The Electrical Power Engineers

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NEUTRAL GROUNDING REACTORS FOR GENERATORS

Reactor Design...

Design Criteria

1. Limit I_3 in each generator to $\leq$ 5% of its continuous current rating. (See NEMA Standard MG-1, Section 32.15.)
2. Limit the single line-to-ground fault current in each generator to less than the single line-to-ground fault current for which the grounded generator was originally designed or less than the three-phase fault current, whichever is higher. If it is needed for equipment ratings, limit the total single line-to-ground fault current to less than the total three-phase fault current.
3. Keep $X_O/X_1 \leq 3$ for each generator to be effectively grounded. (See IEEE Standard C62.92.1-2000)

Other Application Considerations for the User

1. The generator continuous negative-sequence and zero-sequence currents should not exceed 5% of the positive-sequence current. (See NEMA MG 1, Sections 32.14 and 32.15.) This is of special concern if the grounded generator is feeding grounded single-phase loads.
2. It is recommended that the continuous current rating of the neutral reactor be at least 30% of the generator phase current rating.
   a. A generator neutral current can be caused by the circulating 3rd harmonic current between generators and by unbalanced loads if single phase loads are fed from the generator. However, the generator design (per MG-1) is limited to an unbalance of 5% of the positive-sequence component for both the negative-sequence and zero-sequence currents, as noted above.
   b. Since the current in the neutral reactor would be three times the phase zero-sequence current, it should not exceed 3 x 5% = 15% if the system is designed properly.
   c. A safety margin of 2 x 15% is suggested for a total of 30%.
   d. If the generator and the system are designed for greater load unbalances than the 5% limits defined in NEMA MG-1, then the neutral reactor must be designed for that unbalance.
3. It is recommended that protective relaying be used to assure that the continuous current rating of the neutral reactor is not exceeded. The reactor current can be monitored to either alarm or trip if the rated current is exceeded for a prolonged period of time. The neutral current could be monitored directly with a current transformer (CT) in the neutral of the generator or it could be determined from the sum of the three phase currents. The relay must be able to accurately determine the total rms current from a combination of the 60 Hz and 180 Hz components of the current.

Key References

1. NEMA Standard MG 1-2006, Motors and Generators:
   a. Section 32.13 Short-Circuit Requirements
   b. Section 32.14 Continuous Current Unbalance
   c. Section 32.15 Operation with Non-Linear or Asymmetric Loads
2. IEEE Standard 142-2007, Recommended Practice for Grounding of Industrial and Commercial Systems (Green Book)
   a. Section 1.4.4 Reactance Grounding
   b. Section 1.7 Grounding of Industrial and Commercial Generators
3. IEEE Standard C62.92.1-2000, Guide for the Application of Neutral Grounding in Electrical Utility Systems – Part I: Introduction – Table 1.

Qual-Tech Engineers will design and supply properly engineered reactors to reduce the ground fault currents and third harmonic currents.

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