INCREASING BRANCH CIRCUIT RELIABILITY FOR COMPUTER ROOMS

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I. INTRODUCTION

Branch circuits carry the power to the computer loads. They contain the last overcurrent protective device in the power distribution circuit. Improvements in more dependable power to those circuits increase the reliability of the computers. Prevention of extended voltage wave collapse and ensuring true selective coordination in branch circuits increases the overall reliability of the computer equipment.

II. VOLTAGE COLLAPSE

Data center loads generally comply with the ITI (CBEMA) Curve for voltage tolerance. See Figure 1. It shows that less than a 70% voltage condition will be tolerated until 20 milliseconds, and then it can cause an interruption of equipment function. The condition of less than 70% voltage is a collapse of the voltage wave. See Figure 2.

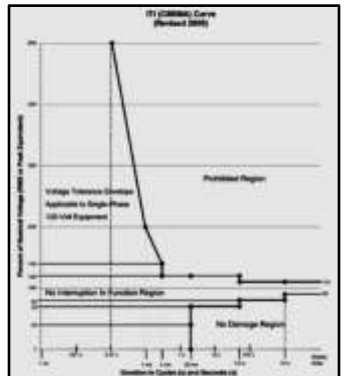

Figure 1 - ITI Curve

A 60 Hz voltage wave is a sine wave with 60 cycles per second or one cycle per 0.1667 seconds. Thus in figure one, 20 milliseconds corresponds to 1.2 cycles of low voltage. This can occur when one circuit has a high overcurrent and loads down the supply transformer affecting all branch circuits feeding from that transformer

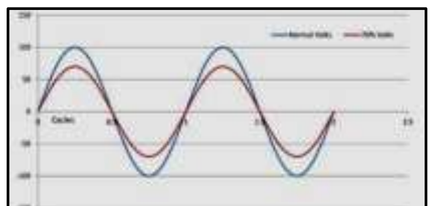

Figure 2 - Voltage Collapse with High Overcurrents

Often overcurrents are overloads. While the problem circuit is waiting to be disconnected by its branch overcurrent protection, it is not disrupting the voltage of other branch circuits. Overloads will have enough current to overheat the branch circuit if it persists, but a properly selected circuit breaker will disconnect the power before it causes disruption to other loads.

However, sometimes a short circuit or high overcurrent occurs. This allows high current levels to flow to the problem circuit and reduces the voltage for the other branch circuits. The overcurrent protection device response time is critical to avoid disrupting other branch circuits. This response should be less than 20 milliseconds (1.2 cycles) for a high fault current.

Circuit breakers and fuses have different characteristics with high fault currents. [2] Typically small breakers have a clearing time of 1 to 2 cycles. Larger breakers can have a clearing time in excess of 4 cycles. In comparison, a fuse operating in its current-limiting range operates in ¼ cycle. The goal is to always have the overcurrent device clear the problem circuit in less than 1.2 cycles when the high current is collapsing the voltage wave below 70%. Fuses will cause less disruption to the adjacent loads with a high overcurrent condition. See Figure 3.

Also there is uncertainty about the actual operation time of a circuit breaker on its first trip after several years without a trip. NETA conducted a survey in 2008 [3] that measured trip performance of 340,000 items under field testing. Most of the equipment had not been serviced within 5 years. Over 22% of the breakers tested had an issue causing out of specification results. An average of 10.5% did not function at all when tested.

There were several suspected reasons for these results. Circuit breaker mechanisms could have been undisturbed for years collecting dust, drying out their lubricant, and potentially corroding fine mechanical linkages. This would make the mechanical trip linkages and contact bearings sluggish. When retests were done, often the second trip and subsequent trips were within published specifications.

Current limiting fuses are enclosed in their cartridge and their short circuit mechanism is solid material. They do not depend upon mechanical linkages to open with high overcurrents. A fuse is more reliable for fast opening with these high overcurrents. See Figure 3 for a comparison of operation.

