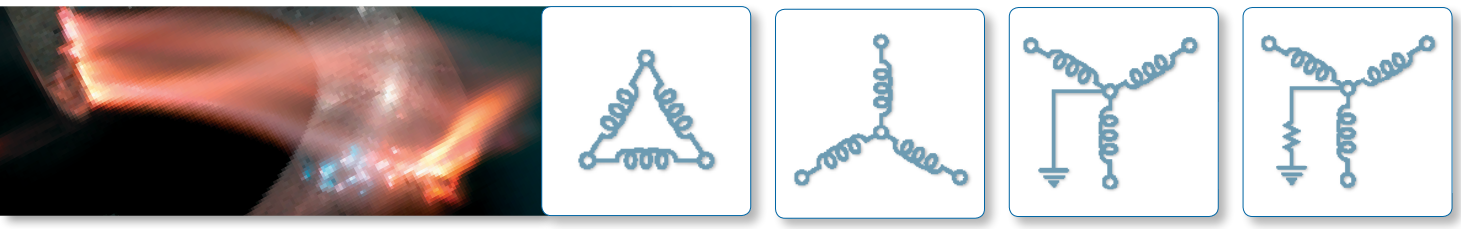
GARD

Unparalleled Protection

WHY HRG IS SUPERIOR TO SOLIDLY GROUNDED TECHNOLOGY IN INDUSTRIAL FACILITIES

Q&A



Webinar Q&A, May 2020

HRG IN INDUSTRIAL FACILITIES

Thank you for attending our webinar focused on why HRG technology is the superior choice for industrial facilities. For those of you who missed it, or would like to watch it again, the 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. How high a voltage do you consider safe for use with HRG? 12,470V P-P, 13,800V P-P or lower?

A. HRG is used on medium and low voltage systems where continuity of operations is important. IEEE Standard 141-1993, Recommended Practice for Electric Power Distribution for Industrial Plants (Red Book), states that “high-resistance grounding should be restricted to 5 kV class or lower systems with charging currents of about 5.5 A or less and should not be attempted on 15 kV systems (Walsh 1973 [B37]), unless proper ground relaying is employed. The reason for not recommending high-resistance grounding of 15 kV systems is the assumption that the fault will be left on the system for a period of time. Damage to equipment from continued arcing at the higher voltage can occur. If the circuit is opened immediately, there is no problem.” Hence, HRG can safely be used on systems up to 5 kV with ground fault current limited to 10 A.

McClung also had an experiment on a 13.8 kV system and limited the fault current to 50 A and witnessed some destruction. When the current was lowered to 18 A there was very little damage.
All that being said, you can have an HRG on systems greater than 5kV as long as the charging current is low and you trip safely.

Q2. When setting up a ground fault system test, is there a specific lead used to make the connection used or is it simulated with a ground chain connection?

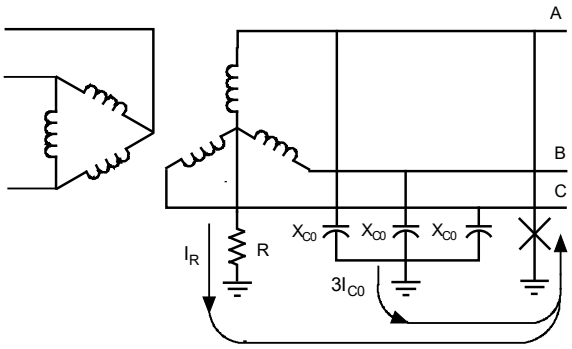
A. We have done this test with a wire rated the same voltage as the system in series with a fuse and a resistor to limit current.

Q3. Did I hear correctly that you suggested one might have a HRG generator on an auto Transformer to a solidly system?

A. It was mentioned that I found an autotransformer on an HRG system where the user grounded the autotransformer on the secondary side. The results were not favorable. The ground prevented the HRG to function.

Q4. Is the reason why the NGR let-through current is greater than L-G capacitive charging current to prevent an arc-restrike or to dissipate stored energy in the NGR? Can you comment and provide clarity?

