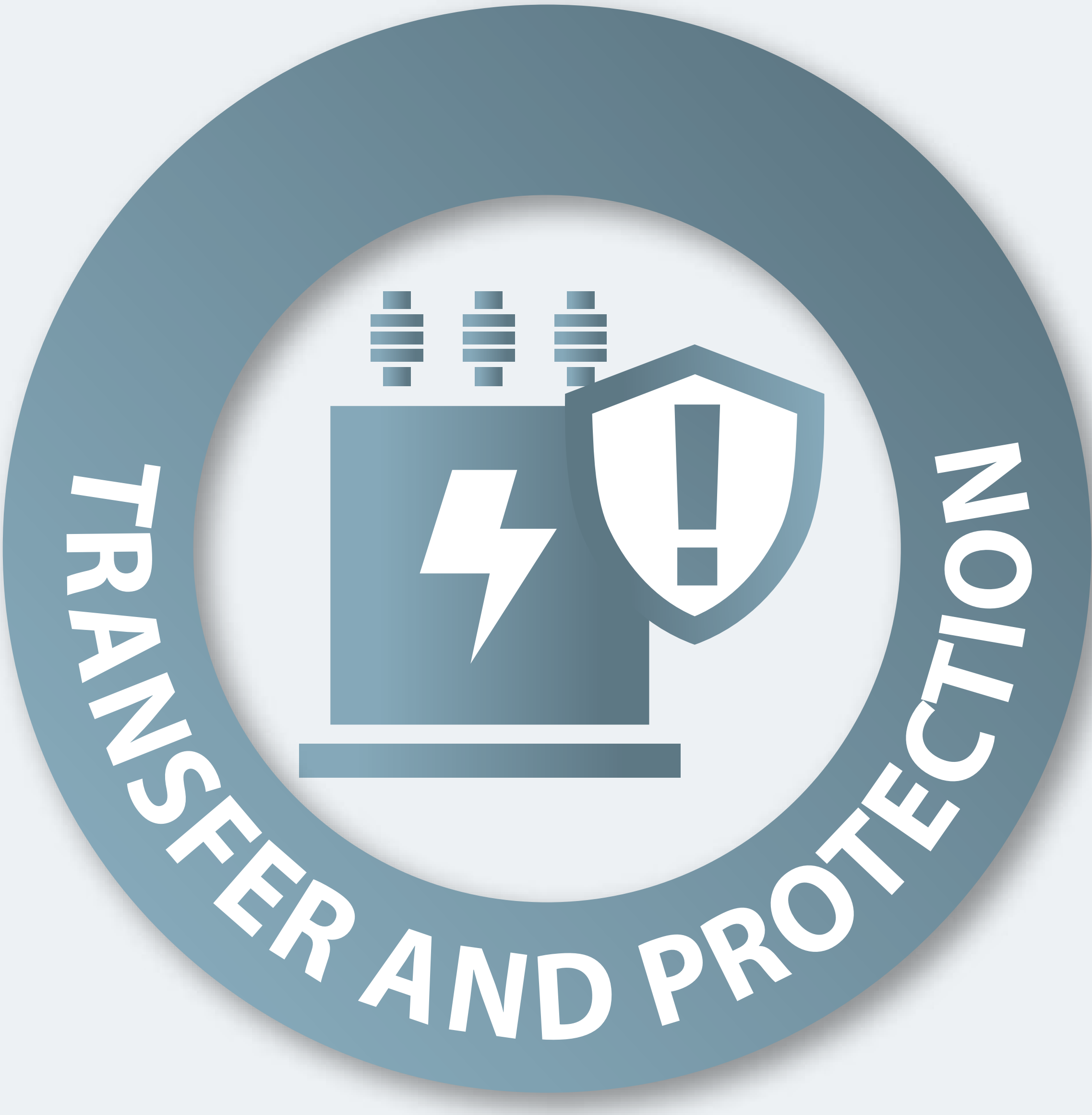
WHITE PAPER

Design optimisation for improved availability without impacting protection

Power availability

By Jérémie Pleynet



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Glossary

ATS	Automatic Transfer Switch
ATSE	Automatic TSE
CB	Circuit Breaker
DB	Distribution Board
I/L	Interlocking
LBS	Load Break Switch
MTSE	Manual Transfer Switching Equipment
RTSE	Remote Transfer Switching Equipment
SLD	Single Line Diagram
SPF	Single Point of Failure
SWBD	Switchboard
Tfo	Transformer
TSE	Transfer Switching Equipment

