The Barn Raiser

Mid-South Engineering Company

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Grounding Demystified

The subject of grounding seems to cause confusion even in the minds of people who deal with electricity on a regular basis. The plethora of terms used in this context such as "system grounding", "equipment grounding", "grounded system", "ungrounded system" etc. appears to add to the confusion. **Article 250** in the NEC (National Electrical Code) –**Grounding and Bonding**- is often violated or misapplied due to a lack of understanding of the <u>intent</u> behind the wording.

The concept of grounding is fairly simple to grasp once we examine the fundamentals, however, considering the vast scope which could be covered under this topic, only the very basic concepts are being discussed.

The purpose of the NEC as stated in **Article 90** is the <u>safeguarding</u> of persons and property from hazards arising from the use of electricity. **Article 250 – Grounding and Bonding** - covers the requirements for limiting the voltages imposed by lightning, line surges or unintentional contact with higher-voltage, to stabilize the voltage to earth during normal operation, providing low-impedance paths for ground fault currents to facilitate the operation of overcurrent protective devices, and removal of dangerous voltage potentials between conductive parts of building components and electrical systems. (*Impedance is the total opposition that a circuit offers to the flow of current)*

Grounding may be broadly classified into two categories, ***system grounding*** and ***equipment grounding***.

A. ***System grounding*** refers to the practice of connecting the neutral of a transformer to ground in order to accomplish the following,

1.To limit the voltages caused by lightning strikes.

2.To stabilize the voltage under normal conditions (to maintain the voltage at one level relative to ground such that any equipment connected to the system will be subject only to that potential difference).

The NEC requires *separately derived AC systems* (most commonly transformers) to be solidly grounded under specific conditions (see **NEC 250.20**). The NEC also allows *impedance grounding* of transformers where a known resistance is included between neutral and ground in order to limit the amount of fault current to a low value (see **NEC 250.36**). This allows for continuation of operation until the ground fault can be traced and cleared.

A *grounded* conductor is a conductor which is intentionally connected to ground and <u>normally carries current.</u> The neutral conductor in a 120/208-volt or 480/277-volt grounded system is a *grounded* conductor.

B. ***Equipment grounding*** (safety grounding) accomplishes the following,

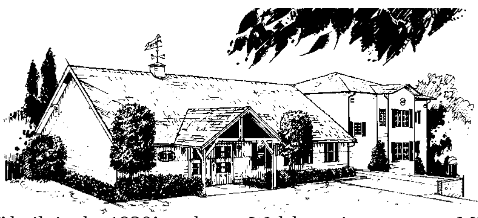
1. Ensures that all metallic equipment is kept at the same potential (no voltage difference between metallic raceways) and facilitates the operation of overcurrent devices such as fuses circuit breakers etc. under ground fault conditions.

2. Provides an intentional path for fault current during a fault condition.

A *grounding* conductor is a conductor which under normal conditions <u>does not</u> carry current. The conductor used to connect the ground bus of a 480-volt switchgear unit to the ground bus of a downstream MCC is an example. The <u>only</u> time this conductor will carry current is when there is a "line to ground" fault downstream from this equipment and the fault current is flowing back to the neutral terminal of the transformer feeding the system.

One of the common NEC violations results from electronic equipment vendors insisting upon installing an "isolated grounding electrode," (such as a ground rod) with the bonding jumper between the neutral terminal and ground removed. This can be a serious safety hazard.

A thorough reading of **NEC article 250** from the 2005 **NEC handbook** is recommended as the handbook, in addition to listing the code requirements also clarifies several points by means of footnotes and discussions.



"The Barn" built in the 1930's to house Welsh ponies, serves as Mid-South's offices.

An Introduction to Value Engineering

Value Management is an organized effort directed at analyzing the functions of goods and services to achieve those necessary functions and essential characteristics in the most profitable manner. Value Management (VM) is also called Value Engineering (VE) or Value Analysis (VA) depending on how it is applied.

Benefits and Application of VM/VE to projects

Value management/Value Engineering is listed among the dozen or so specific "value improving practices" that characterize excellence in capital project development and execution. Organizations that study capital projects have recognized that some projects have performed noticeably above average and determined common factors among those top performing capital projects. Consistently, the top performing projects included these Value Improving Practices (VIP's). Lower installed cost, shorter project durations and quicker achievement of performance objectives, are the benefits of practicing VIP's on capital projects. One Fortune 100 company demonstrated a 12% savings through the use of VM/VE throughout their capital program. Others have used VM to reach the functionality and project cost targets that had been unattainable before implementation of Value Management.

Value Management is employed early in a project life cycle to achieve process simplification. It is used at later stages in machine selection, process engineering and preliminary engineering design to increase the value of the capital effort.

Value management has often been wrongly identified with brainstorming sessions on how to cut cost. Cost is only one of the components of value and focusing only on cost reduction disregards true value and, in some cases, can harm the long term performance of a capital project.

Value Concepts

Value is a concept encompassing three other terms –Function, Worth, and Cost.

Function – the intent or purpose of an item or service performing in its normally prescribed manner

Worth -- the minimum cost to reliably perform the function

Cost – the amount actually being paid for the function

One should remember that Value is always defined by the user or customer (not by the producer of seller!) A graphic definition of Value is:

$$\textbf{VALUE} = \frac{\textbf{Function}}{\textbf{Cost}}$$

The goal of VM is to increase VALUE! It might be done by lowering cost, or by increasing functionality or through some combinations of the two and even, in some cases, by increasing cost, provided that functionality increases even more. However, this process must be done within the buyer's definition of value and must always recognize that the two components of Function and Cost cannot be separated from the value process.

Future articles about Value Management will include:

Defining value attributes for a project
Analyzing functions and costs.
Outline of a Value Management Workshop

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