A. When the ground fault is intermittent or allowed to continue, the system could be subjected to severe over-voltages to ground, which can be as high as six to eight times phase voltage. Such over-voltages can puncture insulation and result in additional ground faults. These over-voltages are caused by repetitive charging of the system capacitance. The NGR let through current has to be higher than the system capacitive charging current for discharging of the system capacitance to avoid severe transient over voltages or re-striking.



$$I_F = \sqrt{(I_R)^2 + (3I_{C0})^2}$$

$$I_{F_{MIN}} = \sqrt{2}(3I_{C0}) \qquad \text{At minimum fault current, } I_R = 3I_{C0}$$

Q5. Do you see HRG employed in commercial applications? Retail and strip malls @ 120/208 V.

A. In Canada, distributed Neutral are allowed by code. In the US, they are not. At 120/208 V there is very little need for ground fault protection so this will not be a benefit.

We do see a benefit when the distribution is 480/277 V or 600/347 V. When the majority of the load is 277 V or 347 V lighting. We can isolate the mechanical load, heating, air conditioning, with an isolation transformer so that they can operate on a high resistance grounded system. In this way, they can ride through most ground faults and continue to condition the air.

The only time we have purchased airfare for a resistor was when there was a convention of lawyers in the east coast of Canada when a Dynamic Braking resistor needed to replacement. So the importance of heating and cooling for a commercial venue can be seen.

Q6. Have you applied these to the ESP applications? VFD output and MV transformer and how does VFD interfere with the MV transformer especially Delta to Wye and Wye being grounded or not. How does the bonding play role?

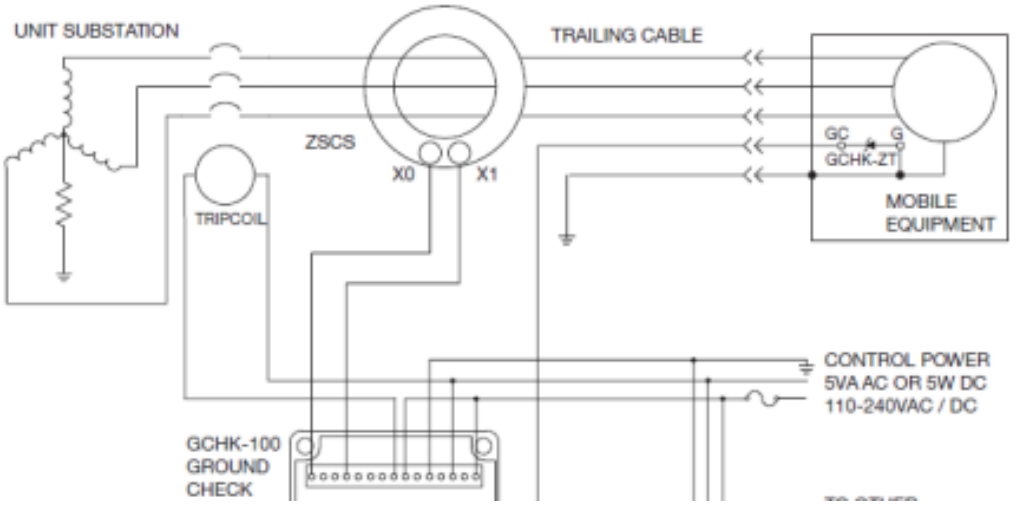
A. Yes, we have applied HRG to ESP application. We would need to analyze the cable lengths.

Q7. What is the implication of a second ground fault in the same system that has a standing HRG ground fault? How is the code requirement addressed in that case with the HRG system?

A. With SMART HRG technology there is the option to pre-select up to 50 feeders with priority from the lowest to highest (16 different settings are available) so that in the event of a second ground fault the least important feeder will trip within 100ms. This allows process continuity of the more important feeder. With this feature, the most important process in your facility will remain operational at all times. The SMART HRG system is equipped with visual or alarm indication on occurrence of ground fault which fulfils the code requirement.

Q8. In mining applications, is it common to use HRG for mobile loads? Is there any standard?

A. The use of HRG is common in mining applications. This allows tripping on the first fault at a low current value, which is the safest method for such applications. An issue when using HRG for mobile loads is the possibility of a disconnection at the trailing cable. This is due to the fact that if the trailing cable disconnects, there is no return path from ground which may cause safety issues for the mobile loads. Industry standards look to use an NGR that trips on the first fault in combination with our GCHK-100 relay. The GCHK uses a terminating diode to determine if the ground loop has been shorted or opened. This is crucial because without the GCHK, a shorted ground loop would appear as normal loop impedance, while in fact, the mobile equipment may be completely ungrounded. In Canada, CSA standards, section C421 focuses on mining industry requirements, while the US uses both CFR and MSHA standards.