Contents

Introduction

Designing a high availability installation requires that both protection and transfer functions be carefully analysed and taken into account. The basics of this approach can be found in the document "Basics for electrical system design including protection and transfer"[1]. In this paper some tips will be given in order to optimise the choices that can be made concerning protection and transfer functions.

This optimisation is based on 4 aspects:
- optimising the protection function without transfer restrictions,
- converting the incomers into TSE,
- optimising the cabling vs. the position of the TSE,
- optimising the control system.

Optimising protection and continuity of service without transfer restrictions

Having the right **selectivity and discrimination** will lead naturally to the optimum service continuity of the process along with a reduction in the cabling costs. **Issues concerning the transfer should be ignored at this stage**. Just connect the necessary incomers on each distribution board (through Load-break switches (LBS) as protection is already provided upstream) according to the logical functions defined above. The transformation into TSE will be done in the next step.

In order to study these points with some diagrams, the SLD below will be used. The SLD has already been optimised from a protection point of view. Selectivity between upstream and downstream protections is ensured, and certain of the gears are 3-pole when possible (if not an incomer and if the neutral grounding system allows it).

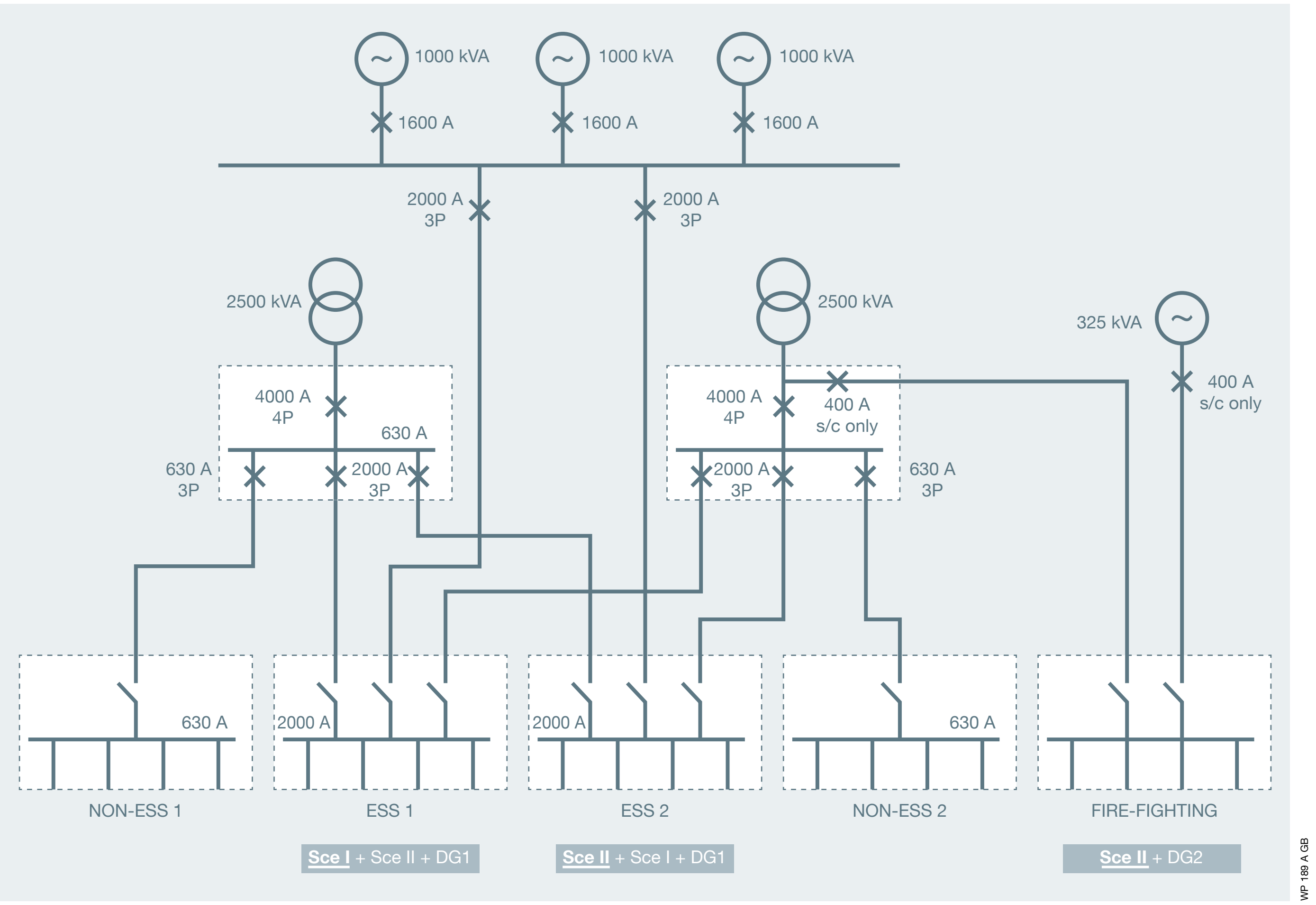

Fig. 1 - SLD with optimised protection.

(1) Consult the document: www.socomec.com/resourcesTSE

Converting the multiple incomers into TSE

At this stage it is important to remember that protection of the distribution board incomers is already ensured upstream, in the MSWB. Therefore adding another protection at the incomer level is not needed (except in certain rare exceptions), and a switch-disconnector (LBS) is the best solution to be used for these incomers.

The conversion is straight forward between a set of LBS in parallel and a set of TSE (switch based) which also provide the necessary mechanical interlockings.

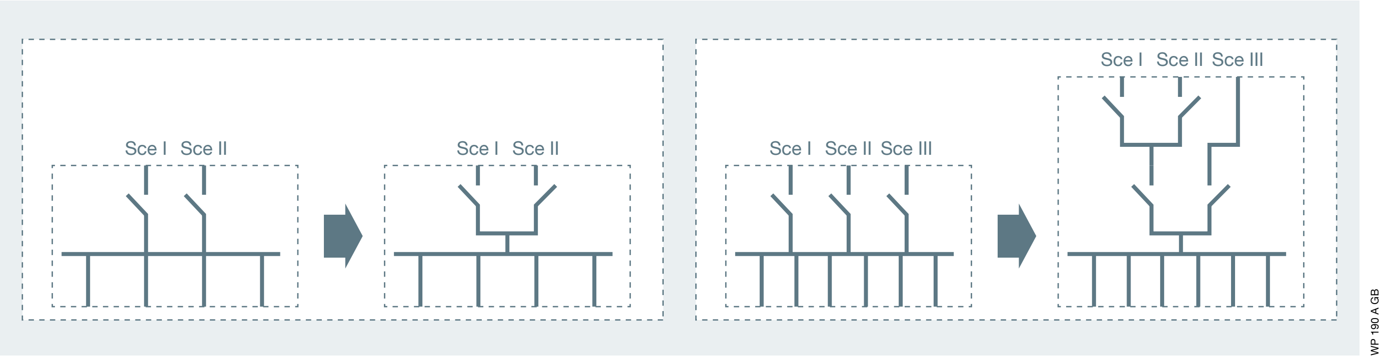

Fig. 2 - Conversion of multiple incomers to TSE schematic.

We will note that if the TSE are IEC 60947-3 compliant, then they are the panels' incomers. There is no need to add another device for disconnection/isolation purposes. For further details, see the document "How to select the proper incomer gear for a switchboard"[1].

