To Study the Effect of Voltage Sag in Electrical Equipment

B. Kandavel and A. Subramanian

Abstract--- In this method attempts to have the effect of studying electrical devices for voltage drop. Modern industrial methods are based on a large number of electronic devices such as programmable logic controllers and adjustable speed drivers. Unfortunately, electronics are sensitive to interference, and as a result, industrial loads cause less resistance to power quality problems such as voltage sag, voltage swells and harmonics. Voltage sag are an important measure of the power quality problem, and Dynamic Voltage Restorers (DVRs) are known to mitigate their usefulness. Dynamic Voltage Restorers (DVR) have become popular as a cost effective solution to protect sensitive loads from voltage sag and swelling. A control system that uses a phase locked ring. The phase locked ring is used to maintain a continuously synchronized load voltage and monitor the source voltage. The results show that the proposed method improves the performance of the DVR.

Keywords--- Voltage Sag, Power Quality, Dynamic Voltage Restorer.

I. INTRODUCTION

In the past, equipment used to control industrial processes was mechanical and could withstand voltage interference. Today, modern industrial equipment often uses a large number of electronic components such as PLCs, adjustable speed drivers, and optical instruments, which are highly sensitive to such voltage interference. Typical disruptions that cause electronic device problems include voltage interrupts and drops, voltage fluctuations, capacitor switch transients and harmonics. Voltage disturbances have been found to be particularly troublesome as random events last only a few cycles. Even though the supply voltage is fully restored within a few cycles after the malfunction, processors may not be able to maintain multiple cycles and continue to travel or shut down during normal operation. Therefore, from the perspective of industrial customers, voltage sag and transient interference can have the same effect on their processes. In addition, the frequency of the voltage sag at a given point in the power supply system is much higher than the frequency of the instantaneous interruptions because the voltage sag are still far from the wrong location. Due to faults in a line, the term "fragile area" is often used to serve voltage amplitudes on a geographical or line map.

1.1 Single Phase Sags

The most common voltage drop, over 70%, is usually caused by a single phase event somewhere in the system, which usually leads to ground fault. The fault of the earth from this point is caused by a single-phase voltage drop from the other feeders in the same substation. Common causes include lightning strikes, tree branches, and animal contact. It is not uncommon for single phase voltages to decrease by 30% of the nominal voltage or even in the factory.

1.2 Phase to Phase Sags

In the second stage, intermittent recession can be caused by tree branches, bad weather, vehicle or vehicle collisions on utility poles. Two-phase voltage typically occurs in the other feed from the same substation.

1.3 Three Phase Sags

Symmetric three-phase sag make up less than 20% of all sag cases, and can be caused by switching or replacing three-phase voltage sag from one sub-circuit to other lines or by switching or re-adjusting three-phase circuit breakers. Three-stage sag can also occur with the launch of larger motors, but

B. Kandavel, Assistant Professor, Department of EEE, SCSVMV, Kanchipuram, Tamil Nadu, India. E-mail: kanda71@gmail.com
A. Subramanian, PG Scholar, Department of EEE, SCSVMV, Kanchipuram, Tamil Nadu, India. E-mail: subueee@gmail.com

this type of event usually reduces the voltage to 80% of the nominal voltage, usually only to industrial plants or their immediate neighbors

II. LITERATURE REVIEW

The quality of power delivered to the end user is important, as the performance of consumer devices depends largely on the device. However, power quality is affected by a number of factors, such as voltage and frequency changes, harmonics presence and phase failures. Among them, voltage change is one of the most common problems. There are many ways to alleviate voltage sag, the best of which is to connect the real devices in the area of interest. For this purpose, popular equipment such as DSTATCOM, DVR and UPQC are used. The world's first DVR installation was completed in 1996 at a 12.47 kV substation at Duke Power in Anderson, South Carolina. Since then, ABP, Siemens and other companies have worked for years to implement immediate workflows, eventually developing their own product models to ensure the quality of voltage-sensitive loads. So, there is a lot of research in this area. This article introduces the structure and control strategy of DVR. It discusses how to control the DVR to alleviate voltage disturbances. It also shows the other benefits of connecting the DVR to the electrical network. The DVR design for voltage drop mitigation applications is proposed. In the fall, it's DVR's

III. VOLTAGE SAG

3.1 Definition of Voltage Sags

The definition of the voltage node is usually based on two parameters (amplitude or depth and duration). However, different sources interpret these parameters differently. Other important parameters that describe the voltage drop are the point wave of the voltage drop and how the phase angle changes during the voltage drop. Phase angle jumps during faulting are caused by changes in the X / R-ratio. Phase angle hopping is a problem, especially for power electronics devices that use grid or zero crossing switches.