Q9. Is it common to use HRG for Hospitals in Canada or the USA?

A. HRG is common for hospitals in Canada and the USA. HRG offers ground fault current limitations, feeder monitoring, second fault tripping, and pulsing to assist in the locating of a ground fault. The cumulative efforts of these HRG functions provide hospital personnel and maintenance workers with the necessary tools to i) identify that there is a fault, ii) use pulsing to locate the fault, iii) and provide ground fault limitations using a resistor at the neutral to ensure continuous operation for vital applications that are greatly affected by down time.

Q10. When is the new graphical display module for the DSA going to be officially available for purchase?

A. The IC2 will be available for purchase next month! To stay informed, we suggest you follow us on LinkedIn.

Q11. Can a HRG system feed directly to a motor with autotransformer control? If so, it will be difficult to locate the ground fault if this ground fault happens upstream of the motor. Is this true?

A. Yes, this is true. Autotransformers are electrical transformers that use only one winding, while isolation transformers have two. The main difference between the two is that isolation transformers are built with special insulation to separate the circuits on the primary and secondary side. Since autotransformers do not isolate the primary and secondary windings, several issues when locating a ground fault may occur. This is due to the lack of separation between the windings which allows the ground fault current to travel upstream.

Q12. What is the IEC view on HRG systems? Is it similar to NEC and CEC?

A. HRG is not prohibited for use in Europe, but is less commonly seen than in North America. IEC refers to HRG systems as IT systems.

Q13. Could you comment on compliance to EMC with HRG systems?

A. I-Gard has a third party evaluate our relays for EMC, EMI compliance. This allows us to apply the CE mark.

Q14. Could you explain again how you measure the current pulsing on downstream loads without opening any swgr or MCC doors?

A. I-Gard's pulse-enabled HRG black boxes provide a rotary pulsing switch on the front panel that creates a pattern of step pulses in the ground fault current. Since the pulses only appear in the faulted circuit, a clamp-on sensor (I-Gard provides the TS-sensor) is used to trace the source of the ground fault by wrapping the sensor loop around all phases. After confirming that the pulses are active, begin checking for the presence of pulses at branch points. If no pulses are found - move on to the next circuit. Once current pulses are found, move down the circuit to the next branch point and repeat the process. The pulsing signal will eventually lead to the faulted equipment or section, at which point the location is identified and that portion can be isolated for repair or replacement.

Q15. How do you tackle the problem of the presence of VFDs during an HRG installation?

A. There are no problems with HRG when VFDs are present. One thing to watch out for is the voltage isolation to ground, which shows that a phase to ground fault will increase the voltage on the two unfaulted phases with respect to ground. Ensure that the drive manufacturer has taken the necessary precautions to allow for the additional voltage rating in the instance of a ground fault.

Q16. Why are the standard pulsing time settings (Ex. 0.1s to 0.5s instead of 1-5s) so fast if most multi-meters have slow read times?

A. Not sure why .1 to .5 s are used except for pickup times. Our Pulsing setup are from1 Hz to 3 Hz or 1 s on 1 s off.

Q17. Is there a rule of thumb for setting the value of the neutral ground resistor in 5kV, 13.8kV voltage system?

A. NGR let through currents should be sized higher than the system capacitive current. This is done to avoid severe transient over voltages, caused by repetitive charging of the system capacitance. As a rule of thumb, charging current is estimated at 1A per 1000KVA of system capacity on medium voltage systems. This estimation increases if surge suppressors are present (approx. 1.5A per surge suppressor). Additional factors like Coordination and protection schemes should also be taken into consideration.

Q18. What are the disadvantages of an HRG system? Potential causes of failure for NGR units.

A. A possible disadvantage is that on the occurrence of a ground fault, unfaulted phases are elevated towards line to line voltage. This issue is easily eliminated by ensuring all elements (cabling, drives etc.) throughout the system are insulated and rated for full line to line voltage, also neutral loads should be served through an isolation transformer. If the latter cannot be accomplished, the Canadian electrical code requires the system be tripped in the event of a ground fault.

Potential causes by mechanical failures and thermal overloads (e.g. a short circuit on a section of the NGR reduces the overall grounding resistance which leads to thermal overloads and consequently an open NGR), extended service life, improper installation/specification, manufacturing defects etc.

Q19. Are you saying to help control ground fault and opening the correct CB we should try to use 4 pole circuit breakers?

