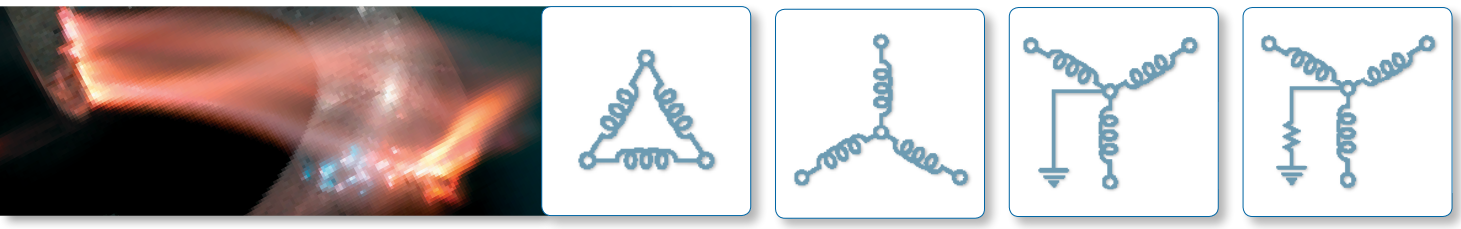
GARD

Unparalleled Protection

SMART HRG V. STANDARD HRG

Q&A



Webinar Q&A, May 2020

SMART HRG V. STANDARD HRG

Thank you for attending our webinar focused on the key differences between Standard HRG v. SMART HRG. For those of you who missed it, or would like to watch it again, both the PDF and webinar recording is available on our website. Please find the link below or visit www.i-gard.com. As always, if you have any further questions, please email support@i-gard.com and one of our support team members will gladly assist.

Click here

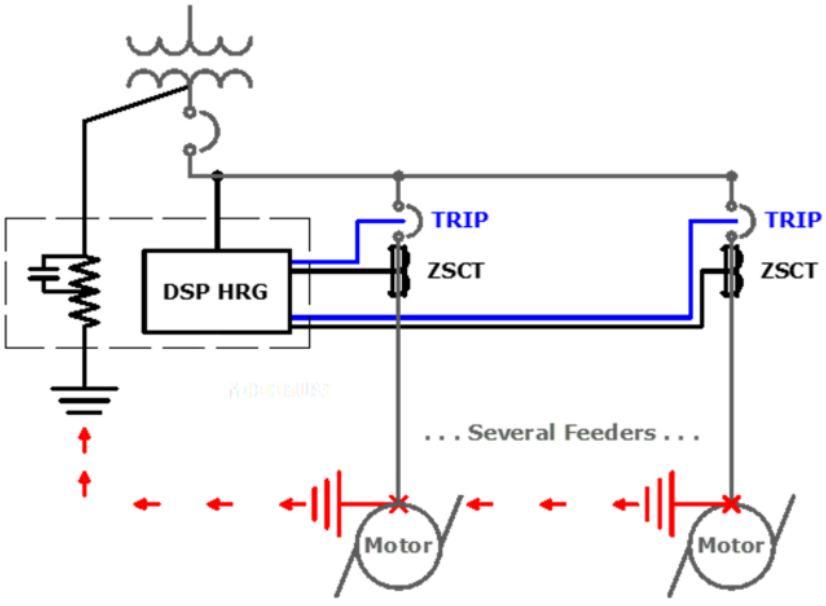
QUESTIONS & ANSWERS

Q1. What are your thoughts on using molded or insulated case breakers (UL489) on HRG systems? Issue with single pole fault ratings/tests for MCCB's as opposed to low voltage power circuit breakers (UL-1066).

A. While it is true that not all molded case circuit breakers can isolate a single phase fault, we try not to put HRG system through the entire facility. HRG is placed where the switchgear and where the breakers can be used in isolating these types of faults.

Q2. How does the smart HRG system limit the current for a second ground fault?

A. If the second fault occurs before the first one is cleared, the grounding resistor no longer limits the ground current, and is limited by the supply impedance and the ground impedance between the two faults. Protection against second ground faults can be provided when each feeder is equipped with a zero-sequence current sensor, the protecting feeder breakers can be tripped when the fault current exceeds a predetermined level. Our simplified and flexible DSP offers an instantaneous trip to minimize damage while providing a priority selection between different feeder circuits. Because two circuits will be involved it is possible to prioritize which circuit will be interrupted by a priority setting ensuing the least important circuit is tripped.



