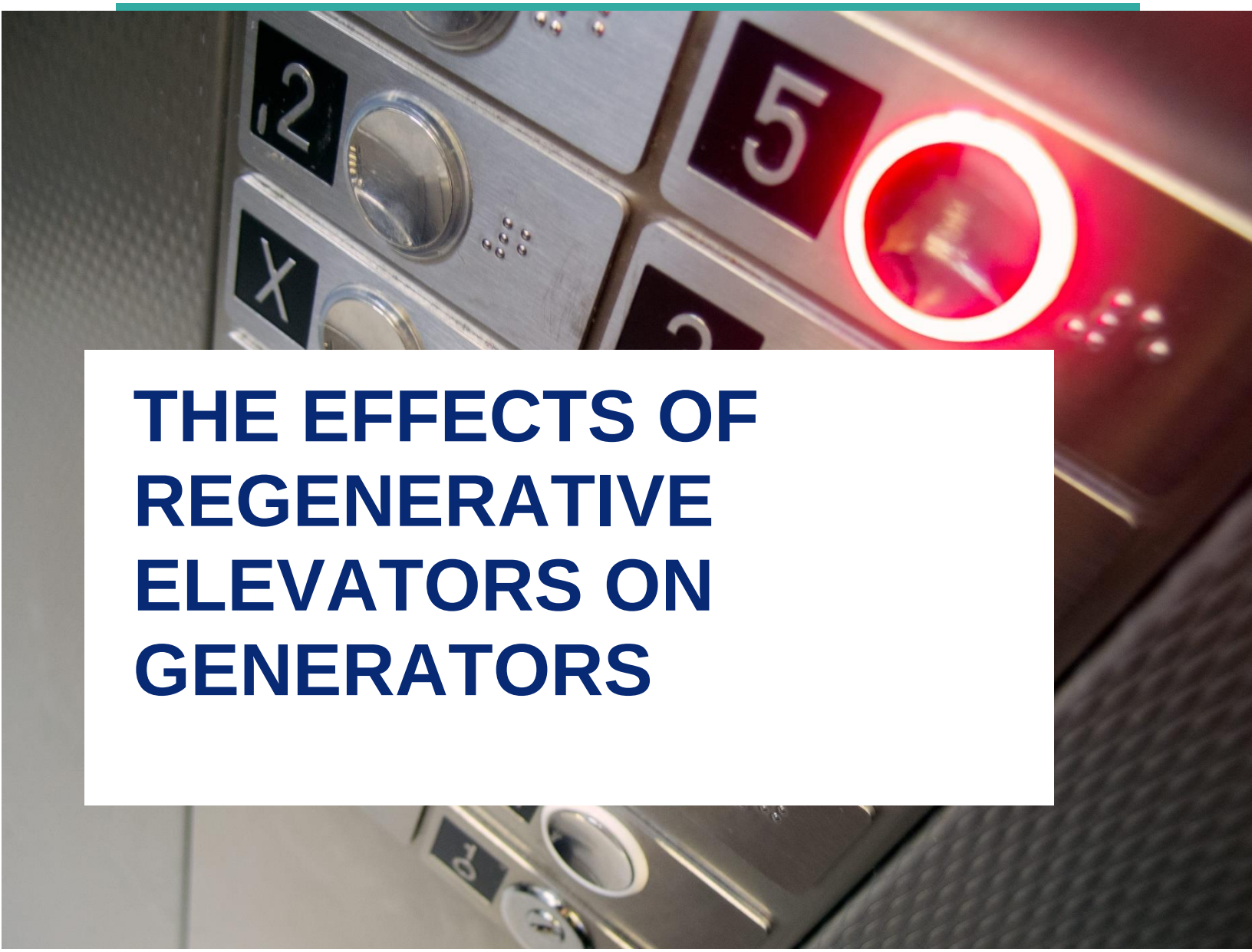

THE EFFECTS OF REGENERATIVE ELEVATORS ON GENERATORS

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Whitepaper

Authored by: Jennifer Kuether, PE

CHICAGO ENGINEERS

The Concern

Although recent advancements in technology have made elevators more energy efficient than ever, regenerative type of drives in elevators can prevent a building's generator from performing its essential job to provide power to equipment, devices and lighting for particular scenarios which will be outlined in this paper. A defective generator can result in interruption or damage to products/processes, hamper rescue operations or, worst of all, create serious life safety hazards. It is important to understand the effects of regenerative type elevators for the case of a brand-new building or an existing building in which the elevators are being replaced.

Regenerative Type Elevators

Shaft or rope type elevators exert energy back into the system when the carriage is descending. During this process the mechanical load causes the motor to turn faster than synchronous speed so that in effect the motor acts like a generator, producing current. Traditional elevator systems utilize braking resistors to dissipate the extra energy which is then turned into heat that is distributed into the elevator machine room. Regenerative type elevators differ from traditional type in that they use drives which recycle energy by capturing heat generated by the elevators and converting it into reusable energy.