A. Not at all. In order to properly open the correct breaker on solidly grounded system with complex schemes like Mani-Tie-Main, additional relays and relay protection is necessary.

Q20. Could you elaborate more on variable frequency drives and HRG systems? Have you experienced any issues with ground faults on VFDs that cause power system quality issues until the fault is cleared?

A. HRG is compatible with VFD applications. One thing to watch out for is the voltage isolation to ground – which shows that a phase to ground fault will increase the voltage on the two unfaulted phases with respect to ground. Ensure the drive manufacturer has taken the necessary precautions to allow for the extra voltage rating on the two unfaulted phases.

Q21. Why does, almost any, AC/DC drive manufacturer recommend in their installation manuals that the best grounding scheme is solidly grounding systems? What would be the best recommendation around applying AC/DC drives on an HRG System?

A. Solid Grounding being the best grounding scheme is an outdated opinion. HRG provides added benefits by reducing the likelihood of exposure to arc flash incidents (CSA Z462 Annex O), and also allowing for continuous operation in the event of a ground fault. Cost savings are also seen where the neutral is not distributed.

Drives can seamlessly be applied to HRG systems as long as they are compatible with HRG (check with OEM).

Not all drive manufacturers tend to gravitate to solidly grounded systems. There are some very knowlegable drive manufacturers that understand HRG systems very well. The ones that do not understand HRG think there is a mystical atmosphere around HRG systems in that:

1) They are an arc flash mitigation technique
2) You don't have to shut down on the occurance of a ground fault
3) There is less damage at the point of the fault,
4) It is more economical than solidly grounded systems
5) You can find where the fault is in a timely manner

So drive manufacturers are stuck in a dilemma; on one hand they need to remove harmonics from the electrical system to comply with regulatory agencies. To do this they need to place filters, capacitors, from line to ground. On the other hand, they need to comply with their customers wishes to have all the advantages listed above. So what is easier, to tell your customer that they chose the wrong grounding system or that they chose the wrong drive manufacturer?

Q22. Has I-Gard developed any white pages discussing the topic of benefits of HRG?

A. Please visit our website at www.i-gard.com, and browse Case Studies and Technical Library.
http://www.i-gard.com/technical-library/i-gard-editorials/

Q23. Please clarify the difference between High-Impedance Resistance Grounded System Vs. Low-Impedance Resistance Grounded System? Is there any threshold between High and Low RG?

A.

Application	HRG	LRG
Current	10A and Below	Above 10A
Voltage (Typical)	5KV and Below	5KV and Above
Operation	Continuous (1st Ground Fault)	10S -1 Minute
	Is considered an arc flash mitigation technique	
	Allows fault to be located without de-energizing feeders (ground fault pulse locating)	Must isolate the faulted feeder or system
	Commonly in continuous process industries, hospitals, data centers and station service in gen stations where unscheduled downtime is costly or cannot be tolerated.	

Note: The description above applies for Canada. US has less defined thresholds to differentiate HRG from LRG. NEC mentions “low value” of current and I believe up to 1000 Volts

Visit our website (www.i-gard.com) to see Case Studies and Technical libraries to take advantage of I-Gard’s technical presentation and papers for HRG and LRG applications.

Q24. What is i-Gard's experience with Variable Frequency Drives on HRG systems?

A. I-Gard has vast HRG experience (over 30 years) with facilities with Variable Frequency Drives. I-Gard HRG systems have been widely used in North America particularly on the following industries: Pulp and Paper, Oil and Gas, Food and Beverages, Hospital, etc. VFD manufacturers provide VFD models that are fully compatible with HRG systems. Most of these facilities used I-Gard DSP-OHMNI System. I-Gard DSP System, suited for this application because of its unique characteristics – 1. Monitors the voltage and current, to detect a legitimate ground fault; 2. Feeder Monitoring, to detect ground fault on a particular feeder and phase. You have the option to isolate faulted feeder or you can easily finding the source of the fault without interruption of service; 3. 2nd Fault Protection, can detect 2nd Fault (Line-to-Ground-to-Line Fault) and trip the low priority feeder to revert the situation back to Line-to Ground Fault to limit the ground fault current to 10A and below for continuity of service and 4. Modular Design, expandable without replacement of existing system components. To add additional feeders and functionalities is easy. You just need to buy the modules you need, it’s just plug and play. Unlike other product in the market that uses different relays and put them together connected to a PLC to build a pseudo system. Aside from having high initial cost, it may require major work when expanding the said system. Click here to see a white paper on Pulp and Paper Article (Field Study), a success story using I-Gard HRG systems.

