

# ELEVATOR GUIDELINES FOR EMERGENCY GENERATORS

by Patrick J. Welch

Passengers trapped in elevators need every opportunity to escape an emergency situation. If designed to operate on standby power, the emergency generator must operate elevators safely and reliably. If the elevators do not operate properly while on emergency power, serious consequences can occur.

The most commonly ignored operation of an elevator is its ability to operate properly on standby power. The American Society of Mechanical Engineers (ASME) A17.1 and most local codes require elevator standby power testing annually, with no-load and full-load (125% of capacity) test every five years. Furthermore, if more than one elevator is capable of running simultaneously, they shall be tested simultaneously.

Experience shows that many buildings ignore this code requirement. Some large facilities, including hospitals, have not tested any of the elevators on emergency power in over 20 years! With the advent of SCR and VFAC drives for elevators and other devices, existing emergency generators are often not capable of providing the proper power to operate the elevators in an emergency.

Keep in mind that older elevator systems often do not operate at the original contract speed. Therefore, if any equipment has been added since the original installation, the change to a solid-state drive operating at the proper speed can cause unpredictable problems. Additionally, older emergency generators have a difficult time with the rapid changes in current demand that solid-state drives require.

Current and voltage harmonics also differ greatly from utility power to the emergency generator power supply. Improper grounding methods and increased impedance of the generator system can cause additional problems with sensitive devices on the emergency bus, due to increased harmonics and RFI.

Several tests with the Reliable Power Meter® monitor have determined that existing generator or emergency feed-

ers must be upgraded to operate with an adjustable-speed elevator solid-state drive. Each test conducted followed ASME A17.1 requirements.

After establishing a benchmark on utility power, the generator was started, and a power loss was mimicked at the transfer switch. While on emergency power, the quality of power was measured as defined here:

- ◆ frequency;
- ◆ total harmonic distortion (THD) for current and RMS voltage;
- ◆ RMS voltage; and
- ◆ current.

After comparing utility power quality to the emergency generator power, the quality of power with no load was determined. The load on the elevator was then increased until 125% of rated capacity was reached, as required by A17.1. *Continued* ▶



# ELEVATOR GUIDELINES

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The most common problems operating on emergency power discovered to date have been:

1. Increase in THD, up to a 300% increase over utility power;
2. Improper or inadequate grounding methods;
3. Poor voltage regulation (>25%); and
4. Voltage sags in excess of solid-state drive parameters.

Since our testing program was started in February 1997, roughly one Syska & Hennessy existing building project per month has required significant upgrading of the emergency generator and/or emergency feeder, if a modern solid-state elevator drive is desired. Often, the client is unprepared for the additional expense of upgrading the emergency generator, and motor generator elevator drives have to be specified to save the client the emergency generator upgrade costs, as well as the potential disaster of a failed emergency system.

To help prevent problems, a conservative course of action developed through research, testing and feedback from knowledgeable clients and vendors is recommended. This does not mean that you cannot specify outside the suggested parameters. It does mean, however, that you must be careful and should thoroughly investigate existing conditions to predict the effect of all of the various types of drives on the emergency generator.

Other potential problems of concern include:

1. What other devices are operating on that emergency bus? UPS systems? VFD for fire pumps?
2. Are other harmonic-rich devices on the same bus? For example, electronic ballast light fixtures - the harmonics of which can create problems for elevators.
3. Are harmonic-sensitive devices - such as radio or telephone dispatching equipment or critical computer equipment - on the same emergency bus?
4. Can the emergency generator handle the chopped waveform of regenerative power from the elevator SCR without affecting its performance?
5. Is the voltage regulator for the emergency generator designed for the worst-case scenario, as the code requires?

Keep in mind that several different types of elevator drives are in use today, including:

- ◆ Six-pulse SCR drives (typically filtered to 5% THD);
- ◆ 12-pulse SCR drive (no filter);
- ◆ Variable frequency/variable voltage AC (nonregenerative);
- ◆ Variable frequency/variable voltage AC (regenerative) - rare but increasingly more common;
- ◆ Motor generator set; and
- ◆ Across the line and WYE delta (hydraulic and rack & pinion).

It is recommended that the emergency generator specifications be coordinated with the exact elevator drive to be used on the project.

## Hydraulic Elevators

It is recommended that hydraulic elevators not be put on the emergency generator unless they are critical hospital patient care elevators that will need to be used throughout the power outage. It is far more efficient to provide an emergency-battery lowering device on these elevators to rescue the passengers instead of including a large horsepower motor on the emergency generator just to allow passengers one trip to get out of the elevator.

## Sizing Emergency Generators

Do not design more than two elevators equipped with solid-state drives to run on the same emergency bus simultaneously. Research and field testing reveals that the harmonics and regenerative nature of most elevator drives can cause voltage distortion problems on the same bus. Do not allow adjustable-speed solid-state drives of any type to exceed 50% of the capacity of the emergency generator. This includes other solid-state drives in the building that will be using the same emergency power supply.

Should circumstances require a greater than 50% drive capacity of the emergency generator, ensure that the generator manufacturer is aware of the type and quantity of the drives. Serious consideration should be given to specifying the allowable voltage distortion. If there is an overall voltage distortion limit, make sure that the generator unloaded waveform is well below that limit. It is virtually impossible to filter an inherently distorted generator waveform.