Q3. How do you manage race conditions between the Main, and the two downstream breaker curves when you have a L-G-L fault and you are trying to selectively shed with SIFT, if the L-G-L fault current is high it might still operate the breaker before the ZSCT and Module can trigger the shunt trip on the lower priority breaker?

A. The second fault occurring on two different feeders resulting in a phase-to-ground-to-phase fault will not have a high magnitude to be cleared quickly by the overcurrent devices since the ground impedance between the two faults will limit the fault. With the SMART HRG system, the priority system will operate to determine the least important (low priority) module and will trip that module within 100ms. You have to keep in mind that the function of circuit breakers will not operate at levels of 3X or 4X, there is a minimum of the multiplier used. The current must be greater than the multiplier before the device operates. With SIFT, we begin to detect the fault at multipliers like 0.1, 0r 0.2, which provides better protection.

Q4. What if you have HRG in a data center where there are closed transition & soft load transfer and switching between utility and diesel?

A. Since the two power sources are synchronized to be connected in parallel for a very short time (in milliseconds), no adjustments will be required with the smart HRG system. During the time of transition, the ground fault current will be greater for a short time period. If you have two HRG systems with 5 A each with closed transitioning, then the total ground fault current will be 10 A during the transition. This is still within the limits of NFPA 70E, Z463, CSA and NEC.

Q5. What about retrofit (space requirements, difficulty) of all those 64 devices if one wants to convert a standard HRG to a smart HRG?

A. Our smart HRG systems are very compact and designed to fit into smaller spaces. We can offer customized solutions as per the requirement.

Q6. I work in a facility that has several 480 V unit substations fed by delta wired transformers where B-phase is solidly grounded. Do you have any thoughts on keeping this system versus converting it to HRG with grounding transformers? I see plenty of benefits to convert, what drawbacks exist with B-phase ground system?

A. The corner-grounded delta system (B-phase ground system) has little reason for modern day use, the drawbacks are:

a) A higher line-to-ground voltage exists on two phases than in a neutral-grounded system

b) Most electrical distribution equipment manufactured in North America is not rated for use on this system

c) Fault switching (opening) is much more severe for the clearing device, and ratings may be greatly reduced

d) The biggest drawback we see is the B-phase, grounded and distributed. Unlike a distributed Neutral, this B-phase wire can be grounded in several locations, defeating the ground fault protection of the system

Q7. We can set the priority to trip one of feeders. What is about the time of tripping in ms?

A. Trip time is 100 ms. We have developed feeder modules that will trip in less than 3 ms. Typically, one does not employ HRG system to selectively coordinate tripping with downstream devices but it can be done.

Q8. How to calculate the Neutral Grounding Resistor in the network/grid system?

A. For high resistance grounded systems, the fault current has to be higher than the system capacitive current to avoid restriking and to be lower than required in the code to operate continuously. The selection of the NGR let-through current for low resistance grounded systems is generally determined by the following factors:

1 System charging current
2 Types of motors
3 Coordination, and
4 Protection scheme and sensitivity of protection devices.

For complete details, please refer the application guide on our website www.i-gard.com.

Q9. Do you prefer/recommend current or voltage detection based HRG units? Can you speak to the pros/cons of both, including cost and use with systems containing VFDs, and what i-Gard offers/uses?

A. I Gard uses both Current & Voltage detection to ensure that Ground fault is genuine before it signals an alarm or trips. The system module monitors the system line-to-ground voltages through a standard I-Gard DDR2 voltage sensor unit. It determines if there is voltage unbalance in the system and the level of ground fault current in the grounding resistor by measuring the voltage displacement of the neutral from ground, without any connection to the neutral grounding resistor. It also signals phase indication to the DSP-DM Display.

The feeder modules (DSP-DFM) measure the fault current level in the branch circuits that are protected. This module uses standard I-Gard zero sequence current sensors Type TxA or Rx-yA. It is equipped with a Form C 10A output relay that can be used for breaker control. The DSP-DFM detects two fault levels. Firstly, it detects the single fault, which creates a system alarm condition, and secondly through a priority level system it provides breaker control to disconnect the least important circuit breaker in the event of a second fault occurrence providing continuity of supply to the critical feeder. Through the setup of the DSP-DM Display, DSP-DFM is automatically set to the same alarm level as that of the system module during feeder module set-up.