3.2 Voltage Sag

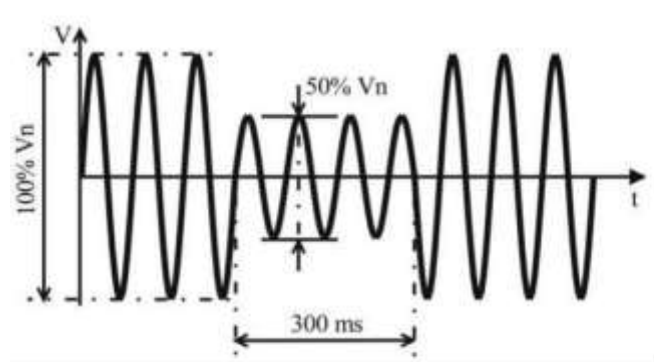

Figure 1: Voltage Sag

3.3 Sources of Sags and Short Interruptions

Power systems have a non-zero impedance, so each increase in current causes a corresponding decrease in voltage. Usually these reductions are small and the voltage is within normal tolerance. However, when there is a large increase in current, or when the system impedance is high, the voltage can decrease significantly. So theoretically, there are two sources of voltage drop

In fact, most voltage sag are caused by increased current. Think of the electrical system as a tree that connects the client system to a branch. Any voltage drop on the trunk or branch of a tree for a customer's branch can cause a voltage drop on its load. But short circuits in long-distance branches reduce the voltage of the mains, so even a fault in the distance of the tree will reduce the customer's load. Most voltage sag are caused by short circuit failures in the industrial facility or utility system under consideration. The magnitude of the voltage drop depends mainly on the impedance between the fault bus and the load and the coupling mechanism of the transformer windings. The voltage dip lasts only when the safety device clears the throttle (usually up to 10 cycles), so the duration of the voltage node depends on the fault erasure time of the security system used. In addition, if a utility company uses an automatic bracket, the voltage sag may recur in the event of a permanent failure. Finally, depending on its size and duration, the sagging device can cause travel, which can become a power quality problem. The most common cause of equipment failure.

Start with heavy loads such as electric motors or anti-heaters. Loose or defective wiring, such as fully tightening the power conductor's frame screws. A faulty or short-circuit facility is located elsewhere (bad weather, such as trees, animals, wind or lightning). The voltage sag can also start the power company. The most common type of application-source voltage drop is: over long distances of the circuit, it causes the associated reduction in circuit voltage to fail. Regulator failure (very uncommon).

3.4 Voltage Sags Due to Transformer Energizing

- The causes for voltage sags due to transformer energizing are:
- Normal system operation, which includes manual energizing of a transformer.

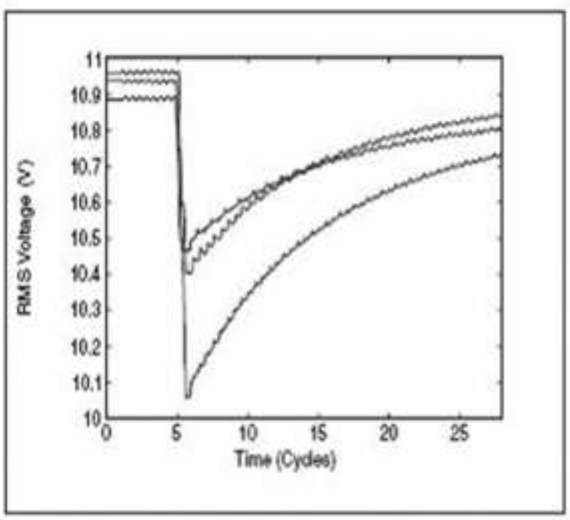

Figure 2: Voltage Sag Due to Transformer Energizing

Voltage sag are asymmetric in nature and they are often depicted as a sudden drop in computer voltage, then a slow rise. The main reason for the excitation of the transformer is the excess, so that the center of the transformer joins the enrichment. Sometimes, long-range sag, many transformers are pumped into the envelope. This is called sympathetic nerve contact. Figure 2 shows the voltage node as the transformer receives energy.

