An MCE Technical Publication

Static Drives vs Motor Generators

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Purpose

This Technical Publication examines variables that help determine the suitability of static drives vs motor generators for any given project.

Motion Control Engineering, Inc. experience with various drive configurations suggests the **need for review** of drive considerations by consultants and contractors prior to the selection of a drive system for any project, whether new installation or modernization.

Overview

Most of today's elevator control specifications require the utilization of static drives. Nonetheless, experience shows that there are applications where motor generator control systems may be a better choice (in fact they may be the only choice). It is important to have a **basic understanding of variables** that must be reviewed for proper drive selection.

Introduction

The selection of an elevator drive requires examination of the adequacy of the power distribution system and possible interference with other devices sharing the power line. After all variables have been considered, select the drive type (and if necessary, appropriate isolation and filtering devices) to satisfy the needs of the specific application.

In today's world, for elevator drive systems, the product of choice is Static drives in lieu of motor generator sets. Nonetheless, sometimes after thorough evaluation, **motor generator drives may be the most appropriate choice** for a particular project. In this bulletin, we evaluate the merits of these drives and look at some situations in which it might be better to specify motor generator drives in lieu of static drives.

Old elevator control technology was analog, which created little or no line pollution and worked well with emergency power generators.

Issues to consider before selecting static drives include:

- Power consumption
- Maintenance
- Emergency power generators
- Shared power feeders
- Equipment sensitive to harmonics
- Marginal AC feeders
- Gearless motors with straight slots

Power Consumption

One of the advantages of solid state drives is that they are more efficient then motor generator sets. There are three elements that contribute to an elevator system's use of power.

1. The power used by the MG set when running idle. Many are not aware of the fact that a motor generator draws about 35% to 40% of the full load current when idling. In other words, if the generator is running while the car is stopped, as much as 40% of full load current may be drawn to keep the generator running. This current is used for overcoming friction and provide magnetization current for the MG set. Power used for running a generator at idle may translate to about 12% of the *power* used by the elevator when running on full load. Note that the generator will be running idle well over 50% of the time, and sometimes as much as 70% of the time (any time the elevator is stopped at a floor and the generator is running).

2. MG sets are less efficient than SCR drives. A motor-generator set's two rotating elements operate with 72% to 81% efficiency. A static drive used in conjunction with a line transformer operates with 95% to 97% rectifier-transformer efficiency. By substituting a solid state DC drive for a motor-generator set, drive efficiency can be improved (from 18% to 33%).

3. The power factor. At leveling speeds, SCR drives have a poorer power factor than MG sets. On the other hand, MG's running with no load have fairly poor power factor themselves. Utility rates may or may not penalize for poor power factor. Therefore, some of the effect of the power savings of static drives may be lost as the result of power factor.

Various elevator companies claim anywhere from 15% to 25% power savings with the use of SCR drives. From the above, one can see that the actual amount of savings depends on many elements. However, one could state conservatively that a 15% power savings is likely when substituting SCR drives for MG sets.

Maintainability

Another advantage of solid state drives is ease of maintenance. Motor generators are high speed rotating equipment. Therefore, they need periodic lubrication and bearing and brush replacement. Additionally, brush wear produces carbon dust that can contaminate the machine room environment. Elimination of MG sets removes the maintenance demand represented by MG sets.

These are two of the strongest arguments in favor of using static drives instead of motor generators.

Marginally Sized Emergency Generators

For static drive applications, the emergency power generator must be sized **substantially larger** then the total power demand required by elevators. Undersized generators can result in interaction between the two systems causing **trip-off** of either the emergency generator or the static drive.

Some emergency generators are sized so marginally that they are **at the theoretical minimum rating** necessary to provide power for the elevators. In actual field conditions, static drives can place an excessive burden on these generators, resulting in poor elevator operation, trip-off of generators, trip-off of elevators and other irregularities.

Compatibly problems result from the generator's inability to **cope with the rapid changes in current demand** that are typical of static drives. Consequences include frequency fluctuations that **can trip either system**.

The first step to ensure application of the proper elevator drive system is to **review the various parameters** of the existing elevator control equipment, power distribution system, and emergency power generator. This examination should include full load current, acceleration current, running current, feeder size, emergency generator capacity and power source (natural gas, diesel, etc.).

Ask static drive suppliers to provide the **AC equivalents** for full load current, acceleration current, running current, and so forth. Discuss the issue of conversion to static drives with the manufacturers of emergency generators. Note that natural gas generators, where regulation is a function of gas pressure, are more likely to present a problem than diesel generators. As a rule of thumb, you could expect anywhere up to about 30% more current drawn by SCR drives than MG sets. This depends on the efficiency of both the existing MG set and the new SCR drive.

One example of experience with static drives and emergency power regulation is the case of the emergency generator that would run empty cars, but would only lift fully loaded cars 10 of 22 floors. **Regulation had to be readjusted** to remedy the problem. When writing specifications you may wish to require the generator maintenance company's representative be present during final testing.

Emergency Generators Sensitive to Harmonics

Static drives generate harmonic distortion that, in some instances, places an excessive burden on emergency generators. Emergency generators can be **sensitive to harmonics or other power line pollution** created by static drives. **Ask** the emergency generator manufacturer **about sensitivity** to harmonics and other noise.

