

Minutes
Electrical Power Working Group
Wednesday, 21 March 2001
Westin Hotel
Long Beach, CA

Chairs: Ken Vannice; NSI Corporation, representing Leviton Manufacturing Co., Inc.; principal; producer
Bob Luther; Lex Products Corp.; principal; producer

Members attending: Jeff deRecat; Advanced Devices, Inc.; alternate; producer
George Long; Aggreko Event Services; principal; user (changed interest category
from producer at this meeting)
Roger Lattin; IATSE Local 728; principal; user
Tim Bachman; Leviton / Colortran, representing Leviton Manufacturing Co., Inc.;
alternate; producer (joined at this meeting)
Louis Bradfield; Louis Bradfield; individual; user
W. G. Krokaugger P.E.; Mole-Richardson Co.; principal; producer
Tim Cox; PLASA; principal; general interest
William N. Masten; SMS Inc. / PGS LLC; principal; producer
Michael Lay; Strand Lighting, representing Strand Lighting Ltd.; principal; producer
(joined at this meeting)
Andy Topinka; Technical Group Services, Inc.; principal; general interest
Brian Dowd; TMB Associates; principal; producer
Richard Thornton Brown; Zero 88 Ltd.; observer; producer

1 Opening remarks

Ken Vannice called the meeting to order at 08:08, and Bob Luther welcomed everyone.

2 Attendance and membership

2.1 Introduction of those present

Vannice asked those present to introduce themselves and started the process with his own introduction.

Karl Ruling asked people to sign in on the sunshine yellow attendance sheet.

Ruling noted that Trevor Forrest had sent his regrets and apology for being unable to attend the meeting.

2.2 Determination of quorum

Vannice asked voting members to raise a hand so the number of voting members could be determined. Vannice announced that we have a quorum and the meeting could proceed as an official working group meeting.

2.3 Recognition of alternate voting members

Vannice noted the alternates who would be voting on behalf of their organization or company.

2.4 Requirements for membership

Vannice reminded the assembly that attendance is a requirement for voting members. Failure to attend may result in the representatives for a company or organization being moved to observer status. Membership is open to all who are materially affected by the work of the group. Membership in ESTA is not a requirement.

2.5 Processing of new membership requests

Michael Lay applied as a principal representative for Strand, replacing Milton Davis, who is no longer with the company. Roger Lattin moved to accept the application. The motion was seconded. There was no discussion. The motion was accepted unanimously by a show of hands.

George Long of Aggreko Event Services asked to have Aggreko's interest category be changed to "user" because the company only put bits together to service events, and he did not feel this constituted manufacturing. Roger Lattin so moved. The motion was seconded. There was no discussion. The motion was accepted unanimous by a show of hands, with only George Long abstaining.

Tim Bachman applied to represent Leviton/NSI/Colortran as an alternate to Ken Vannice. Roger Lattin moved that his application be accepted. The motion was seconded. The motion was approved unanimously by a show of hands. None opposed, no abstentions.

The voting body during the meeting was thus:

Name	Company	Representing	Voting status	Int. cat.
Doug Kraus	Advanced Devices, Inc.	Advanced Devices, Inc.	P	P
Bud Toly	Advanced Devices, Inc.	Advanced Devices, Inc.	A	P
Jeff deRecat	Advanced Devices, Inc.	Advanced Devices, Inc.	A	P
George Long	Aggreko Event Services	Aggreko	P	U
David Evaniew	B. I. M. Limited	B. I. M. Limited	P	P
Wolfgang Hofheinz	Bender GmbH & Co. KG	Bender GmbH & Co. KG	P	P
Joe Boardman	Bender Inc.	Bender GmbH & Co. KG	A	P
Jeffrey Measley	Crouse-Hinds Molded Products	Crouse-Hinds Molded Products Inc.	P	P
Trevor Forrest	Helvar Lighting Control	Helvar Lighting Control	P	P
Edwin S. Kramer	IATSE, Local 1	I.A.T.S.E. Local 1	P	U
Roger Lattin	IATSE Local 728	I.A.T.S.E. Local 728	P	U
R. Bruce Prochal	I.A.T.S.E. Local 728	I.A.T.S.E. Local 728	A	U
Patric J. Abaravich	IATSE Local 728	I.A.T.S.E. Local 728	A	U
Earl Williman	IATSE Local 728	I.A.T.S.E. Local 728	A	U
Jose J. Flores	Kino Flo, Inc.	Kino Flo, Inc.	P	P
Don Gray	Kohler Event Services	Kohler Co.	P	U
Ken Vannice	NSI Corporation	Leviton Manufacturing Co., Inc.	P	P
Mitchell Stein	Leviton Manufacturing Co., Inc.	Leviton Manufacturing Co., Inc.	A	P
Tim Bachman	Leviton / Colortran	Leviton Manufacturing Co., Inc.	A	P
Bob Luther	Lex Products Corp.	Lex Products Corp.	P	P
Louis Bradfield	Louis Bradfield	Louis Bradfield	I	U
Phil Fram	Marinco	Marinco	P	P
W. G. Krokaugger P.E.	Mole-Richardson Co.	Mole-Richardson Co.	P	P
Brian Parker	Mole-Richardson Co.	Mole-Richardson Co.	A	P
Tim Cox	PLASA	PLASA	P	G
Robert Barbagallo	Proximo Inc.	Proximo Inc.	P	G
William N. Masten	SMS Inc. / PGS LLC	SMS Inc. / PGS LLC	P	P
Richard A. Prey	SMS Inc. / PGS LLC	SMS Inc. / PGS LLC	A	P
Michael Lay	Strand Lighting	Strand Lighting Ltd.	P	P
Andy Topinka	Technical Group Services, Inc.	Technical Group Services, Inc.	P	G
Brian Dowd	TMB Associates	TMB Associates	P	P
Colin Waters	TMB Associates	TMB Associates	A	P
Richard Wolpert	Union Connector Company	Union Connector Company	P	P
Mitch Hefter	Rosco/Entertainment Technology	USITT	P	G
			23 votes	14 P 5 U 4 G

3 Approval of the minutes from the previous meeting

Roger Lattin moved that the minutes of the January meeting be accepted as written. The motion was seconded. There was no discussion. The motion was accepted unanimously by a show of hands, except for Tim Cox, who abstained because he had not attended the meeting.

4 Call for patents

The following was read by Ken Vannice:

“ESTA intends to publish no standard that contains protected intellectual property, unless that property can be licensed by anyone for a reasonable fee. ESTA uses a process of open patent disclosure to implement this intent. ESTA does not conduct patent searches and does not warrant that its standards contain no protected intellectual property.

“In keeping with the open disclosure policy, I ask if anyone present wishes to notify the working group of the existence of a patent or copyright that might protect material in a standard being developed by the working group. You need not be the holder of the patent or copyright in order to notify the working group of its existence.”

No issues were identified by the assembly when Vannice asked for a response.

5 Anti-trust statement

The following was read by Ken Vannice:

“The ESTA Board of Directors, the Technical Standards Committee, and the leadership of this Working Group will reject or nullify any actions that restrain trade. Anyone who feels that an action restraining trade is being or has been taken is requested to bring the matter to the attention of the chair immediately. Anyone who feels that actions in restraint of trade have been taken and not properly annulled is requested to notify the TSC chair or ESTA president immediately.

“ESTA legal counsel has informed us that any member of this working group may be found individually liable for any action that restrains trade taken by this working group. An individual convicted of a violation of the Sherman Act may be fined as much as \$100,000 and be imprisoned for up to three years. An easy to read pamphlet describing restraint of trade is available from the Technical Standards Committee.”

No issues were identified by the assembly.

6 Approval of agenda

Roger Lattin asked that "AB 931 stuff" be added under New Business. Louis Bradfield moved that the agenda be approved with this addition. The motion was seconded. The motion was accepted unanimously by a show of hands.

7 Old business – task group reports

7.1 Task group on a recommended practice for selection, installation, and use of portable feeder cable.

Roger Lattin reported that he had received no comments on the power feeder survey form that had been distributed. He said that he, therefore, assumes that this survey form is acceptable. Lattin asked everyone to send him a list of people for possible distribution of the survey so we can discuss this at the next meeting.

Roger moved that we accept the survey for publication and distribution. The motion was seconded. The motion was accepted unanimously by a show of hands. There was no opposition and no abstentions.