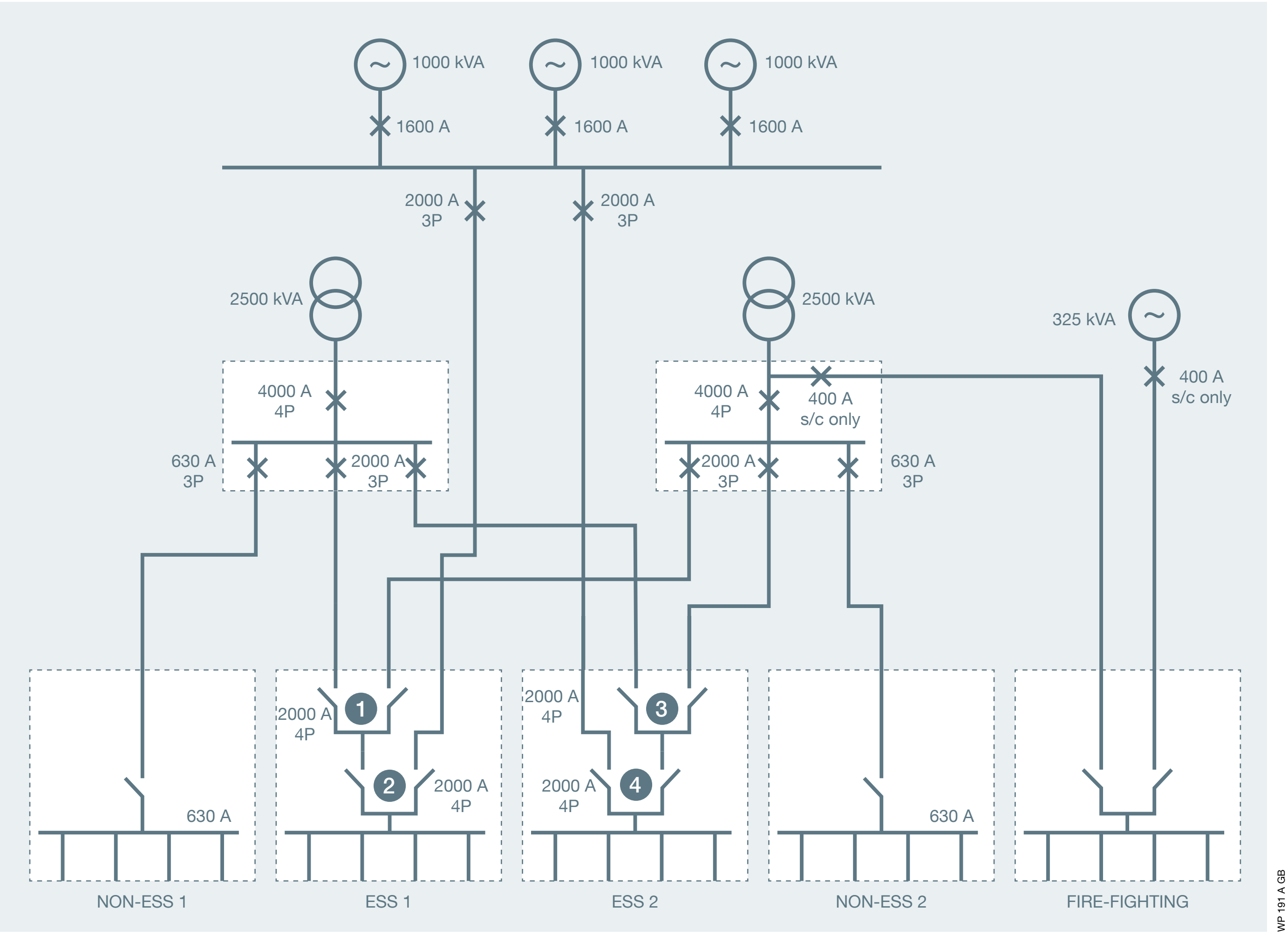

Fig. 3 - SLD with optimised protection and transfer.