Emergency Generators Sensitive to Power Factor

At low elevator speeds SCR static drives **have a worse power factor** than motor generator control systems (at high speed they are similar). KVA ratings for feeder transformers and wire sizing **must** be adequate. If emergency generators are sensitive to poor power factor **the use of SCR drives is not recommended**. Find out about **power factor sensitivity** from the emergency generator manufacturer.

Shared Power Distribution Systems

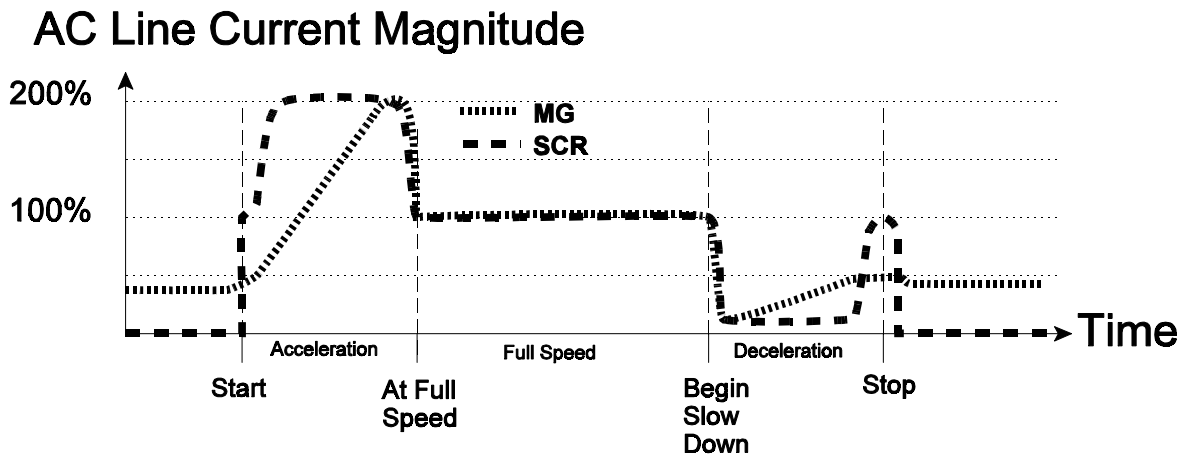
MG sets may be the best choice if equipment sharing the same power feeders is sensitive to harmonics and other line noise created by static drives. This can happen in hospitals, financial centers, airports, government agencies or other similar buildings where electronic devices (computers, scanners, data transmission equipment, and radio-TV transmission equipment) are present. In some cases, RFI generated by certain types of static drives, especially VFAC drives, may cause interference.

Marginal AC Power Distribution

Static drives draw current from the power distribution system differently then motor generator systems. It is **extremely important to note** that, in many modernizations where static drives are to be utilized, the existing elevators may not be running at contract speed. As a result, power distribution systems may appear to be adequate. After modernization is completed, the power system may actually be marginal or even insufficient to run the elevators at contract speed. Here again, thoughtful evaluation of jobsite conditions is required, and motor generator systems may be preferred.

AC Line Current Magnitude Graphs for Motor Generator vs SCR

The curves in the “Motor Generator vs SCR Drive” graph illustrates the difference between the way current is taken from the AC line by these two types of devices. The respective AC line current magnitudes, at full speed, are very similar; however, you can see that there are substantial differences during acceleration and deceleration. The motor generator system’s current magnitude during acceleration, has a gradually increasing curve which rises to maximum current to achieve full speed. The SCR drive has an immediate response, drawing maximum current throughout acceleration until full speed is achieved. The SCR drive is more efficient overall, but the brief extra current loads on acceleration and deceleration can create problems when the normal power distribution system or emergency generator is inadequate.



AC Line Current Magnitude – Motor Generator vs SCR

Current Requirements for SCR Drives

A good approximation for calculating the AC equivalent currents for SCR drive applications is:

$$.82 \times \frac{\text{DC Full Load Amps} \times \text{Armature Voltage}}{\text{Line Voltage}}$$

The AC equivalent current being taken from the elevator power supply is the sum of the current calculated above (SCR drive current), *plus the AC current required for the controller, door operator, brake, and motor field.* For maximum accuracy when determining AC line equivalents, it is best to use field data obtained during operation of the elevator at full load and full speed.

Note: Full load current typically drawn by SCR drives may be about 30% greater than that of the drive motor for the matching motor generator set.

Gearless Machines

When the hoist motor is an old gearless type with "**straight slots**" (motor armature slots relative to the edges of the motor field poles), **torque pulsations may be created** during high current conditions. This effect is subdued with MG sets, but accentuated with SCR drives ***of any kind***.

When retaining this type of hoist motor it is best to modernize using motor generator controls. Motors with straight slots are often GE or Westinghouse gearless machines dating to pre-1930's. A knowledgeable elevator man can usually identify "straight slots" in gearless motors by visual inspection.

Conclusion

Selecting the best elevator control drive for a particular application is not an exact science. However, as you have seen, consideration of factors discussed here can increase the likelihood of success.

Many installation problems result from failure to recognize and consider the issues raised here. With proper evaluation, the transition from motor generator controls to static drives is, in most cases, not only desirable but appropriate.

While this publication addresses many issues relating to selection of motor generator vs SCR drives, it is desirable to continually explore issues relating to drive selection.

MCE's Technical Publication series is intended to be an informative catalyst for ongoing dialogue and sharing of information between consultants, elevator contractors, owners and other interested parties. **MCE Technical Publications are available on our website at www.mceinc.com.**

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