Bob Luther asked that some strategy be developed now for developing this list. Bob Luther sketched an outline of to whom we want to send this survey. There was a discussion of the tasks involved in distributing it. These resolved to:

- 1) Produce a cover letter
- 2) Post the survey on websites
- 3) Produce a list of targeted end users
- 4) Each member commits to producing at least five filled-out surveys.
- 5) We analyze the surveys at the next meeting.

Brian Dowd moved that the above be our action plan for the survey. The motion was seconded. The motion was approved unanimously by a show of hands.

Bob Luther volunteered to put the survey on the Carnival website. Ruling agreed to put it on the ESTA website. Ken Vannice agreed to work to put the survey on the USITT website. Roger Lattin offered to get it on the TEA website. Cox volunteered to put a pointer on the PLASA website. George Long said he would work to get Event Solutions and Special Events to put on their websites. Bob Luther will work to get it on the PERA website. Jeff deRecat volunteered to work to get it on the IAAM and IAPPA websites.

Tim Bachman drafted a [cover letter for the survey](#) to be used in a variety of situations. It was edited by the working group. Brian Dowd moved that the edited cover letter be approved. The motion was seconded. The motion was accepted unanimously by a show of hands.

George Long questioned whether the email reflector was working. He said that he'd had very little mail from the reflector. There was a discussion of this perceived communications problem.

7.2 Task group for a recommended practice for use of GFCI (Residual Current Devices) in entertainment applications.

Bill Masten distributed paper copies of the file "PROPOSAL FOR AN ESTA GFI STANDARD.DOC," and ask that the proposal be distributed with the minutes. [It is appended.]

There was a discussion of how to proceed with this project, since there had not been time for anyone to read the document before the next meeting. Vannice directed members to read it and to be prepared to make recommendations at the next meeting. Ruling suggested that specific proposals be sent to him for distribution with the agenda more than two weeks before the next meeting.

7.3 Task group to write a configuration standard for HMI power cables and/or head to ballast cables.

Brian Dowd says that he'll take on the project from Warren Mays, who is no longer with TMB.

7.4 EMC task group

Vannice reported that the LFEIC has decided to regroup and remarshal forces. They will continue to gather data on measured levels of harmonics on the mains. They will continue to attack stringent harmonic limits on a WTO barrier-to-trade level.

Vannice reported that the WTO cannot agree on a definition of what constitutes an international standard. Instead, the WTO has developed a check list that will be consulted by an arbitration panel when a challenge is raised.

Vannice reported that for CE marking, officially you can either comply with a standard or you can choose to comply via a technical construction file. However, Vannice is discovering that this is not really the case. You must comply with a standard if an applicable standard exists, is what he's finding, so the apparent choice is illusory.

7.5 Task group on troubleshooting power quality problems

Andy Topinka asked for more input and more help gearing his document more toward the entertainment industry. This intent to refocus the book was noted in the minutes of the last meeting.

Roger Lattin said that people he'd shown it to had expressed doubt that there are simple solutions that will always work. They doubt that solutions are practical for portable systems that are broken down and reconfigured several times a day. Topinka asked for some specific examples of these kinds of systems so they can be addressed in the book. Topinka discussed some of Lattin's particular problems with Lattin. Vannice noted that Lattin's problems may be unusual in that he often works with isolated systems comprised of a generator interacting with harmonics-producing loads. Most other people use the public power utility.

8 New business

Roger Lattin noted that AB 931 (a California Assembly Bill) will require people doing electrical work to be qualified, and not simply contractors, with licensing being the way of documenting qualification. According to Vannice, the bill is written so that it only applies to those people working for licensed contractors.

9 Other business

None.

10 Schedule for future meetings

Ruling announced that the next meet will be Friday, July 13, from 8:00 to noon, at the Dallas/Ft. Worth Airport Marriott in Irving, Texas.

The following meeting will be held in conjunction with LDI 2001. This trade show is announced for November 2 through 4. Therefore, the meeting will be on some day from about October 31 through November 3.

11 Adjournment

George Long moved that the meeting adjourn. The motion was seconded. The motion was approved unanimously with a show of hands. Vannice and Luther declared the meeting adjourned at 11:46.

