

Equipment Ground Fault Protection – Where It's NOT Required or Permitted

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Equipment ground fault protection is a relative new kid on the block as far as circuit protection goes. Not required by the National Electrical Code (NEC) before 1971, it is now generally accepted to be an important part of the overall circuit protection package, with little debate as to its value or effectiveness. But having only a partial understanding of applying ground fault protection can result in added project cost, increased liability and defeating the very intent of the code.

What NEC Requires

The NEC has undergone extensive revision in content and appearance in the past few years. Even so, the test to determine whether equipment ground fault protection is required has remained virtually unchanged. The intent of the new 2005 code is clear, relatively the same as the 2002 code in this area, and essentially consistent throughout, including : Article 215.10 (feeders), 230.95 (services), 240.13 (overcurrent protection). The code's requirements for the application of equipment ground fault protection (EGFP) are summarized as follows:

1. EGFP must be provided on solidly grounded wye systems.
2. EGFP must be provided where phase-to-phase voltage is between 260 ("more than 150 volts to ground") to 600VAC, inclusive.
3. EGFP must be provided only if the service or feeder or building/structure main disconnect device(s) is (are) rated 1000A or greater.
4. Settings of the ground fault device(s) are limited to a maximum of 1200A pickup and one second delay for ground faults greater than 3000A (NEC 230.95A).
5. The installed EGFP "system", not just the individual trip unit, must be performance tested when initially installed (NEC 230.95C).

The Obvious "Not Needed" List

The code's deliberate wording and content discloses what is required and, by its absence, what isn't. We can therefore deduce from the above list, item 1, that equipment ground fault protection is not required on single phase or dc circuits. It is also not required on impedance grounded systems, nor ungrounded wye systems, nor on any type of delta or open delta systems whether solidly grounded or not. From the limited voltage range of application defined in item 2 we determine that EGFP is not required on, say, 24V, 120/208V systems, nor on 750V systems, nor on any medium or high voltage system, though it is an accepted industry practice to provide EGFP on grounded wye systems 2400V or greater. It is clear from item 3 that ground fault protection is not required even when the system is a 480V solidly grounded wye service rated 1000A or greater but its service or feeder disconnects are sized less than 1000A, say 800A. The 2005 NEC Handbook (article 230.95) even provides an example of such an application as a service having no main and up to six 800A disconnects.

In addition to this intuitive not-needed EGFP list, albeit with guidance from the NEC Handbook, the code provides clearly worded exceptions for certain applications. Such exceptions are granted to fire pump circuits and "continuous industrial processes where a non-orderly shutdown will introduce additional or increased hazards." In both cases EGFP is not only exempted but may not be applied. The code's intention to favor immediate human safety over possible longer term

protection issues is understandable. The “continuous industrial process” exception, however, has raised some controversy since the test for this exception is somewhat arbitrary. The risk for “increased hazards” could always exist due to a non-orderly shutdown of an industrial process. As a result, the temptation to eliminate EGFP from circuits feeding any continuous process has been known to surface periodically. This exception should, however, only be invoked if the application of EGFP could truly result in increased hazards and not simply as a means to reduce initial costs. Omission of ground fault protection only delays the results of a damaging ground fault condition, should it exist, and increases the eventual damage and downtime if not caught early. In addition, classification of the process as one in which a loss of power could create a “hazard” would suggest other special circuit protective design considerations as suggested in 240.4A, 240.12 and 430.44. All standard non-“hazard” resulting feeders must continue to comply with code EGFP requirements. This could result in a common substation with varying feeder protection and control functions. Care should be exercised to avoid possible confusion in the field.

A third exception is included in articles 215.10 and 240.13 that eliminates the need for EGFP in feeders and branch circuits if provided elsewhere on their line side. As a result of this exception, ground fault protection incorporated into the main disconnect device is adequate for the entire system (except in health care facilities, NEC 517.17). In such a design, however, any downstream ground fault could trip the main protective device resulting in a complete substation power outage. The code’s purpose, in its own words, is “the practical safeguarding of persons and property...but not necessarily efficient, convenient, or ...for good service...” (article 90.1A,B). In other words, system reliability is left to common sense and good engineering design practices. For this reason, though certain functions may not be required by code for human safety, their addition to the circuit may be highly desirable and recommended for reliable and continuous operation. EGFP is therefore recommended to be added on the feeders for all systems where continuity of power is an important consideration, whenever it is provided in the system main disconnect.