Q10. Do coordination studies for circuit breakers differ in any way when using HRG versus ungrounded or solidly grounded systems?

A. In a properly coordinated protection scheme, all factors must be considered. Generally, these consist of LSI & G. Note LSI refers to long time, short time and instantaneous, these are based on 3 phase available fault current and will

be consistent through all types of grounding schemes.

For solidly grounded systems the protective device must open for systems greater than 150V to ground and greater than 1000A as per NEC Article 250 and CSA standards. For ungrounded systems, there is no ground fault coordination as there is no ground fault current; there is only ground fault detection as per NEC Article 250 and CSA standards For HRG systems there is less than 10 A of current and traditional relays have difficulty detecting this type of fault. Normally ground fault coordination is used to coordinate ground faults between 2 separate feeders this can be accomplished by the DSP which will selectively trip the lower priority feeder only.

Note: DSP – OHMNI now comes with optional Arc Detection module to provide protection against arc flash hazard and lowering incident energy level to safer values

Q11. What are the key aspects to check for when converting an existing solidly grounded low voltage network, i.e. <600V, to HRG? Cable insulation? Switchgear BIL?

A. The following key points to be noted

- HRG selection to meet current limitation as desired (5A,10A), Continuous rated
- Resistor monitoring if located in Canada
- As L-G voltage can raise to L-L, SPD ratings to meet this requirement
- VFD to be compatible to HRG
- UPS to be compatible to HRG
- All L- N loads are connected through isolation transformer.

Q12. What are the advantages and/or disadvantages of B phase grounded systems? How difficult is it to switch from B phase to HRG?

A. Corner-grounded delta systems

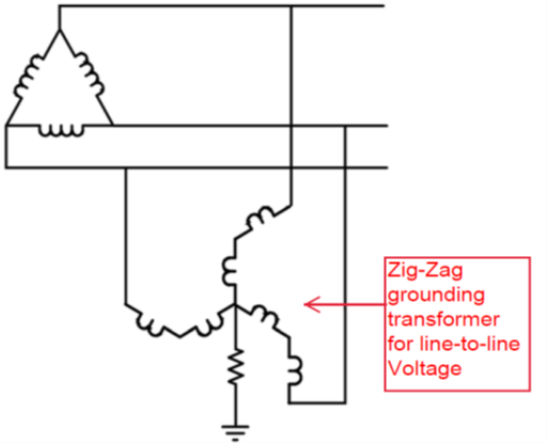
Advantages :

- Stabilize voltages of the ungrounded phases to ground
- Reduce the generation of transient over voltages
- Provide a method for protecting electrical distribution systems when used in combination with equipment grounding

Due to its disadvantages, the corner-grounded delta system has little reason for modern day use:

- The system is unable to supply dual-voltage service for lighting and power loads
- It requires a positive identification of the grounded phase throughout the system
- A higher line-to-ground voltage exists on two phases than in a neutral-grounded system
- Most electrical distribution equipment manufactured in North America is not rated for use on this system
- Fault switching (opening) is much more severe for the clearing device, and ratings may be greatly reduced

Switch from B phase to HRG:
Using zigzag transformer to create neutral & connect HRG to ground as shown:

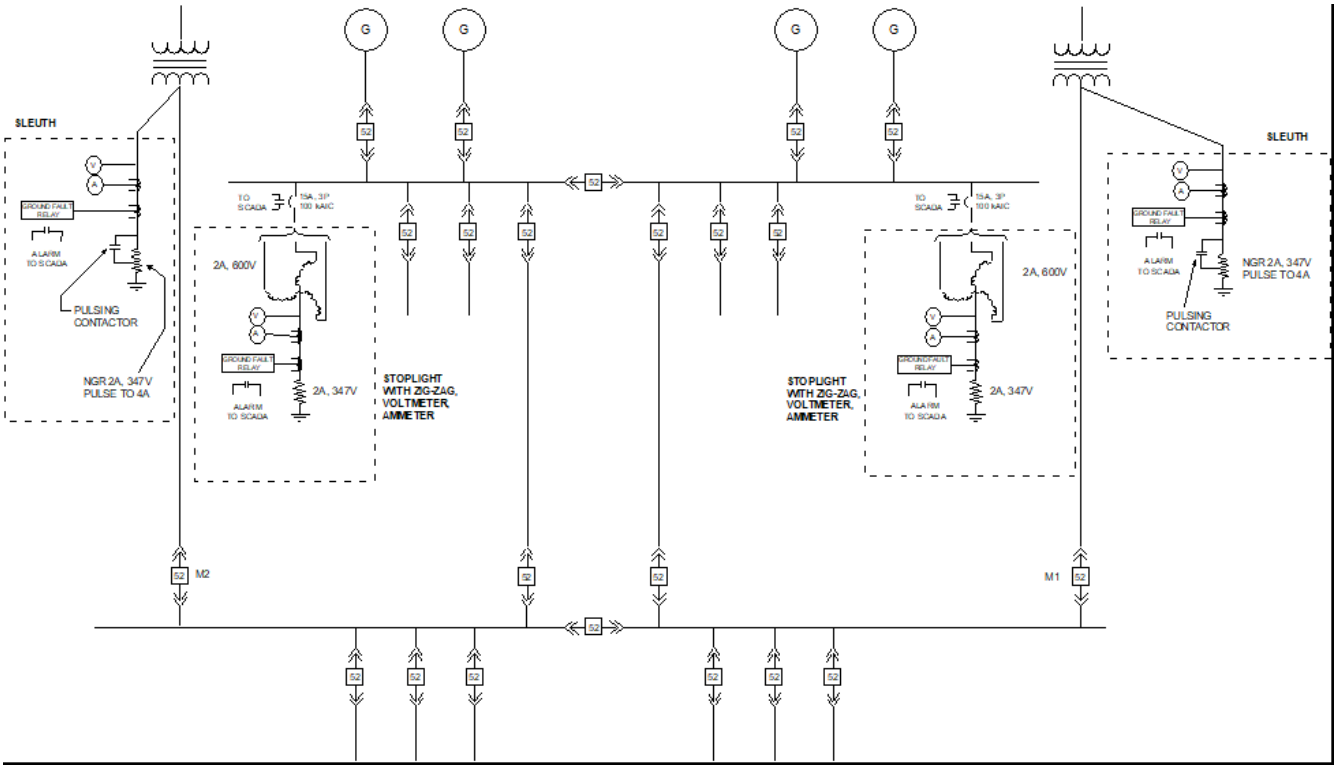


Q13. In your experience, what type of commercial facilities, if any, utilize High Resistance Grounding and/ or Low Resistance Grounding (versus of course the commonly used Solidly Grounded Systems)?

A. The following Commercial facilities:

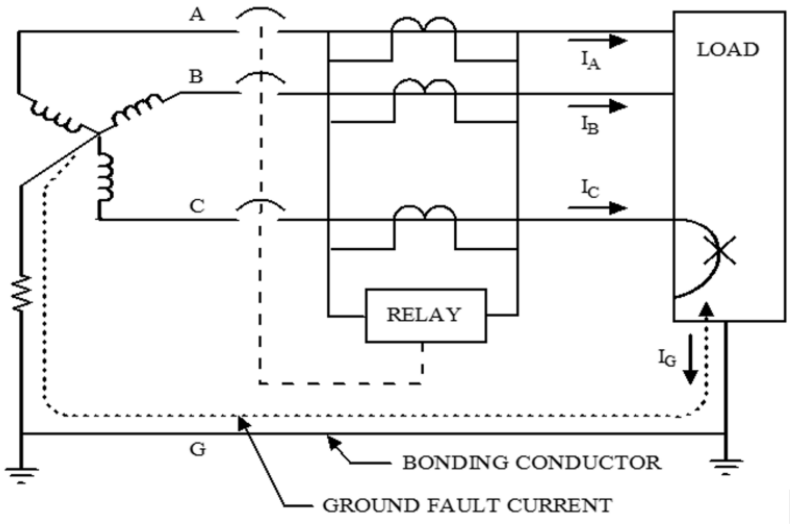
a. Facilities having multiple transformers, Main Tie Main Breakers
b. Facilities having single or Multiple generators
c. Facilities having multiple clients where continuous power supply is a requirement

Please refer typical SLD below showing 4 generators & 2 transformers, total ground fault current limits to less than 10 Amps and process can continue to operation on first ground fault:



Q14. Are the ground fault detection relays compatible with variable speed drives?

