GARD

Unparalleled Protection

2022 Industrial & General Segments Brochure

WHY GROUNDING IS KEY?

When designing or selecting an electrical grounding system for industrial operation for voltages of 5kV and below there are three basic choices – Ungrounded, Solidly Grounded or High Resistance Grounded.

When deciding which type of grounding system to specify there is a need to consider:

- Reliability
- Electrical Risk
- Operating Costs

Under normal conditions any of the three grounding methods are reliable, free from electrical risks and have similar operating costs but ground faults are a reality in any electrical system and so the question becomes how does the grounding system decision affects reliability, risk and costs?

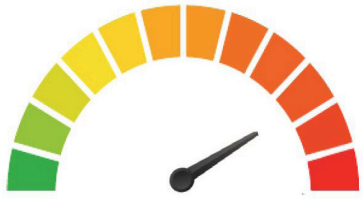
During a ground fault on an UNGROUNDED SYSTEM, the arcing nature 'charges' the system capacitance. When the arc extinguishes the charged system cannot dissipate the charge, so it holds it. When the arc re-strikes, more charge is added to the system. This continues until the insulation breaks down at the weakest point in the system.

The concern over the safety aspect of ungrounded systems when experiencing a ground fault is noted in the IEEE 242-1986 *Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems 7.2.5:*

"A second ground fault occurring before the first fault is cleared will result in a phase-to-ground-to-phase fault, usually arcing, with current magnitude large enough to do damage, but sometimes too small to activate overcurrent devices in time to prevent or minimize damage.

Ungrounded systems offer no advantage over high-resistance grounded systems in terms of continuity of service and have the disadvantages of transient overvoltages, difficulty in locating the first ground fault, and burndowns from a second ground fault".

In effect, ungrounded systems have no advantages over high resistance grounded systems and have higher costs associated with equipment damage, loss of process continuity and risk of arcing flash.



Under normal operating conditions a SOLIDLY GROUNDED SYSTEM is safe and reliable, however both criteria are impacted when the system is subject to a ground fault. A ground fault of sufficient magnitude will trip the over-current protection and interrupt the process.

An arcing fault may not be of sufficient magnitude to be detected by and trip the over-current device until the arc fully develops and it becomes destructive and possible deadly.

In the IEEE 141-1993, *Recommended Practice for Electrical Power Distribution for Industrial Plants section 7.2.4, it states that:*

"The solidly grounded system has the highest probability of escalating into a phase-to-phase or three-phase arcing fault, particularly for the 480 and 600V systems".

"A safety hazard exists for solidly grounded systems from the severe flash, arc burning, and blast hazard from any phase-to-ground fault".

The following table provides a summary of arc flash data over a 23 year period - not all arc flash incidents are effectively captured or reported. This data validates the occurrence of injuries and fatalities associated with arc flash incidents at different voltage levels.

Voltage	Burns	Smoke Inhalation	Shock	Fatalities
Under 400V	19	0	3	0
480V and 600V	283	18	5	33
1kV to 5kV	78	1	0	13
5kV to 15kV	100	3	13	10
Over 15kV	50	16	2	5

NFPA 70E states in Annex O *Safety-Related Design requirements:*

"A great majority of electrical faults are of the phase-to-ground type. High-resistance grounding will insert an impedance in the ground return path and will typically limit the fault current to 10 amperes and below (at 5 kV nominal or below), leaving insufficient fault energy and thereby helping reduce the arc flash hazard level".

IEEE141-1993 Recommended Practice for Electric Power Distribution for Industrial Plants Section 7.2.2:

"There is no arc flash hazard, as there is with solidly grounded systems, since the fault current is limited to approximately 5A".