IV. VOLTAGE SAG ANALYSIS

4.1 Voltage Sag Analysis

According to standard IEEE 1346- 1998, Voltage Sag is defined as-“A decrease in RMS voltage or current at the power frequency for durations of 0.5 cycle to 1 min. “Typical values are 0.1 to 0.9 pu.”

4.2 Characteristics of Voltage Sag

The voltage sag is characterized by its magnitude, duration and phase angle jump. Each of them is explained below in detail.

4.2.1 Magnitude of Sag

A chimney size is defined as the minimum voltage remaining during the event. Size can be defined in many ways. The most common method is to use an RMS voltage. Other alternatives are to use a basic RMS voltage or peak voltage. Therefore, during the event the depression is considered a residual or residual voltage. In all three cases - the phase system, the voltage immersion is not the same, the grid with the lowest slope is used to characterize the aperture. The amount of voltage drop in a given phase depends on the conduction

The time at which the voltage is below a threshold. This is determined by the time of fault removal. The three RMS voltages in the three phase system must calculate the time. When one of the grid RMS voltages is lower than the threshold and the three phase voltages continue above the threshold, the recovery of the fault begins

4.2.2 Phase-angle Jump

The short circuits in power system not only cause a dip in voltage, but also change the phase angle of the system. The change of phase angle is called as “Phase - Angle Jump”. It causes the shift in zero crossing of the instantaneous voltage. This phenomenon affects the power electronic converters which use phase angle information for their firing.

4.2.3 Point-on-wave

To perfectly characterize sag, the point- on - wave where the sag starts and where it ends should be found with high precession. The point- on - wave is nothing but the phase angle at which the sag occurs. These values are generally expressed in radians or degrees.

4.2.4 Impact & Cost of Voltage Sags

There is a strong argument that can be made to claim that voltage sags are the most costly of all power quality disturbances. While perhaps not as costly as interruptions, voltage sags are much more prevalent and in some cases may have the same impact as a supply interruption. Relatively shallow voltage sags can lead to the disruption of manufacturing processes due to equipment being unable to operate correctly at the reduced voltage levels. Industrial equipment such as variable speed drives and some control systems are particularly sensitive to voltage sags. In many manufacturing processes, loss of only a few vital pieces of equipment may lead to a full shut down of production leading to significant financial losses. For some processes which are thermally sensitive a significant loss of material as well as the time taken to clean up and restart the process must also be considered. There have been many studies which aim to quantity the cost of voltage sags. The results of these studies range from relatively modest cost associated with voltage sags through to very high costs generally at high technology industrial plants (such as semi - conductor manufacturing). Table 1 below reproduced from show the costs associated with voltage sags from a range of industries.

Table 1: Typical Financial Loss for Voltage Sags based on Industry

Industry	Financial loss per event (in £)
Semiconductor Production	3 800 000
Financial Trading	6 000 000 per hour
Computer centre	750 000
Telecommunications	30 000 per minute
Steel Works	350 000
Glass Industry	250 000

Table 2: Impact of Voltage Sags on various Industries

Industry	Loss per voltage Sag
Paper Manufacturing	30 000
Chemical Industry	50 000
Automobile Industry	75 000
Equipment Manufacturing	100 000
Credit Card Processing	250 000
Semiconductor Industry	2 500 000

V. VOLTAGE SAG MITIGATION

5.1 Voltage Sag Mitigation

One major problem that power system networks currently face is voltage drop. This is a serious problem that affects the operation of the device. Therefore, this problem should be alleviated to maintain the efficiency of the power grid. Using a custom power supply device solves this problem. This chapter will introduce some basic frameworks and the operating principles of various devices such as DVR and D-Stat Com. Autotransformers are used to quench voltage sag.

5.2 Dynamic Voltage Restorer (DVR)

Dynamic Voltage Restorer is a power electronics converter based gadget designed to ensure the identification of the troublesome effects of other suppliers over other shortcomings. For the purpose of regular connectivity it is connected to the supply line in most parts of the device.