A. Ground fault current has to flow back to source as shown below, and HRG is compatible with VFD, but please ensure that the VFD supplier is aware that you are using HRG



Q15. Can you comment on the impact of HRG systems on electro-magnetic compatibility?

A. A: If this is about EMI (Electromagnetic interference), then HRG does not create EMI but the transformer does create EMI

Q16. If you have an existing solidly grounded system, what are the changes you need to make (e.g., removed line-neutral loads, etc) to change to HRG system?

A. Please refer to response for question #11

Q17. What percentage of the market in Ontario, Canada uses resistance grounded systems for data centre facilities?

A. We are not sure what percentage use HRG, but we are confident a great number of data centers use HRG for essential loads for the following reasons

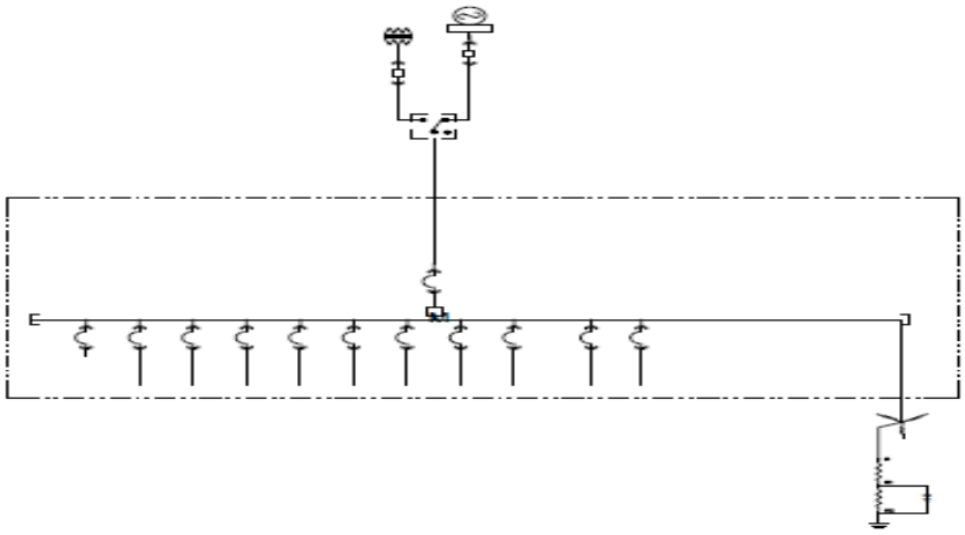
- Limiting ground fault current
- Operation can continue during first ground fault
- Locating ground fault using pulsing
- Safety

Note some of I-Gard's sample installations in Ontario, Canada:

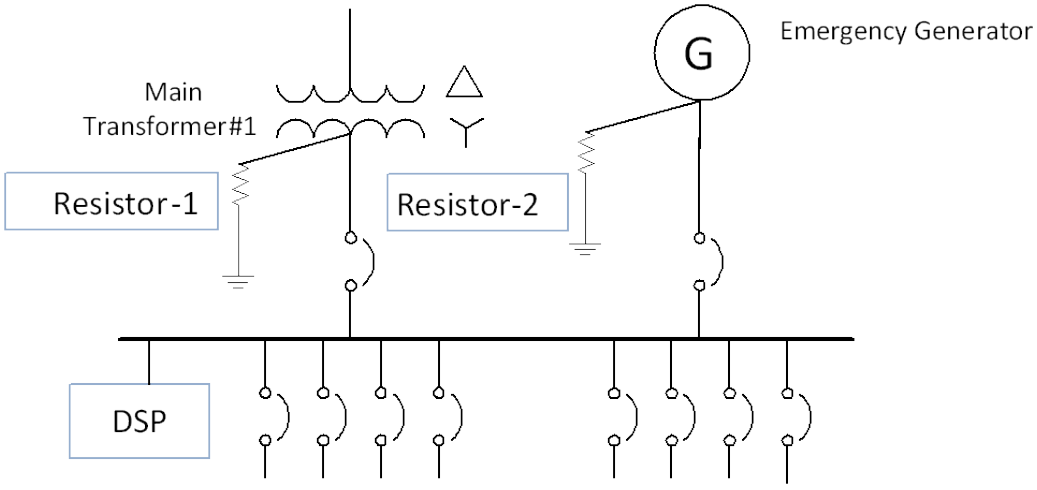
- TD Canada Trust, Ontario
- Ontario Provincial Police, Ontario
- Rogers Communication, Ontario
- Bank of Montreal, Ontario

Q18. Can we consider one HRG installation on one small Utility/ Generator system complete with ATS?

