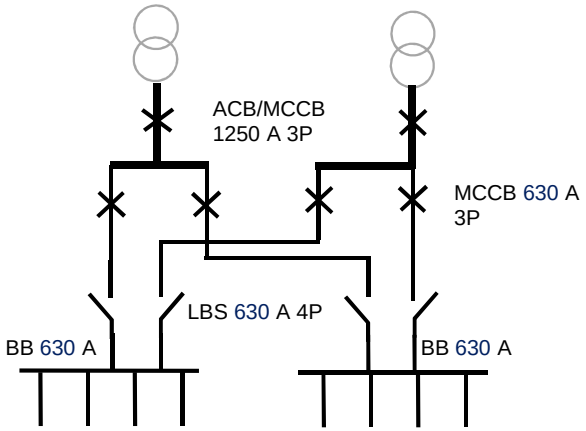


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Optimization: From LBS to ATS …



Let's use the 2 optimized SLD

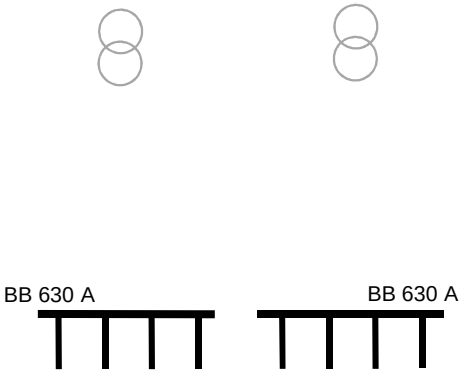


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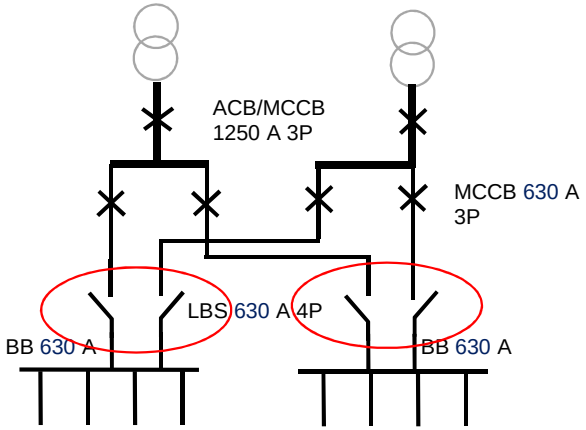
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Optimization: From LBS to ATS …

Need: 2 Tfo,
2 « Load centers »



Let's make it automatic



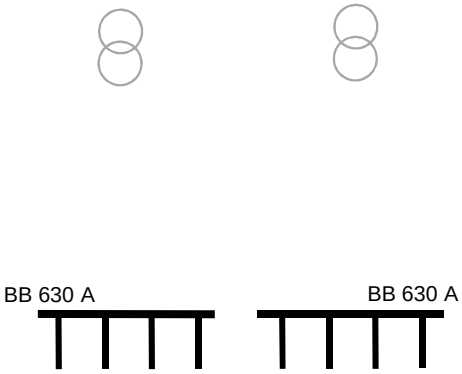
2 LBS + interlocking + motorization + control = ATS …!

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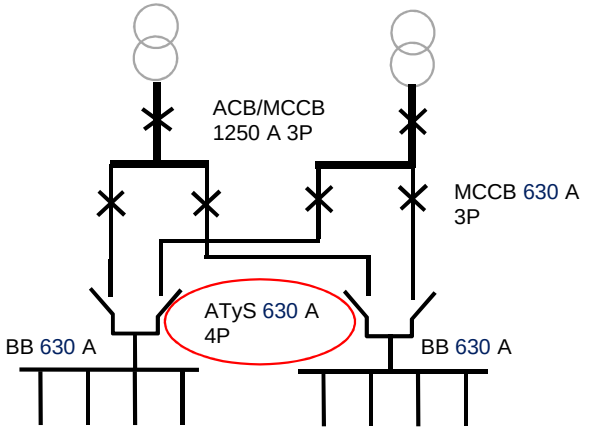
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Optimization: From LBS to ATS …

Need: 2 Tfo,
2 « Load centers »



Optimized schematic



A Transfer SWITCH allows to optimize SLD.
CB doesn't

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