5.3 Basic Structure

The DVR is a series connected power electronic device used to inject voltage of required magnitude and frequency. The basic structure of a DVR is shown in. It contains the following components-

1. Voltage Source Inverter (VSI)
2. DC storage unit
3. Filter circuit
4. Series Transformer

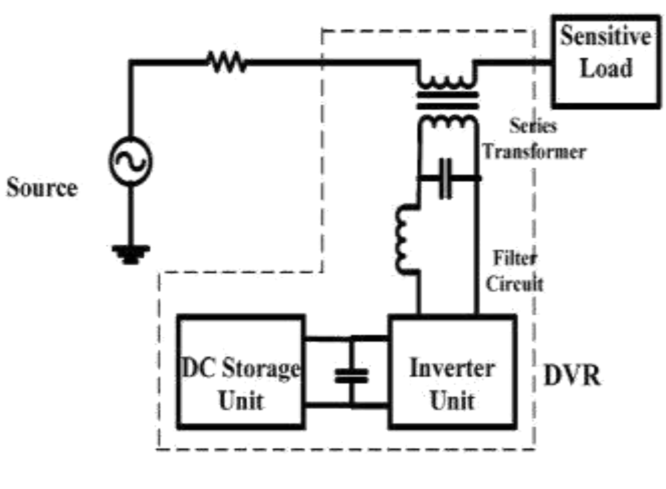

Figure 3: Basic Structure of DVR

Filter Circuit

An LC filter is connected at the output of the VSI to filter the harmonics that are present in the output voltage of VSI. It also reduces the Dv/Dt effect on the windings of the transformer.

Series Transformer

A series transformer is used to connect the DVR with the distribution feeder. In case of three phase system, three single phase transformers are used to connect the DVR with the power network.

Operating Principle

The main operation of the DVR is to inject voltage of required magnitude and frequency when desired by the power system network. During the normal operation, the DVR will be in stand- by mode. During the disturbances in the system, the nominal or rated voltage is compared with the voltage variation and the DVR injects the difference voltage that is required by the load. The equivalent circuit of a DVR connected to the power network is shown in Fig. 10. Here V sis the supply voltage, the voltage injected by the DVR and VL is the load voltage.

VI. D-STATCOM

6.1 D-Statcom

A Distribution Static Compensator is in short known as D-STATCOM. It is a power electronic converter based device used to protect the distribution bus from voltage unbalances. It is connected in shunt to the distribution bus generally at the PCC.

6.1.1 Basic Structure

D-STATCOM is a device designed to connect with a shunt that generates a controlled voltage or absorbs reactive power. A schematic of T -STATCOM is shown in Figure 4. This includes the DC Voltage Source Inverter (VSI) Autotransformer Furnace.

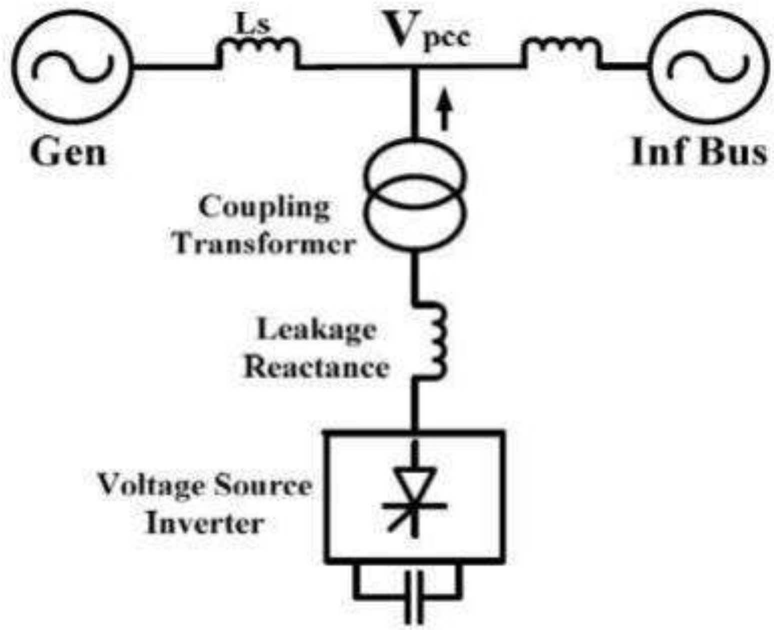

Figure 4: Schematic Diagram of a D STATCOM

As in the case of DVR, this VSI generates a voltage by taking an input from a charged capacitor. It uses PWM switching technology for this purpose. This voltage is transferred to the system through the reactance of the coupling transformer. The voltage difference across the reactor is used to generate active and reactive power exchange.