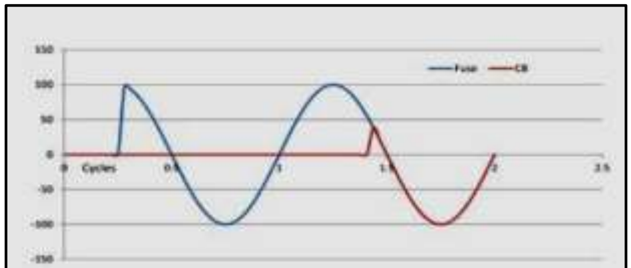

Figure 3 - Fuse and Circuit Breaker Voltage Collapse

III. SELECTIVE COORDINATION

Selective coordination ensures that an overcurrent problem will turn off power to the least amount of the power distribution system. The National Electrical Code® 2014 has a more exact definition. [4]

"Coordination (Selective). Localization of an overcurrent condition to restrict outages to the circuit or equipment overcurrent protective devices and their ratings or settings for the full range of available overcurrents, from overload to the maximum available fault current, and for the full range of overcurrent protective device opening times associated with those overcurrents."

The code also requires selective coordination with Critical Operations Power Systems as found in Article 708. This article applies to, "Power systems for facilities or parts of facilities that require continuous operation for the reasons of public safety, emergency management, national security, or business continuity."

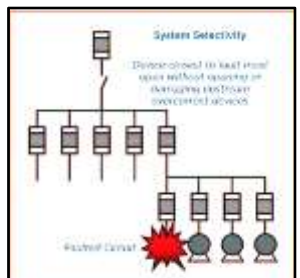

Figure 4 - One line showing selective coordination

If a branch circuit has a high overcurrent situation, the overcurrent protective device should open before allowing upstream feeder devices to operate. See figure 4. A simple molded case circuit breaker trying to selectively coordinate with an upstream molded case circuit is problematic. Most circuit breaker selective coordination is dependent upon the magnitude of the overcurrent. This is unlike fuses which can have a simple minimum ratio such as 2:1 independent of overcurrent magnitude. [5]

Some individual features of circuit breakers and fuses, such as its resetability and current limitation, are needed to increase the reliability of computer room branch circuits. Mersen's Fused Coordination Panelboard combines both in a hybrid form.

IV. MERSEN FUSED COORDINATION PANELBOARD

This panelboard is a combination of fuses and circuit breakers all selected to function together for reducing voltage wave collapse and mis-coordination. Each branch circuit pole has a fuse and circuit breaker in tandem. See figure 5. [6]

Figure 5 - Single Branch Circuit in a Mersen Coordination Panel

The most common type of overcurrent is an overload. The Mersen panel does not open the fuse for an overload, but simply trips the circuit breaker in the branch circuit. This is true from slight overloads up to 200% overloads. The circuit breaker provides resetability for most overcurrent conditions.

When a short circuit or high overcurrent does occur, the fuse opens in a current-limiting mode, reducing the magnitude and duration of the voltage wave collapse. This same current-limiting action sets up easy selective coordination. A similar fuse with at least twice the ampere rating will provide selective coordination for all levels of fault current.

Figure 6—Mersen Fused Coordination Panelboard

Current-limiting fuses 30 amps or less will typically selectively coordinate with an upstream 200 amp molded case circuit breaker. The Mersen Fused Coordination Panelboard will provide better reliability than circuits with only either a circuit breaker or fuse.

V. REFERENCES

1. ITI (CBEMA) Curve, Information Technology Council, http://www.itic.org

2. Steve Hansen, Byron Jordan, Mike Lang, and Peter Walsh, "Fuses Versus Circuit Breakers for Low Voltage Applications," Mersen USA, System Protection Note 1 Tech Topic, TT-SP1

3. Kerry Heid, "Survey Says!" NETA WORLD Summer 2011

4. "National Electrical Code®," NFPA 70, 2011

5. Steve Hansen and Robert Lyons, Jr., "Evaluating Selective Coordination Between Current-Limiting Fuses and Non Current-Limiting Circuit Breakers," Mersen USA, Selective Coordination Note Tech Topic, TT-SC1

6. Mersen, "Fused Coordination Panelboard," Mersen USA BR-MFCP-001