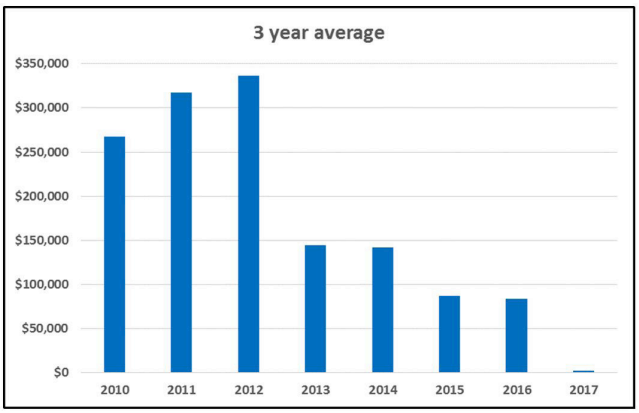
By choosing HIGH RESISTANCE GROUNDING on your electrical distribution system you control the ground fault magnitude to the point where the vast majority of arc flash accidents simply never occur.

Not only does HRG technology allow for process continuity during a single phase to ground fault thereby avoiding unnecessary process interruptions, there is evidence that converting to HRG will reduce equipment repair costs.

One leading industrial company made the decision to change their 3 phase 4 wire system to 3 phase 3 wire high resistance grounded on the basis of arc flash reduction. This company received the unexpected but welcomed benefit of reducing motor repair costs.

In solidly grounded systems, it is not unusual to have several hundred amps of fault current, insufficient to trip the over-current device but more than enough to damage motors.

The change to HRG where the ground fault is limited to 10 Amps or less, reduced the damage so significantly that this factor alone would have provided less than a 3-year return on investment.



The two limitations with standard HRG technology are that a second ground fault trips the entire system, and the arc flash energy levels are not reduced by HRG technology, both of these limitations are overcome through the application of SMART (ADVANCED) HRG technology.

SMART HRG with second fault protection ensures that your most critical process is operational at all times, providing an opportunity for increased revenue.

Feeder indication of a ground fault shortens the time needed to find a fault and removes personnel from the risk involved in starting the search at the main switchgear.

Detecting and interrupting an arc flash as quickly as possible reduces the incident energy levels and ensures workplace safety.

What does a SMART (ADVANCED) HRG offer in terms of features and benefits? It is described through SMART acronym, which stands for:

S - Selective Instantaneous Feeder Trip (SIFT) on 2nd ground fault

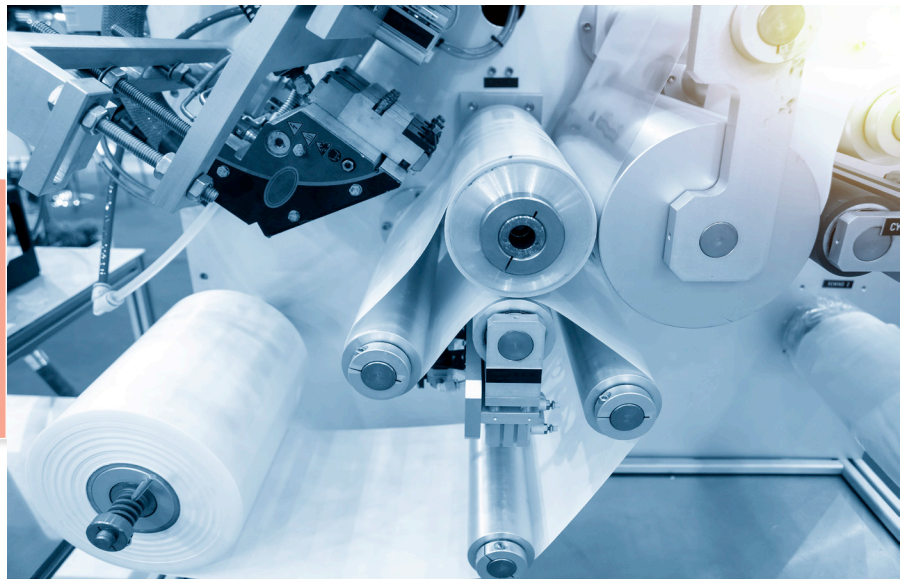
M - Mitigate 95-98% of arc flash incidents on 1st phase-to-ground fault

A - Assisted Fault location through pulsing system and indication/alarm of faulted phase and feeder

R - Resistor integrity monitoring. It continuously monitors neutral and resistor continuity to meet the new CSA code requirement

T - Time selective feeder isolation. Feeders can be programmed to trip on 1st fault, first fault with time delay, trip on 2nd fault. It allows the user to set priority levels

CASE STUDY



Benefits of upgrading an Ungrounded system to a Resistance Grounded system in a Plastics & Packaging facility (extrusion and conversion of polyethylene sheeting)

By: Andrew Cochran. Based on: Power Disturbance Report, Brosz and Associate. Pertaining to Regency Plastics, Toronto ON.