Operating Principle

The auto transformer is controlled by a PWM operated power electronic switch. The single- phase diagram of a power system network

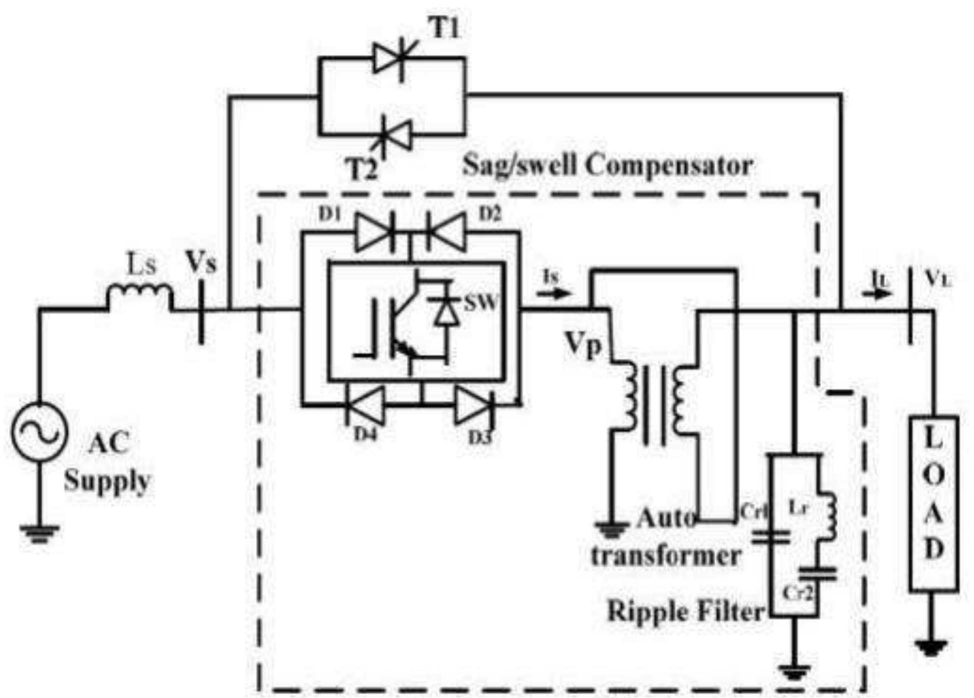

Figure 5: Voltage Sag Mitigation Scheme Using Auto Transformer

IGBT Switch: This switch operates based on pulses generated by the PWM generator and controls the operation of the automatic transformer. Automatic transformer: Used to increase the load voltage unchanged, regardless of the change in power supply voltage. It is controlled by an IGBT switch. Ripple Filter: The harmonics and fundamental components in the output voltage provided by the automatic transformer. Therefore, these harmonics must be filtered to keep the THD of a given system voltage within the IEEE standard specifications. Therefore, a ripple filter is used for the output of the automatic transformer. Bypass Switch: There is a bypass switch made up of parallel SCRs. This switch is used to avoid automatic transformer during normal operation. If the voltage nozzle occurs, the switch is open and the automatic transformer is running. Single-phase circuit diagram under voltage drop conditions. Here the Bypass switch is opened and the automatic transformer works according to the IGPT switch function to generate the required voltage on the load side

Solid State Transfer Switch (SSTS)

SSTS can be used most effectively to prevent voltage sag, swelling and other electrical interference sensing loads. SSTS ensures continuous high-quality power-sensitive load by transferring from the wrong bus to the healthy person in milliseconds. The basic configuration of this device consists of two three-phase solid-state switches, one for the main feeder and one for the backup feeder. These switches are then connected to the TO-BIN arrangement