The problem with connecting regenerative type elevators to a generator is there most often will not be other loads to absorb the extra power generated back into the system. The generator will then act as a motor and possibly cause the engine to overspeed which can then lead to engine failure. Most generator manufacturers indicate that their generators can handle up to 10% of regenerative loads without an issue. For example, a 100kW generator can accept up to 10kW of regeneration power.

Generator Loads

Loads connected to generators are activated at different times as programmed; these loads are separated onto different automatic transfer switches (ATS). Figure 1 on page 4 represents a simple partial emergency power riser diagram. The loads served by the generator distribution panel, "GDP-1", are branched off per National Electric Code (NEC) requirements. 3 separate transfer switches are shown in the diagram; they feed the following load types as defined by the NEC: emergency, legally required standby and optional standby.

- ATS-1 serves emergency loads and must switch over to the generator in the case of an emergency in 10 seconds or less. Per NEC 700.2 "these systems are intended to automatically supply illumination, power, or both, to designated areas and equipment in the event of failure of normal supply or in the event of accident to elements of a system intended to supply, distribute, and control power and illumination essential for safety to human life."[1.] Loads off of this ATS switch are typically comprised of emergency egress lighting fixtures and exit signs.
- ATS-2 serves legally required standby loads. Per NEC 701.2 these types of loads are the type that "when stopped during any interruption of the normal electrical supply, could create hazards or hamper rescue or fire-fighting operations."[1.] Elevators are an example of one of these legally required standby load types; the associated ATS must switch over in 60 seconds or less.
- ATS-3 serves optional standby loads. These loads do not have to be switched over to the generator at a specified minimum time and they are comprised of any loads which building management would like to back up and are not in the emergency or legally required standby category. Per NEC 702.2 these are types of loads that "when stopped during any power outage, could cause discomfort, serious interruption of the process, damage to the product or process, or the like."[1.] An example of this type of load is walk in coolers for a large commercial kitchen.

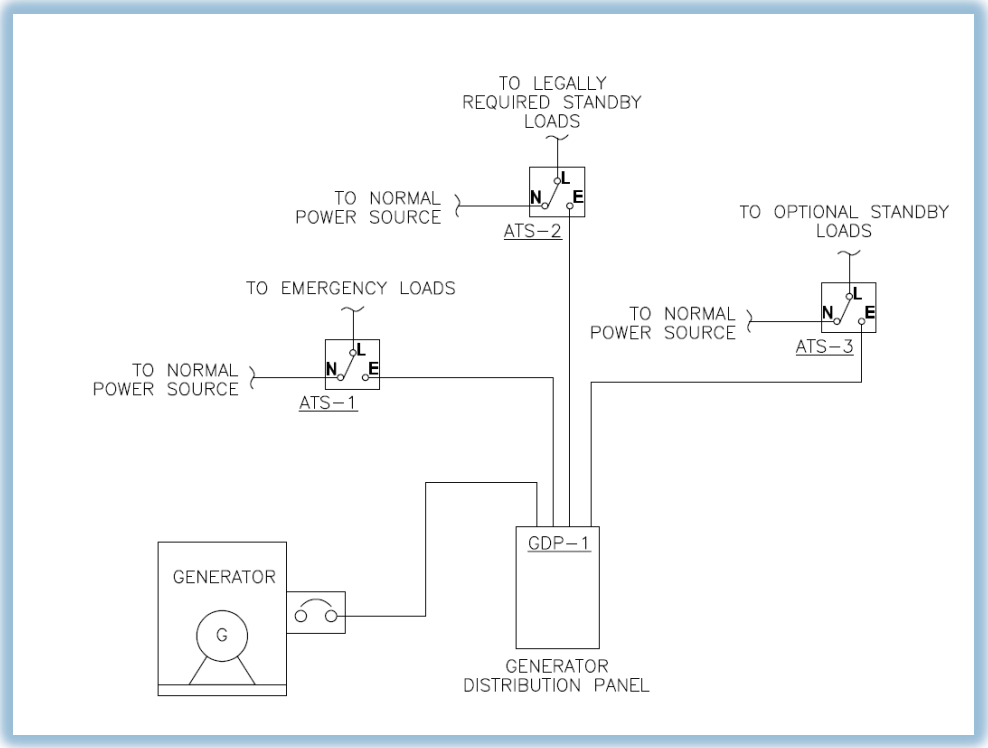

Figure 1

Solution

Some may ask why other loads served by the generator cannot be factored into consideration for absorbing the regenerative loads. Typically, they cannot for several reasons. Since automatic transfer switches bring on loads at different times only those loads fed from the same transfer switch as the elevators (or regenerative loads) should be considered. Although the emergency loads on ATS-1 will be activated prior to the elevators loads on ATS-2 they should not necessarily be considered as a source for absorbing regenerative loads. There are some situations that could present themselves in which only ATS-2 is activated. One being exercising of the ATS that feeds the elevators with load. It is not necessary to exercise the ATS with load however if this were done then the emergency loads associated with ATS-1 could not be factored in since only ATS-2 would be in the process of being tested. Another possible, although rare, situation that could happen is a local fault inside of the building combined with normal power lost only to ATS-2. In this case, only the ATS that lost normal power will connect to the generator. In any case, emergency type loads associated with ATS-1 typically make up a very small percentage of the overall loads connected to a generator so even if they

were factored in to absorb regenerative loads, they most likely would not be sufficient to fully address the issue. Likewise, with loads other than elevators which may be fed from the same transfer switch, ATS-2. Some other examples of legally required standby loads are communication systems, ventilation and smoke removal systems and sewage disposal. These are all small loads compared to the elevators and also may or may not be a part of the building's systems depending on several factors.