Regency Plastics based in Toronto were operating a main distribution system that was 600V 3 phase 3 wire and this is a common approach for companies requiring process continuity. The 35-year-old distribution system had three ground fault indicating lights, which is all that was required by the electrical code.

Applicable Codes and Standards

According to the Canadian Electrical Code 2021 Edition, Clause 10-400 :

1) DC or AC systems shall be permitted to be ungrounded, provided that the system is

a) Equipped with suitable ground fault detection; and

b) Maintained by qualified persons.

2) On the occurrence of a ground fault, the ground fault detection shall activate a visual or audible alarm to indicate the presence of the ground fault.

In a high number of installations this requirement is met through the use of a three light system that indicates the presence and phase of any ground fault. To be truly effective this system requires constant vigilance and inspection a task made ever more difficult with switchgear being located in locked electrical rooms or electrical service being provided by a sub-contract firm.

There is an interesting perspective provided with regard to this practice in the IEEE Standard 242-1986 *Recommended Practice for the Protection and Coordination of Industrial and Commercial Power Systems* 242-1986 section 7.2.5.
"Ungrounded systems employ ground detector to indicate a ground fault. These detectors show the existence of a ground on the system and identify the faulted phase, but do not locate the ground, which could be anywhere on the entire system."

The plant had experienced several failures within their drives over the previous several months and Brosz and Associates were retained by the State Group to assist in monitoring and evaluating the power disturbances and to recommend a solution.

Ungrounded Systems

The ungrounded system was often chosen for industries where process continuity was vital as the system would continue to operate under a single ground fault condition. An "ungrounded" system is a system with no intentional connection to ground, in reality the system is coupled to ground through the capacitance of the conductors as well as the transformer and motor windings. Under normal operating conditions (i.e. no ground faults) the three phase ground voltages are roughly equal, in this case nominally 347V.

However, when one phase of the system experiences a solid ground fault, that phase and ground are at the same potential and the remaining two phases experience an increase in voltage to ground of 73% (in this case nominally 600V). Although under these ground fault conditions the phase-ground voltages change, the phase-to-phase voltages remain unchanged and the system continues in service as normal.

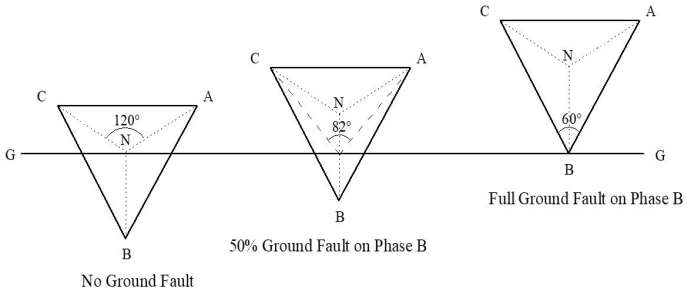


Fig. Phase-to-ground voltages V_{AG},V_{BG},V_{CG} in an ungrounded system.

When one phase of the system becomes grounded, the occurrence of a second ground fault on a different phase results in a phase-phase fault via ground. These faults will result in equipment damage and operation of the phase overcurrent devices – fuses or breakers.

Ungrounded systems are susceptible to severe over-voltages due to a couple of possible ground fault conditions. The first scenario involves a ground fault through an inductive reactance (i.e. operating coil, transformer winding, etc.). When the inductive reactance of the ground fault closely matches the system capacitance to ground, over-voltages a much as ten times normal can be experienced.

The second scenario involves an intermittent, sputtering or arcing ground fault (i.e. in vibrating equipment etc.) and in this case, it is possible that the recurring ground fault can generate over-voltages in the 6-8 time normal range.