## Existing Buildings

Check the governor/regulator of the emergency generator; older buildings being renovated often have mechanical governors on the emergency generators. Modern solid-state drives simply cannot operate properly with the voltage distortion created by a solid-state drive

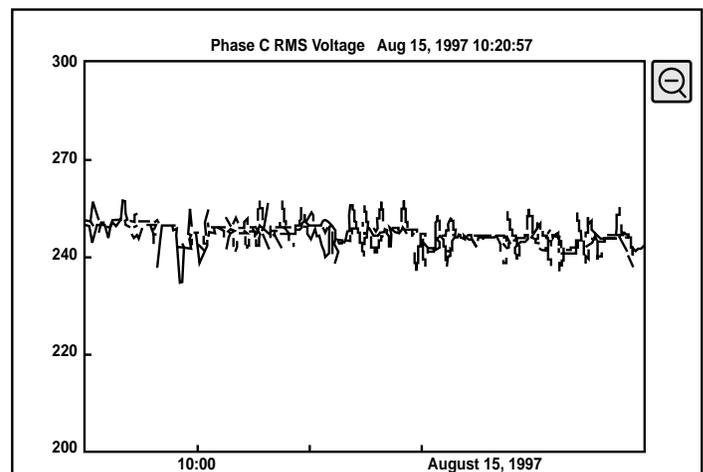


Figure 1: Utility power during full load runs of elevator; Voltage fluctuation is less than 6 volts.

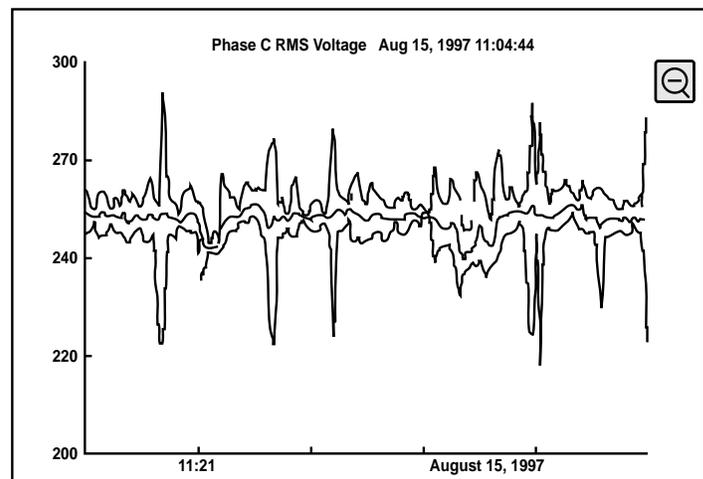


Figure 2: This is the same elevator on emergency power. The voltage fluctuation is up to 40 volts.

and an emergency generator with a mechanical governor. Keep in mind that elevator drives move people, not fans or computers, and the operating tolerances are tight. Simply put, rarely is it recommended to allow an elevator with a solid-state drive to operate on an emergency generator without a solid-state regulator being installed on the emergency generator.

For example, Figures 1 and 2 show a graphic expression of the quality of the voltage of an elevator system with a motor generator drive while on utility power during a full-load weight test of the elevators. Had solid-state drives been utilized, the emergency generator or elevator would not have operated properly.

### **Testing**

All existing buildings should be properly tested to determine a final design. The test should not use a load bank. It is critical to determine what other sensitive devices operate on the emergency generator. The load bank is simply too clean (no reactance or interference) to properly determine how the elevator affects the system.

Elevator maintenance contracts should define this requirement clearly. Experience shows that if the building does not require this test, the elevator maintenance contractor will consider it a building manager's responsibility.

The load bank is also too clean to determine if the elevator drive will affect other devices on the same emergency generator bus - items such as electronic ballast lights, fire control systems, radio dispatching centers and other communication devices.

A "blackout" type test is recommended whenever possible, so all concerned parties will understand which device operates properly and which devices have difficulties under emergency conditions. In other words, all devices designed to operate on the emergency generator should be tested simultaneously. This will allow building management to understand how all of the life/safety devices will operate on emergency power while in full control of the power source.

It is far better to fail this controlled blackout test due to an improper design or modification under controlled circumstances than to discover that the elevators either fail to operate or, even worse, cause the emergency generator to trip out, causing other life/safety devices to fail during a true emergency. Updated one-line diagrams for all life/safety systems should also be reviewed and updated during these tests.

Elevators are part of an entire building operation system. Elevator drives affect the building's electrical system and, in turn, are affected by the building's electrical devices as well. Close coordination of drives and distribution of power is critical to a building's safe and reliable operation.

*Patrick J. Welch is President of Vertical Transportation Excellence, a division of Gannett Fleming, Inc. He oversees their Vertical Transportation offices located in Washington, Baltimore, Philadelphia, New York and Connecticut. In addition, he is a member of the A17 Escalator and Moving Walk Committee and chairs the "Vertical Transportation Chapter 12 in the Institute of Electrical and Electronics Engineers, Inc. (IEEE) Std. 241, Recommended Practice for Electrical Systems in Commercial Buildings."*