A permanent, radiator-cooled, unit mounted load bank can be added to the generator to absorb regenerative loads produced by the elevators. This type of load bank is ideal for this application since it uses the air outflow of the generator's engine radiator to cool the resistive load elements. These types of load banks are also compact making them ideal for easy installation and retro-fit applications. The load bank should be equipped with an automatic controller and be programmed for auto-loading. This allows for automatic variable response to total load demands on the generator. Figure 2 on page 6 builds upon Figure 1, incorporating a load bank for the case where regenerative loads on a generator exceed 10% of the generator's nameplate rating. A permanent load bank can also be utilized for testing the generator if sized appropriately for this application. This would save maintenance costs associated with renting a temporary load bank.

Example-Sizing a Load Bank

Note, not all elevators in a building need to be factored into calculating the total regenerative load. Typically, elevators are programmed to be sequentially recalled and only a single elevator per bank would be considered to be on the generator at a time. Sequential operation allows for the elevator controller to select the first elevator in a bank to lower to the main floor and continue on to each of the rest of the elevators within the same group until all have been lowered.

Below is an example for sizing of a load bank for the purpose of absorbing regenerative loads:

- Generator size: 750KW
- Elevators: 28KW each; there are 5 different banks in the building – 3 elevators in each bank
- Total regenerative load (assuming sequential recall for elevators): 5 elevators (one per bank) x 28KW each = 140KW
- Remember, the generator can handle up to 10% of it's nameplate rating of regenerative type loads. This generator can handle 75KW of these types of loads without issues. Therefore, load bank should be sized for 140KW-75KW = 65KW.
- Load banks are manufactured in standard blocks of sizes. Assuming the load bank manufacturer produces in blocks of 50KW, a 100KW load bank would be required.

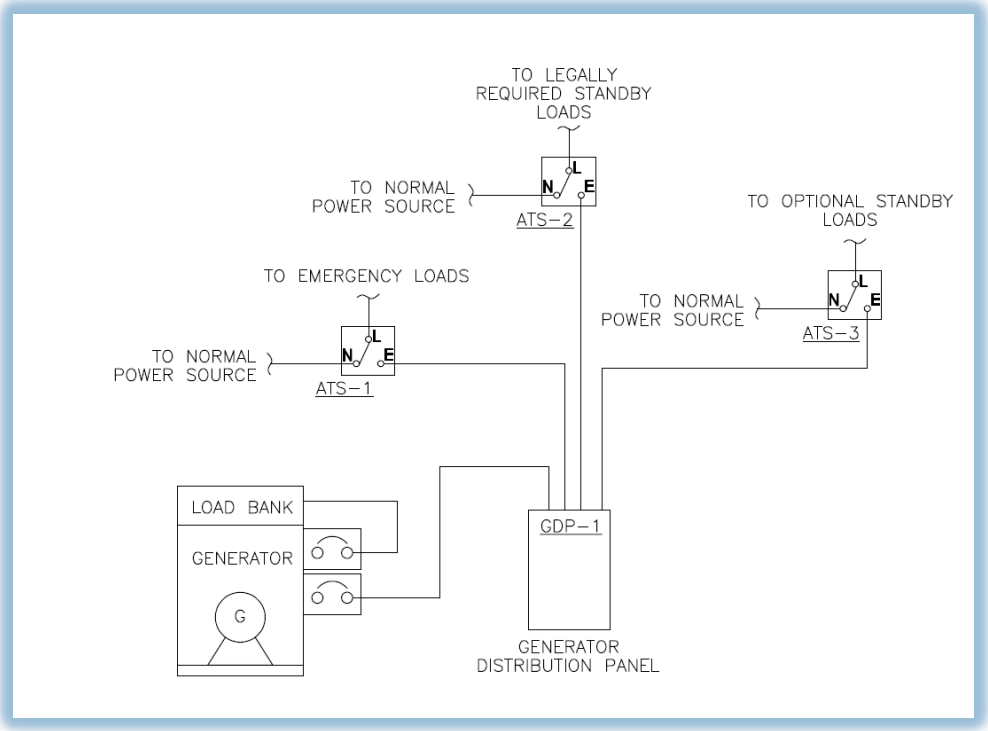

Figure 2

Conclusion

The effect of regenerative loads on a generator is an important issue that should be well thought out at the beginning of a design for new buildings and also factored in to decisions that are made when refurbishing elevators in an existing building. The impact of ignoring this can lead to serious implications for both building systems and the occupants inside of the building. If there are excessive regenerative loads on a generator steps can be taken to establish a safe and orderly system by introducing a load bank.

Sources

1. National Electric Code 2017