A. Yes, typically you can install the HRG on the distribution switchgear using a zig-zag transformer. Please see below attached proposed arrangement. Based on this arrangement we recommend adding small NGRs on the Xo of Transformer and Generator. To protect these equipment during internal fault. The cost of these small NGRs is just a fraction of equipment cost, therefore very practical investment.



If there are no loads on the Utility and generator besides the load on the ATS m then you can use the SMART HRG as defined in the presentation.



Q19. For an industrial facility, which type of grounding is the best?

A. If your system voltage is 5KV and below, then HRG is the best option. Using HRG, you can have the benefits of continuity of service on 1st Ground Fault which is the same advantage of un-grounded and protection for transient over voltage which is the same advantage for solidly grounded system. On top of that using HRG will limit you ground fault current to 10A and below. Therefore limiting damage to your equipment, improves your system reliability and personnel safety by limiting the probability of an arch-flash. Having all these benefits will improve profitability. If you find that you have some lighting loads that are service by the neutral, then you would need to place isolation transformer at lighting panels. This would allow the use of Line to neutral loads as well as provide a safer workplace by lowering the incident energy at the lighting loads themselves by lower the available fault current.

Q20. Have HRG systems been used for grid-tied PV system?

A. Unfortunately, with grid tied PV systems, the method of grounding will rely on the grid type grounding.

Q21. Is there a rule that says 600V or 5kV system has to be HRG?

A. I am not aware of any rules that 600V up to 5KV has to be HRG. In Canadian Electrical Code 2018, Section 10.300 – if your system is operating 5KV or less you can use HRG (10A and below) for continuity of service. Similar wording in NEC 250.36 and NEC 250.186 for system voltage up to 1KV.

Q22. Can you compare HRG systems to LRG systems? Costs and benefits?

A. Typically in HRG, the let-through current is limited to 10A and below continuously, while LRG is higher than 10A and usually has a time rating of 10 seconds to 1 minute. Cost of HRG vs. LRG is a bit challenging to compare since their application differs in terms of system voltage. HRG widely used in system operating 5KV or less while LRG are widely used in system above 5KV. Generally speaking, if the let-trough current of a Medium Voltage LRG is 200A and above, it is more expensive than HRG. The major benefit of HRG vs. LRG is continuity of service during 1st ground fault while LRG you have to trip within 10S to 60S. Other benefits of HRG vs. LRG are the following: HRG, limit current ground fault current to 10A and below, thus protecting the equipment against electrical and mechanical damage; improve system reliability; limit the likelihood of an arch-flash – improve personnel safety; low equipment maintenance cost; minimize uncontrolled shutdown and improve productivity.

Q23. Can the HRG unit be placed on the load side of a utility gen board?

A.Yes, however it may vary depending on the overall system design. It would be best to provide a copy SLD so we can recommend the best location for HRG.

Q24. Why do we see intermittent resistor fault in 480V transformer NGR system? This fault disappears when the system is reset and then comes back again. How can we troubleshoot this?

A. Intermittent NGR fault is not only limited to 480V system. I-Gard resistor monitoring relay has two modes of detecting NGR fault: continuity and measurment mode. In continuity mode, I-Gard GFR injects DC or AC voltage to check the continuity of the circuit. In measurement mode when current is present on the neutral path (~5% of NGR let-trough current), I-Gard GFR will calculate the resistance, if resistance value is <60% or >150%, then GFR will detect a NGR Fault. Intermittent NGR occurred typically when there is are power quality issues.

Intermittent NGR typically occurs when there is too much noise in the system. If your facility has a lot of motors, check if they are compatible with HRG and installed in accordance to manufacturer's recommendation for HRG application. You can take a similar approach for system with UPS. However, you also have to measure the voltage and current on the neutral conductor if circulating current is present. HRG connections should be checked properly to make sure Xo and G are terminated. Follow the O/M manual to verify connections. I-Gard provides product support online and conduct onsite visits, so if you are not able to resolve the NGR Fault issue, please email support@i-gard.com for further assistance.