During a ground fault on an ungrounded system, the arcing nature 'charges' the system capacitance. When the arc extinguishes (possibly due to AC waveform – zero crossover), the charged system cannot dissipate the charge, so it holds it.

When arc re-strikes, more charge is added to the system. This continues until the insulation breaks down at the weakest point in the system.
The concern over the safety aspect of ungrounded systems when experiencing a ground fault is noted in IEEE 242-1986 *Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems.*

Clause 7.2.5 has a number of notes on ungrounded systems:

A second ground fault occurring before the first fault is cleared will result in a phase-to-ground-to-phase fault, usually arcing, with current magnitude large enough to do damage, but sometimes too small to activate overcurrent devices in time to prevent or minimize damage.

Plant Facing Failures in Operation

On site observations and discussion with plant personnel confirmed that the ground fault indicating lights were functional and indicating active ground faults. Plant personnel were committed to locating and eliminating the source of the ground faults as soon as possible but confirmed that they often existed for days. The delay in locating faults has several causes, as there is no current flow in the ground fault it is not possible to trace the fault and the only means of identifying where the fault is occurring is by cycling breakers on and off and looking to the indicating lights to validate when the fault disappears, which is a time consuming approach.

Recommendations

With concern that severe over-voltages created by ground faults would result in insulation breakdown, the development of phase-ground-phase faults which would result in equipment damage and lost production the recommendation was made to install an artificial neutral (zig-zag grounding transformer) and to resistance ground the system while incorporating appropriate ground fault monitoring equipment.

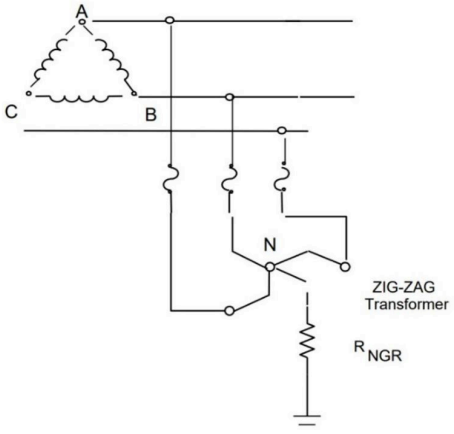


Fig. Zig-Zag grounding transformer connected to an NGR

This recommendation is consistent with the approach noted in IEEE 242-1986 Clause 7.2.5:

Ungrounded systems offer no advantage over high-resistance grounded systems in terms of continuity of service and have the disadvantages of transient over-voltages, locating the first fault and burn-downs from a second ground fault. For the reasons, they are being used less frequently today than high-resistance grounded systems, and existing ungrounded systems are often converted to high-resistance grounded systems by resistance grounding the neutral.

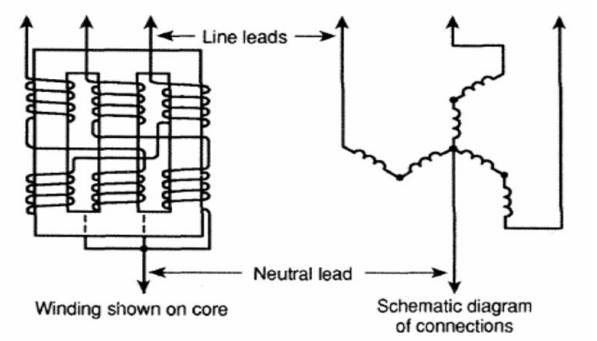


Fig. Zig-Zag grounding transformer windings

Once the system is high-resistance grounded, over-voltages are reduced and modern highly sensitive ground-fault protective equipment can identify the faulted feeder on first fault and trip one or both feeders on second fault before an arcing burn-down does serious damage.

An artificial neutral was installed between the main breaker and the main power transformer so that the artificial neutral was always on line. Adding a resistor to the created neutral solved the issue of transient over-voltages and continued to permit the facility to remain operational under a single ground fault condition but does not address the issue of locating the ground fault in a timely and safe manner.