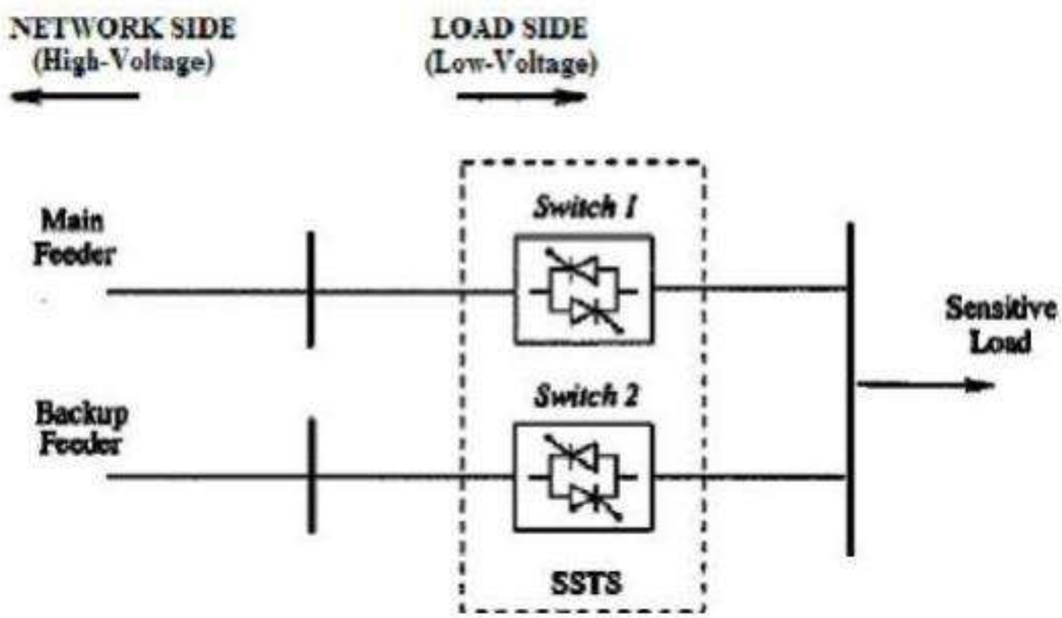

Figure 6: Schematic Representations of the SSTS as a Custom Power Device

Each time a fault is detected in the main feed, the control system switches the firing signal on the two switches, for example, switch 1 on the main feed is deactivated, and switch 2 is activated on the backup feed. The control system measures the peak value of the voltage waveform every half cycle and checks whether it is within the pre-specified range or not. If it is out of range, an abnormal condition is detected and the firing signals of the thermostat are changed to shift the load to a healthy feeder

VII. CONCLUSION

The demand for electricity is growing at an exponential rate. At the same time, the most important problem in the power industry is the quality of transmitted power. Therefore, in order to maintain power quality, issues that affect power quality should be addressed. Among various power quality issues, voltage sags are one of the main factors affecting end-user equipment performance. In this report, the methods for requesting voltage sags are described. From this report, the following conclusions are drawn: Between the different methods of mitigate voltage sags, the FACT devices of use are the best method. FACT equipment such as DVR helps solve the voltage imbalance problem in the power system.

DVR is a series device that can voltage imbalance to compensate for injectable voltage. These devices are connected to the grid at critical points to protect critical loads. These devices also have other advantages, such as asking harmonics, and the power factor correction DVR is slower, but it also excels at demanding harmonic content. The demand for electricity is growing at an exponential rate. At the same time, the power sector has become the most prominent issue of quality power. Therefore, in order to maintain power quality, issues that affect power quality should be addressed. Among various power quality issues, voltage sags are one of the main factors affecting end-user equipment performance. In this report, the methods for requesting voltage sags are described. The following conclusions were drawn from this report: - Among different methods of mitigating voltage sags, the use of FACT equipment is the best method. FACT equipment such as DVR, D-STATCOM, etc. power system DVR in the voltage imbalance problem. Is a series device that can inject voltage to compensate for voltage imbalance?

D-STATCOM is a device connected in parallel and drives current in the system. These devices are eager to protect critical load points connected to the grid. These devices also have other advantages such as harmonic reduction and power factor correction. The transparent electrical injection installation required by the D-STATCOM is more than the DVR. DVR works slower for a given voltage nozzle, but at reduced compatible content. Both DVR and D-STATCOM require a large number of power electronics. Switches and storage devices for their operation. To overcome this problem, PWM switch automatic transformers are used here to reduce the number of switches needed to alleviate voltage disturbances, thus reducing switching losses. The size and cost of the device is small, so the PWM switch is an effective and economical solution for autotransformer voltage mitigation

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