Q25. Can HRG be applied to LV systems?

A. A: Yes, HRG can be applied to LV systems. In fact, HRG is perfect for operating systems of 5KV and below in Canada and 1KV and below in US.

Q26. Does I-Gard help size the resistor size - i.e current limit should it be 5 amp, 10 amp etc..

A. Yes, I-Gard can provide assistance in sizing the NGR. Not only in sizing the NGR, we can also provide recommendation on the type and functionalities of your NGR to make sure it is compliant with Code and Standards. We have Engineering Team that can provide assistance during the design stage of your electrical system. We also have many resources in our website at i-gard.com and look for application guide and NGR specification.

Q27. Can I covert my solidly grounded system to HRG? How long a shutdown I need?

A. Yes, you can convert your solidly grounded system to HRG. As for shutdown time, it depends on your size, voltage and type of HRG. For example if you are installing an HRG on the Xo of your Power Transformer, shutdown is minimal. However if you are installing HRG with feeder monitoring, then your shutdown time will be longer. Please take note of the following guidelines for converting your electrical system from Solidly Grounded to HRG:

a. Cable should be rated for Line-to-Line Voltage. This is not an issue for LV system.
b. VFDs, SPDs and UPS should be compatible with HRG application.
c. Single Phase loads should be isolated using an isolation transformer.
d. Do not recommend distributed neutral in Canada. NEC do not allow distributed neutral for system with HRG.

Q28. The comments about lowering incident energy with HRG is potentially misleading. The method of grounding is not an input parameter in incident energy calculations (1584-2018), a facility who installs HRG will not see a reduction in the calculated incident energy as a result of this grounding method.

A. HRG does not reduce the incident energy associated with an arc flash. This method of grounding reduces the probability of the arc-flash happening in the first place i.e. the likelihood of exposure, by limiting the ground fault current to a small magnitude (see Annex O of NFPA-70E).

Q29. Do I need a 2000 Volt cable insulation with HRG grounded 480 Volts system? You said voltage on unfaulted phases goes of 173%

A. When a ground fault occurs on a system, the un-faulted phases increase to full line-to-line voltage, essentially 173% of the line to neutral voltage (277V). According to the section 10-302 sub-rule one of the Canadian electrical code, ungrounded conductors on an impedance grounded system shall be rated to the nominal full line to line voltage of the system, in this case 480V minimum. The concept started from the NEC when it stated that when a ground fault occurs on a system and is allowed to continue for more than 1 hour, the 173% insulation is required. Manufacturers of cable only have 2kV rated cables and not 831 V rated cables which is 1.73 x 480V.
This is misleading because the table in the NEC also states that this is only of concern when the system voltage exceeds 5001 V. It is not a concern when the system voltage is below 5000 V; the main reason for this is manufacturers of cable add more insulation in wire and cables at low voltages to meet the mechanical stresses, that they far exceed the minimal electrical ratings of the cable.

Q30. What is the frequency response of these devices considering the impact of storm strike?

A. Our products meet or exceed all ratings for storms like these.

Q31. Is alarm only allowed by code on HRG system in case of first ground fault?

A. This is dependent on if a distributed neutral is present or not. If the neutral is distributed then no, you must trip on the occurrence of the first fault; if the neutral is not distributed, then an alarm will work.

Q32. The CEC code allows the use of the ungrounded system. If you have an HRG system that fails (eg, open NGR,etc) now you have an ungrounded system. How long can you operate that way till we work on a replacement

A. Section 10-302, sub-rule 2 of the Canadian electrical code mandates that the integrity of an impedance grounded system must have an audio or visual alarm, that corresponds to the occurrence of a loss of continuity of the impedance grounded circuit from the system source through the impedance grounding device to the grounded non-current carrying conductive parts of the electrical system, an open resistor in this case. This alarm should clearly annunciate the status of the system to the persons monitoring it, and continue signaling until the condition is corrected; it is

recommended to clear the fault as soon as possible. A maximum time allowed to operate on this NGR fault is not stipulated in the code.