The next recommendation therefore was to not only resistance ground the system but also to add pulsing capability as a means of locating the fault quickly, safely and without interrupting operations. This recommendation was aimed at addressing the time required to locate and then eliminate ground faults and Brosz and Associates recommended I-Gard Corporation, a local company that is a leader in this technology..

By installing a pulsing contactor in the resistor, once a ground fault is indicated, the pulsing contactor is activated and the current through the resistor modulates between two values.

This pulse or modulating current signature can be seen on a hand held meter which is connected to a portable current sensor that is wrapped around all three phases. The ground fault can then be quickly and safely located and since the current sensor can detect the pulse through conduit, the process does not require personnel to open electrical cabinets and be exposed to unnecessary risk.

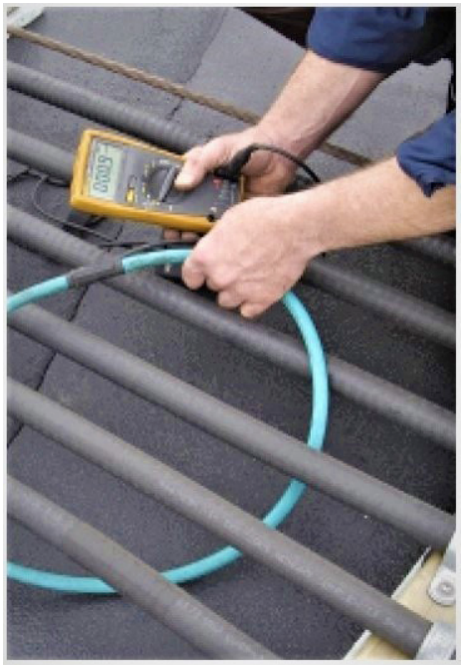


Fig. Ground Fault Location using a portable current sensor connected to a hand held meter.

Upgrading a facility from ungrounded to high resistance grounded is simple, economical, provides the same level of process continuity while resolving the risks and potential damage associated with transient over-voltage and through the use of pulsing technology allows for quick and safe location of a ground fault.

INDUSTRIAL AND GENERAL SEGMENTS CUSTOMERS

I-Gard values its long standing relationships with hundreds of industry leaders and widely recognized institutions, I-Gard Product and Solutions have been installed in a diverse variety of segments including Mining, Water, Transportation, Commercial & Industrial Buildings, among others. Discover which companies have used and continue to use I-Gard products. Please see a small portion of our clients outlined below.

Customer	Product	Location	Year
Nutrien	Gemini	Nebraska, USA	2021
Pacific Air Forces	NTR	Tokyo, Japan	2021
Edmonton Airport	MV NGR + SIGMA3	Edmonton, Canada	2020
Estée Lauder	Sleuth	Ontario, Canada	2020
Chantier Naval Davies	DSP-OHMNI, NGR, SIGMA3	Quebec, Canada	2020
Aurora Cannabis	NGR	Ontario, Canada	2020
CBC Toronto	DSP-OHMNI	Ontario, Canada	2020
Fraser Valley Trout Hatchery	DSP-OHMNI	British Columbia, Canada	2020
Paradigm Controls	Sleuth + Ethernet TCP/IP	Texas, USA	2020
New Gold Mine	NGR	British Columbia, Canada	2020
Université McGill	DSP-OHMNI, NGR	Quebec, Canada	2019-2020
Siemens	Sentinel	Texas, USA	2019-2020
Foley Inc	NGR	Pennsylvania, USA	2019
Maison Radio-Canada	Sentinel	Quebec, Canada	2019
Merck	Sentinel	Pennsylvania, USA	2012-2018
Metro Vancouver	DSP OHMNI + VIA	British Columbia, Canada	2018
Eaton	GCHK-100	Chile	2018
Government of Canada	DSP-OHMNI	British Columbia Canada	2017
Schneider Electric	DSP-OHMNI	Ontario, Canada	2016
Vancouver Airport Authority	Sentinel + DSP OMHNI	British Columbia, Canada	2015-2018
Neptune Terminals	DSP-OHMNI	British Columbia, Canada	2015
Greenfield Specialty Alcohols inc.	NGR	Ontario, Canada	2015
Polygon Industries	NGR	Ontario, Canada	2015
Argos Cement	Sentinel	South Carolina, USA	2015
York and Durnham Region	DSP-OHMNI	Ontario, Canada	2014
Ace Electric INC.	Sleuth	Kentucky, USA	2007
Johnson & Johnson	DSP-OHMNI	Quebec, Canada	2007
Guillevin International	Sentinel + Zigzag transformer	Quebec, Canada	2007
Eaton	DSP MK III System	Ontario, Canada	2006
Infasco	DSP MK III System	Quebec, Canada	2006
Chevron	Sleuth + Zig-Zag	California, USA	2005
Nucor Steel	NTR	Texas, USA	2003
Minera Yanacocha	NGR	Peru	2001