http://www.i-gard.com/site/assets/files/1117/pulp_and_paper_article_2019.pdf

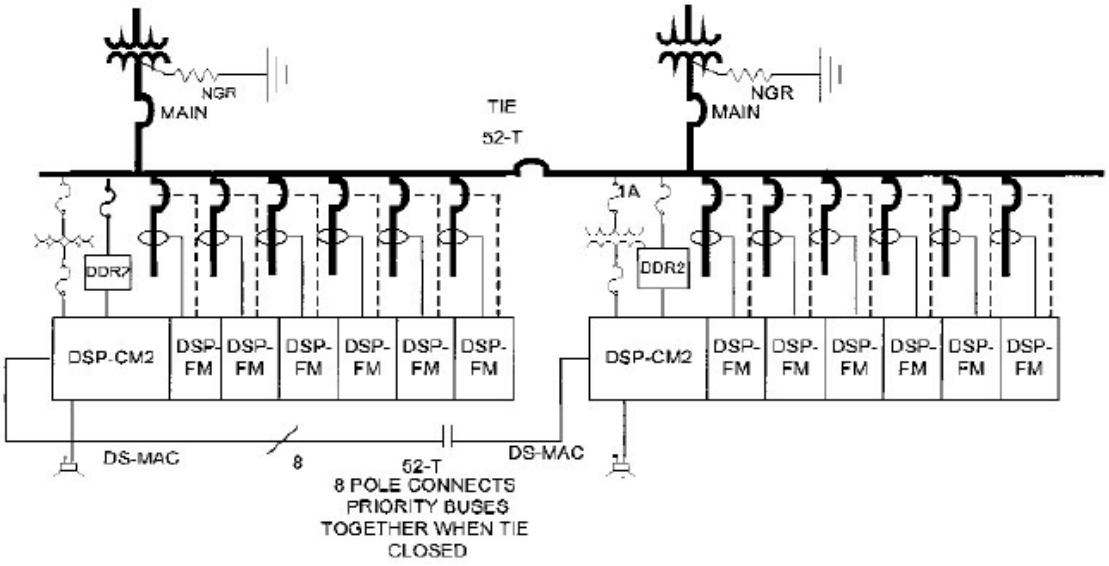
Q25. How does adding an NGR impact the Ground Potential Rise, touch potential and step potential of a pad mount transformer?

A. The GPR and Touch Potential are created by line to ground fault current and are directly proportional to it. So larger the fault current higher are the GPR and Touch Potential. Applying NGR reduces the line to ground fault current. In case of HRG, the fault current will be less than 10A so there would be hardly any GPR or Touch Potential considering low impedance in bonding and the ground grid resistance. IEEE 80 standard covers the math to show GPR and Touch Potential

Q26. Is there a limitation based on feeder circuit length for application of HRG?

A. I-Gard DSP System can handle up to 50 feeders per system. Which is typically more than enough to accommodate feeder protection for most electrical system. To accommodate more than 50 feeders, multiple DSP System can be used together. They have the ability to communicate to one another and act as one system. For example, see diagram below. If you mean feeder length as in distance to the load, then the only limitation is the increase in charging current that will increase due to this increased length. The circuit on low voltage systems, typically are very low in charging current.

For more details, please contact us at support@i-gard.com or call 905-673-1553 so we can provide further technical assistance.

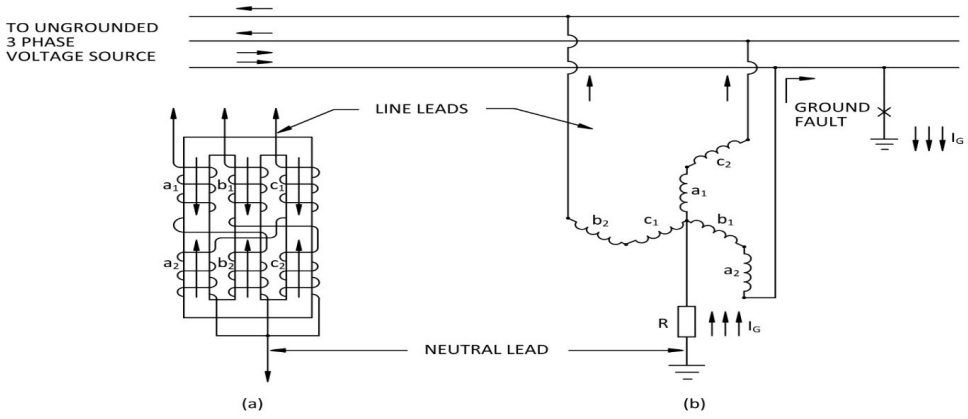


Q27. I am from France, could you explain what standard describes HRG under IEC electrical code?