However, extra measures can be taken in case the fault is not cleared promptly, for any reason. A separate ground fault detection device (e.g. I-GARD's VIA) can be installed in the system to meet minimum requirements for ungrounded systems and detect a ground fault within this period; Ref Section 10-400 of the Canadian electrical code.

Q33. Which Arc Flash mitigation relay do you use - which brand?

A. I-Gard manufactures all its relays in house. We offer several arc flash mitigation relays such as the SENTRI and ARC-i-TEC. We also offer a module (DSP-ADM) that can be combined with our DSP system to provide arc flash detection. With the DSP-ADM in place, I-Gard provides arc flash mitigation by decreasing the probability of having an arc flash by employing HRG as well as lowering the severity of the arc flash by decreasing the time the fault is on the system. Please visit our website www.i-gard.com to see our line of products, each of which comes with a manual for your reference.

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Q34. How does this pulsing system work?

A. I-Gard designs systems with pulsing to include contactors in parallel with a portion of the resistance at the neutral. When activated, pulsing will close/open the contactor at a 50% duty cycle, changing the value of the resistance, and consequently, the amount of current the fault is limited to. The result is a fluctuating current that can be traced using a clamp sensor downstream to identify the location of the fault.

Q35. Normally in the US, we use 277 volts for lighting. You can't do that with a HRG system can you?

A. In the US, you cannot use HRG on a distributed neutral. What you can do is place all these loads on isolation transformers (480 X 480/277) and service these loads through the transformers. This is very simple as most lighting panels have room for isolation transformers. Once this is done, the incident energy labels can change on the lighting panels because the available fault current is lower. This way you can have a safer system by lowering the probability of an arc flash using HRG and lowering the incident energy with lower fault current

Q36. How does the pulse fault detector work?

A. The pulse fault detector works by measuring the current within the cable that is being clamped. Because of the pulsing capability to fluctuate the current at the neutral in the instance of a ground fault, this current is seen downstream, which allows you to identify the location of the ground fault.

Q37. Can you elaborate on the pulsing contactor?

A. Pulsing contactors are placed in parallel with a portion of the resistance at the neutral. When open, the resistance is untouched and operates normally. When closed, the contactor side becomes a short circuit, which removes that portion of the resistance from the neutral point. This creates a fluctuation in the current levels seen at the neutral through the faulted path, which can be identified downstream using a fault detector.

Q38. What is the difference between a Neutral Grounding Resistor and Neutral Grounding Reactor?

A. Both the Neutral grounding resistor and the neutral grounding reactor will limit the fault current to a set value. The main difference is that the impedance of the reactor is frequency dependent and the impedance of the resistor is not. This has a large impact when using adjustable speed drives.

When using reactors to limit fault currents to low values, a high reactance system is usually desired. This is problematic because the main reason a reactor is used is due to the Peterson Coil. This is when the reactor is sized to limit the fault current to a value that is equal to the system charging current. Theoretically, the fault current at the point of the fault will be zero and the inductive current of the reactor and capacitive current at the point of the fault will be zero. This is extremely difficult to do with the constant load variations and changes in configurations and speed to drives.

The last difference is a reactor's ability to limit the overvoltage when used with low reactance systems. This can be very complex and a thorough knowledge of X/R ratios must be analyzed.

Q39. When is HRG not an option?

A. HRG is not an option when system voltage is greater than 15kV, or if the charging current exceeds 10A. In the US, HRG is not an option if your entire load is lighting loads at 277V or 347V. In addition, HRG is not an option if you use slash rated devices (which are small and do not have the isolation to ground that is required). If charging current is larger than 10A, I-Gard provides LRG (Low resistance grounding) resistors that are rated for line-to-ground currents over 1000A, but keep in mind that unlike HRG, LRG does not offer second fault tripping and continuous operation (must trip on the first fault).

Q40. What was the SIFT acronym again?

A. Selective Instantaneous Feeder Tripping.

Q41. If you have a ground fault detection relay on every feeder, do you still need a pulsing contactor at the resistor?

A. Although a GF relay on every feeder will allow you to identify which feeder carries the ground fault, the use of a pulsing contactor allows the user of the pulse detector to pinpoint the exact location of the fault. This is particularly

helpful if your feeders extend over large distances. The I-Gard DSP is a perfect example of a grounding system that offers feeder indication and protection, while also including a pulsing contactor at the neutral resistor to assist in the locating of a fault.

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