KEY BENEFITS OF SMART (ADVANCED) HRG

High-resistance grounding is a proven technology that provides process continuity even under a single ground fault condition.

The SMART HRG from I-Gard is the only HRG system that ensures process continuity of your most critical processes even under second ground fault conditions.

The SMART HRG system offers feeder indication and second fault protection which ensures that your most critical process is operational at all times, providing an opportunity for increased revenue.

The SMART HRG system can be configured with the time delay feeder trip.

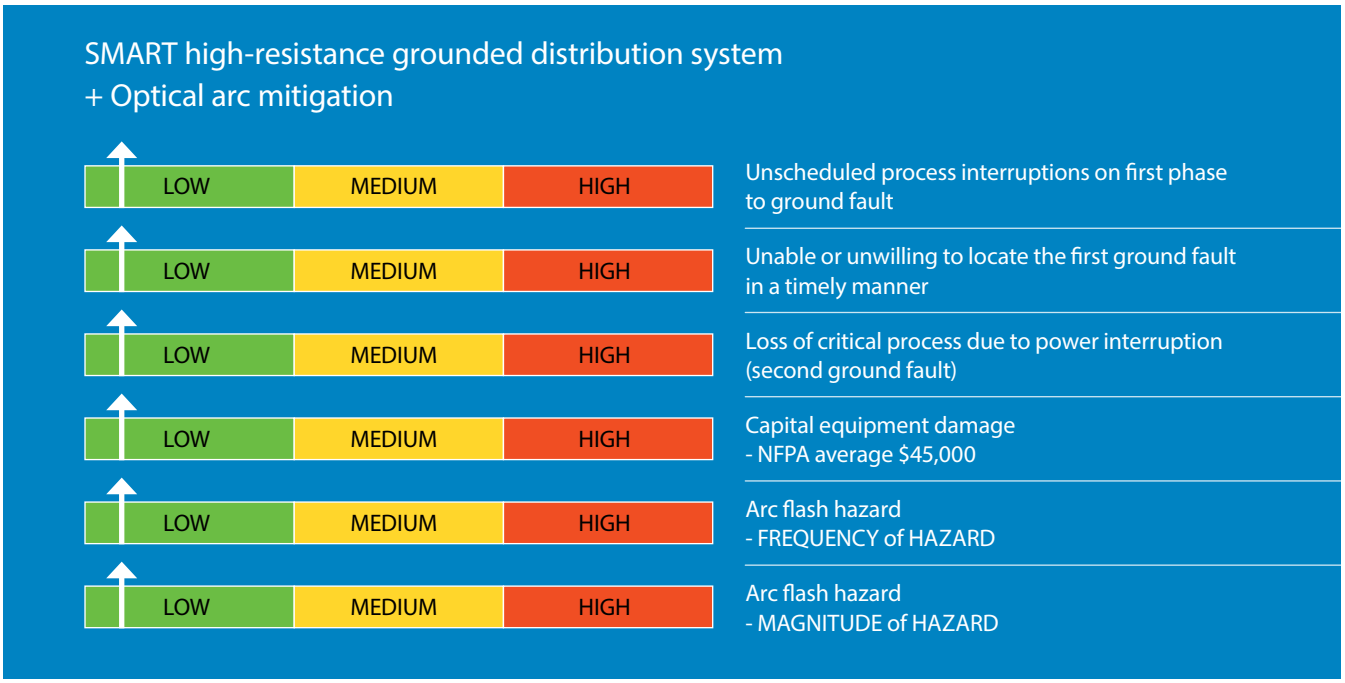
Feeder indication of a ground fault shortens the time needed to find a fault and removes personnel from the risk involved in starting the search at the main switchgear.