(1) Consult the document: www.socomec.com/resourcesTSE

The following should be noted:

- there is **no conflict in protection** as is often found in CB based schematics (similarly rated CBs in series) and therefore there is an optimisation of availability,
- there is **no need for any truth table**; the operation mode is fully automatic (i.e. each TSE has a source priority set on the priority source, which arises from the logical equations) and each TSE is **independent** from the others,
- the TSE 2 & 4 are "Transformer/DG" type: they manage the start & stop of the DG if needed (their output contacts are in parallel). The TSE 1 & 3 are "Transformer/Transformer" type: they do not manage the DG start & stop,
- the **maintainability is maximum** (i.e. there is no external I/L to re adjust, and some TSE allow a change of the motorisation without stopping the process downstream),

Fig. 4 - Maintenance free solution.

WP 191 A GB

- a four-incomer configuration can easily be done with 3 TSE in the same way. Nevertheless, a reliability study should be done to assess if the improvement in availability is worth it. This is a decision for the end-user alone,
- the order of the sources' priority will be managed through the timer settings of each TSE. For example, TSE 1 will have a timer set at a lower value than TSE 2 in order to transfer from Tfo 1 to Tfo 2 without the need of DG.

Optimising the cabling vs. the position of the TSE

Location of the TSE

Fig. 3 shows the TSE inside their respective loads panels. It is an obvious configuration which offers the advantage of using the TSEs as panel disconnectors (if they are IEC 60947-3 compliant). The drawback is that 2 or 3 cables are laid down to ESSential panels.

- If the distance between the Main SWBD and the ESS panels is small (i.e. in the same switchroom), then this configuration is optimum.
- If this distance is not small (i.e. ESS 1 & ESS 2 panels are far from the MSWBD in other buildings), the cost of the cabling will be high. An optimisation is possible:
  - put the TSE 1, 2, 3 & 4 in the main 4000 A SWDBs and pull only one cable to ESS 1 and ESS 2,
  - ESS 1 and ESS 2 have an additional LBS functioning as an incomer,
  - the ratio between cabling cost reduction vs. additional LBS becomes positive after a certain distance depending on the rating of the cables. But for a LBS costing around 0.3 €/A, the comparison between the two options can be quickly done,
  - there is a drawback however, which can be important for critical loads: having only **one cable to the ESS panel means its becomes a Single Point of Failure (SPF)**. This downgrade in availability should be carefully considered to see if it is worthwhile.

It should be remembered that availability always has a cost.

Groupin of TSE

Some might think that the SLD can be optimised by grouping some TSE into a higher rating. It is generally a false view. If the design is done according to the method described above, there should not be any two switchboards with the same logical equation. Grouping the TSE will probably infringe the basic principles used to define the SWBD and "deconstruct" the sound initial design.
Nevertheless, if a function is often present in several Distribution Boards (DBs) (i.e. Tfo 1+DG), then it could be of interest to implement this function into a specific panel, then distributing it to the DBs. The disadvantage is that this panel will become a SPF for all its sub DBs. The designer might specify a special design for it (i.e. an ATS Bypass) to reduce the risk.
As always, the cost of non-availability has to be evaluated.

Optimising the TSE control

Most of the TSE will be of “Automatic” type (ATSE)
Either Transformer to Transformer type: 2 incomers coming from two upper bus bars, no DG start & stop control is required.
Or Transformer to DG type: 1 incomer coming from the Mains supply and the 2nd one from a DG (or a DG set with Sync panel). In this case, the ATSE will have to start the DG and stop them once the return to Mains is done and the cooling period is over.
As all the control is given to the ATSE automation, it would be of interest to plan and specify the use of devices that are able to monitor their operating status. A good example is a TSE with a watchdog output that can send information about its own availability after regular diagnostic operations, thus ensuring that it is ready to function should there be an anomaly on the netywork.