The Less Obvious “Not Needed” List

Because of their life safety issues, health care facilities and emergency power generators represent special applications, which have evolved with some unique requirements. With regard to EGFP in health care facilities, article 517.17B stipulates that, where required by articles 215.10 or 230.95, EGFP must also be incorporated in the feeder disconnecting means one additional step downstream of the first device. This is a requirement regardless of the rating of the second downstream feeder, be it 1000A or 100A, because its purpose is selectivity. However, this additional level of EGFP may not be installed on:

1. The load side of essential electrical system transfer switches.
2. Between the essential system generator(s) (ref 517.35B) and the essential system transfer switches.
3. On electrical systems other than solidly grounded wye between 260 to 600VAC, inclusive.

The intent of the first two restrictions would seem to be the prohibition of inserting EGFP into an essential electrical power system. Item 1, however, only prohibits locating the additional step of EGFP on the secondary side of that transfer switch, not the first. The same is true for item 2 with respect the installation of the additional level of EGFP between the essential system’s generator and transfer switch.

In fact, the code permits the addition of EGFP to the emergency electrical system. Article 700.26, only states that the alternate source of power for an emergency system “shall not be required” to

have automatic EGFP. This is quite different than a clear prohibition. It is left to the commentary of the 2005 NEC Handbook, article 700.7D, to provide necessary clarity, which is not included in the basic code publication. That commentary states that locating any EGFP in such an application is "not appropriate." The code's intent in these applications is clear and no level of automatic EGFP should be applied to the alternate emergency power source. But "ground faults can occur in such systems, and they can result in equipment burndown." So states the handbook commentary to article 700.7D, which, along with 700.26, therefore requires EGFP sensing, alarming and personnel instruction for these applications.

Where Ground Fault Protection Is Required....But Not Equipment with Ground Fault Protection

Article 430, 'Motors, Motor Circuits and Controllers'; includes no requirements for equipment ground fault protection. That is not to say there are no requirements for 'Ground Fault Protection,' words which appear extensively throughout that section, including 430.51, 430.53, 430.55, Table 430.52, and countless others. Though no definition of the difference between these two terms is provided, article 430.51 outlines what Ground Fault Protection is not: It is not anything covered by articles 210.8 (GFCI protection), 230.95 (equipment ground fault protection) or 527.6 (no such article exists in the 2005 code, though in the 2002 NEC it referred to GFCI requirements for temporary installations), nor does it apply to circuits rated over 600V, nominal.

From the context of its use, it would appear article 430's (and a few other articles') requirement for 'Ground Fault Protection' is referring to bolted phase-to-ground protection. If so, that need would seem to be satisfied with the standard instantaneous short-circuit protective function. Even though not directly stipulated, traditional practice for standard motor applications is to provide rapid EGFP wherever the value of a motor rewind or the loss of an extended outage would economically outweigh the cost of the EGFP function. That value is typically 50HP or greater, depending on application details, including the importance of rapidly identifying the branch circuit which caused the upstream trip if EGFP were not provided on the motor branch circuits.

How To Comply With The Code's Requirements

EGFP is available as an integral part of various low voltage protective devices. In these devices, all current sensors, controls, trip coils and displays are packaged in an electronic programmer and incorporated within an automatic operating disconnect device. Integral GF protection can be obtained in molded case circuit breaker construction, but only within a 600A frame (type SG, 60-600A ratings) and a 1200A frame (type SK, 300-1200A ratings). They are also available in insulated case (PowerBreak, to 4000A) and steel frame (AKR/Wavepro, to 5000A) construction and in high-pressure contact switch construction (HPC) through 4000A. In all these products the ground fault function has field adjustable pickup and time delay settings suitable in magnitudes, delay times and delay band quantities to comply with all the requirements as stipulated by NEC. The breaker products also incorporate local and remote metering capability and other protection and relaying options. In addition, discrete components (CT's, relays and monitor panels) are available for use with existing gear and for compliance with NEC 700.7d and 700.26. These can be referenced at http://www.geindustrial.com/cwc/products?pnlid=6&famid=42&catid=99&id=tr-ele&typeld=4&lang=en_US. The requirement to performance test the ground fault protection system when first installed (NEC 230.95C) is plainly included in the code but seldom specified in the equipment spec. This is a requirement, which resulted from a realization that, if improperly installed, the ground fault system could be inoperable or result in false tripping. Guidance on how to perform these tests are provided in GEI-48907.

Conclusions

Though the benefits of, and the requirements for equipment ground fault protection are relatively clear today, its unconstrained use can be unnecessarily costly and, in certain cases, inappropriate and contrary to permitted code practices. These difficulties can be avoided through the prudent application of ground fault protection as described in this article.

Additional Reference Material

GET-6533	Ground Fault Protection For Solidly Grounded Low-Voltage Systems
DET-167	Wave Pro Application Guide
GET-8052	Power Break II Application and Selection
GET-6205	Type HPC High Pressure Contact Switches
GET-8032A	Spectra Series Switchboards