- Feeder identification feature provides information of where to start looking for a ground fault.
- With feeder time delay you control how long the ground fault is on the system and reduce the likelihood of a second ground fault.

The SMART HRG solution offers HRG and Arc Flash Mitigation functions in the same system.

- Once a certain level of light produced by an arc flash event is detected, the I-Gard sensors react in 1 milliseconds sending a trip signal to the relay.
- Detecting and interrupting an arc flash as quickly as possible reduces the incident energy levels and ensures workplace safety.

The figure below shows the Low Risk Level that the SMART HRG + Optical Arc Mitigation system provides by reducing the likelihood and magnitude of exposure of an arc flash, enabling achievement of an electrically safe work condition.



ABOUT I-GARD

I-Gard's commitment to electrical safety provides both industrial and commercial customers with the products needed to protect their electrical equipment and the people that operate them.

As the only electrical-safety focused company whose product portfolio includes neutral grounding resistors, high-resistance grounding systems and optical arc mitigation, we take pride in our technologies that reduce the frequency and impact of electrical hazards, such as arc flash and ground faults.

For those customers who have purchased from us over the last 30 years, you know us for the quality and robustness of our product, our focus on quality, customer service and technical leadership. We build on this foundation by investing in developing new products in electrical safety education – including the EFC scholarship program – by actively participating in the IEEE community programs on technical and electrical safety standards, and working with local universities at uncovering new technologies. We remain unrelenting in our goal of improving electrical safety in the workplace.

Our commitment to excellence is validated by our long-standing relationships with industry leaders in fields as diverse as oil and gas, hospitals, automotive, data centres, food processing, aerospace, water and waste water, and telecommunications.

We provide them with the product and application support required to ensure that their electrical distribution system is safe and reliable.

3 SOLUTIONS & FACTS ABOUT I-GARD

I-Gard offers more HRG products at more price points than any other competitor in the industry, with customized solutions for your specific application.

I-Gard is the exclusive supplier of FAIL-SAFE and ADVANCED HRG systems with 2nd ground fault protection to better match your need for electrical reliability and safety.

We are the only HRG supplier that also offers optical arc mitigation for Total Protection against ground faults and arc flash incidences.

- The first power resistor company in North America to be ISO 9001 certified.
- The only resistor manufacturer with a CSA-approved testing facility in-house under CSA SMTC program including CSA 295-15 and CSA 22.2 Part 1.
- The only resistor manufacturer with UL listing of our complete NGR product offering.
- Approved by the Government of Canada in its Controlled Goods Program for Defense applications.


Certificate of Qualification

THIS IS TO CERTIFY THAT

I-Gard Corporation

7686 Bath Road, Mississauga, ON L4T 1L2 Canada

has been qualified by CSA Group Testing & Certification Inc., as a Testing Facility for

Supervised Manufacturer's Testing for Certification Program

Based on ISO/IEC 17025:2017

ISSUED DATE: March 23, 2020

EXPIRY DATE: March 23, 2023

Samuel Baloun
Operations Manager


intertek

CERTIFICATE OF REGISTRATION

This is to certify that the management system of:

I-Gard Corporation

Main Site: 7686 Bath Road, Mississauga, Ontario, L4T 1L2, Canada

has been registered by Intertek as conforming to the requirements of:

ISO 9001:2015

The management system is applicable to:

Manufacture of electrical safety products for industrial applications.

Certificate Number: 0006248

Initial Certification Date: 11 November 2010

Date of Certification Decision: 11 November 2019

Issuing Date: 11 November 2019

Valid Until: 10 November 2022

Intertek

Calin Moldovean
President, Business Assurance

- Visit: www.i-gard.com to get access to our technical documentation and certificates.

GARD

Unparalleled Protection

2022 INDUSTRIAL & GENERAL
SEGMENTS BROCHURE

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