In some instances, the TSE will be only of the “remote” type (RTSE) or motorised TSE
Such is the case when the control is already implemented by another existing controller. Ex 1: by the DG controller, Ex 2: several RTSE tapping from the same main riser and externally controlled to balance the power on each riser.
Despite a still frequent practice, the use of individual relays to create a “cheap” TSE controller can lead after a very few years of operation to a loss of connection, to an unsuitable network configuration, a power supply failure, or other problems due to the disappearance of the system integrator who made it, etc. Such controllers can reach a maximum MTBF of several tens of thousands of hours maximum (typically 50,000 hours), instead of 1 million hours for a standard integrated ATSE. For this reason, it is strongly recommended to specify an “integrated controller”.

Finally, some TSE will be of the Manual (MTSE) type
For instance, where the TSE requires the permanent presence of an operator:
- Temporary DG for non-essential installations, rented with a short delivery time guarantee (i.e. 4h),
- TSE used to connect a back-up DG in case of maintenance of the main DG; in this case, the operator will be required to be present.

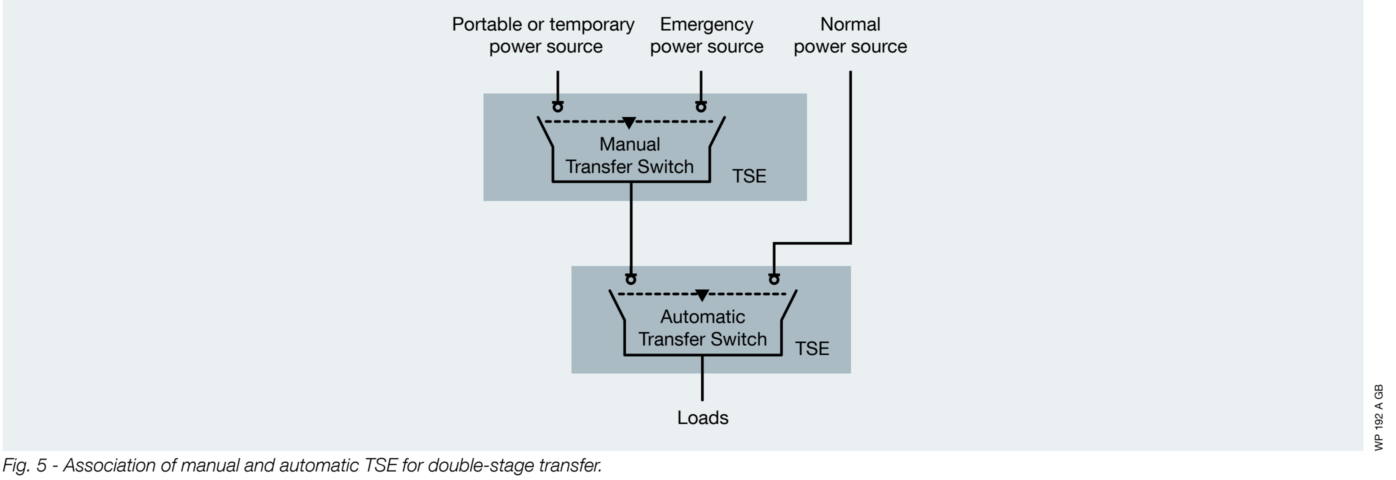

Fig. 5 - Association of manual and automatic TSE for double-stage transfer.

About the author

Jérémie Pleynet received an MSc Engineering degree from the French Arts et Métiers Paris Tech School of Engineering in 2008. He started his career at Socomec Italy in 2008 in Technical Sales Support for Power Switching and Power Monitoring. In 2010 he was promoted to the post of Specification Engineer in Power Conversion.
He later took over responsibility for the Italian Specification and Technical Support teams, and in 2016 he transferred to Socomec headquarters in France to be part of the Specification and Segment Development team with specific focus on the Healthcare and Data Centre sectors.
He is currently in charge of coordinating specification activities for the Socomec Group’s commercial and industrial sites around the world, providing training, technical and commercial support and business development for major projects.

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