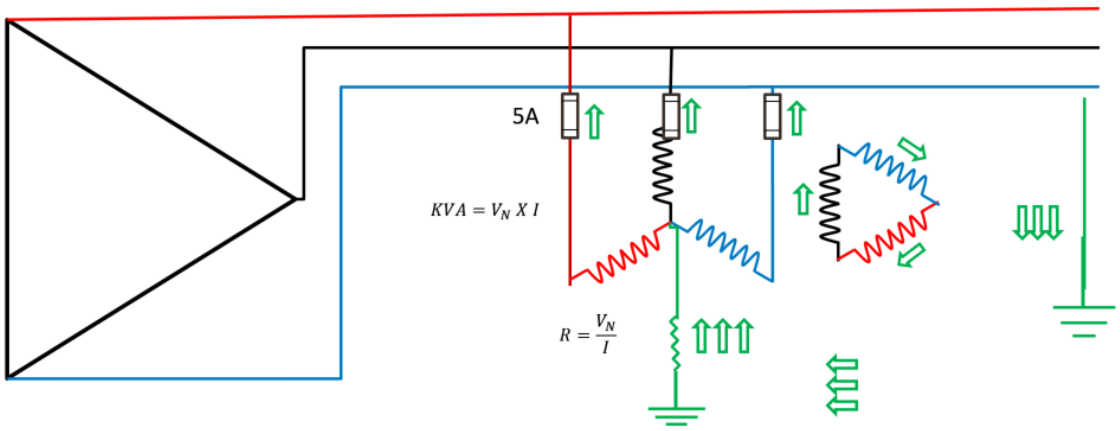
A. We have had some experience working with French standards, however they are a little different. The project we worked on refered to NF C 15-100 Partie 4-44 Defining ITR systems. The IEC community refers to this type of system as IT.

Q28. Can you use a Smart HRG on a delta-delta transformer system?

A. Delta-Delta or Ungrounded System is perfect for conversion to Smart HRG System. Since there is no Neutral loads and most of the equipment and cables rated for line-to-line voltage. However, you need to add a Neutral-Grounding Transformer to derive a neutral. The common methods are Zigzag and Wye-Delta Transformers to derive a neutral. Using Zig-Zag Transformer is more popular because it is cheaper and have smaller footprint. See diagrams below:



Zigzag Grounding Transformer.
(a) Core Windings
(b) System Connection



Q29. Why should we change our clients project to High Resistance Grounding when we have been using solidly grounded systems for 50 years?

A. The answer has 4 standard responses, each a justification on their own but all 4 are attainable.

1) Compliance to Standards - NFPA70E and CSAZ462 Annex O 2.2. notes design considerations should facilitate a reduction in risk and reduction in hazard. HRG Technology lowers the probability of an arc flash by 95% or more. The addition of an arc flash module reduces the impact of any arc flash that does occur.

2) Increased Reliability - HRG Technology allows key processes to stay operational even if there is a ground fault.

3) Lower Costs - HRG Technology reduces motor repair costs significantly - Click here for Case Study

4) Reduce Risk - HRG Technology limits ground faults to such a low level, arcing faults self-extinguish and an arc flash rarely occurs.

Increased output, lower costs, reduced risk, standards compliance, that is why more and more projects are using HRG technology.

Q30. After locating the the feeder the fault is on, what is the next step?

A. Option 1 - trip the feeder as we don't want to operate with a ground fault. This is the most common reason given for operating a solidly grounded system, a ground fault trips something. The difference is with a solidly grounded system the fault current is 10,000 amps or higher, in a high resistance grounding system the fault current is 10 amps or less.

Option 2 - provide an alarm, remain operational and allow maintenance personnel a predetermined amount of time to clear the fault or trip. You select the time up to 99 hours.

Option 3 - provide an alarm, remain operational and only trip if a second ground fault occurs on a different feeder and only if this feeder is determined to be of low importance, otherwise trip the other feeder

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