Electrical Power Working Group Membership After the End of the 21 March 2001 Meeting

Name	Company	Representing	Vote status	Int. cat.
Doug Kraus	Advanced Devices, Inc.	Advanced Devices, Inc.	P	P
Bud Toly	Advanced Devices, Inc.	Advanced Devices, Inc.	A	P
Jeff deRecat	Advanced Devices, Inc.	Advanced Devices, Inc.	A	P
George Long	Aggreko Event Services	Aggreko	P	U
David Evaniew	B. I. M. Limited	B. I. M. Limited	P	P
Wolfgang Hofheinz	Bender GmbH & Co. KG	Bender GmbH & Co. KG	P	P
Joe Boardman	Bender Inc.	Bender GmbH & Co. KG	A	P
Lee J. Bloch	Bloch Design Group Inc.	Bloch Design Group Inc.	O	G
Jeffrey Measley	Crouse-Hinds Molded Products	Crouse-Hinds Molded Products Inc.	P	P
Ron Dahlquist	Dadco	Dadco	O	P
Trevor Forrest	Helvar Lighting Control	Helvar Lighting Control	P	P
Richard Thornton Brown	Zero 88 Ltd.	i Light Group PLC	O	P
Edwin S. Kramer	IATSE, Local 1	I.A.T.S.E. Local 1	P	U
Roger Lattin	IATSE Local 728	I.A.T.S.E. Local 728	P	U
R. Bruce Prochal	I.A.T.S.E. Local 728	I.A.T.S.E. Local 728	A	U
Patric J. Abaravich	IATSE Local 728	I.A.T.S.E. Local 728	A	U
Earl Williman	IATSE Local 728	I.A.T.S.E. Local 728	A	U
Jose J. Flores	Kino Flo, Inc.	Kino Flo, Inc.	P	P
Don Gray	Kohler Event Services	Kohler Co.	P	U
Ken Vannice	NSI Corporation	Leviton Manufacturing Co., Inc.	P	P

Name	Company	Representing	Vote status	Int. cat.
Mitchell Stein	Leviton Manufacturing Co., Inc.	Leviton Manufacturing Co., Inc.	A	P
Tim Bachman	Leviton / Colortran	Leviton Manufacturing Co., Inc.	A	P
Bob Luther	Lex Products Corp.	Lex Products Corp.	P	P
Louis Bradfield	Louis Bradfield	Louis Bradfield	I	U
Phil Fram	Marinco	Marinco	P	P
Hiroshi Kita	Marumo Electric Co., Ltd.	Marumo Electric Co., Ltd.	O	P
W. G. Krokaugger P.E.	Mole-Richardson Co.	Mole-Richardson Co.	P	P
Brian Parker	Mole-Richardson Co.	Mole-Richardson Co.	A	P
Tim Cox	PLASA	PLASA	P	G
Mac Perkins	PNTA	PNTA Inc.	O	G
Steve Terry	Fourth Phase New Jersey	PRG	O	U
Robert Barbagallo	Proximo Inc.	Proximo Inc.	P	G
Paul F. Mardon	Pulsar Ltd.	Pulsar Ltd.	O	P
Andre Broucke	ADB - TTV Technologies	Siemens	O	P
William N. Masten	SMS Inc. / PGS LLC	SMS Inc. / PGS LLC	P	P
Richard A. Prey	SMS Inc. / PGS LLC	SMS Inc. / PGS LLC	A	P
Michael Lay	Strand Lighting	Strand Lighting Ltd.	P	P
Andy Topinka	Technical Group Services, Inc.	Technical Group Services, Inc.	P	G
Brian Dowd	TMB Associates (NJ)	TMB Associates	P	P
Colin Waters	TMB Associates	TMB Associates	A	P
Richard Wolpert	Union Connector Company	Union Connector Company	P	P

Name	Company	Representing	Vote status	Int. cat.
Mitch Hefter	Rosco/Entertainment Technology	USITT	P	G
Eckart Steffens	SOUNDLIGHT	VPLT	O	G
Bruce Whitehead	Whitehead Engineering Services	Whitehead Engineering Services	O	G

Voting Status

- P Principal voting representative for a company or organization
- A Alternate voting representative for a company or organization
- I Individual representing no organization other than himself or herself
- O Observer; non-voting

Interest Categories

- P Producer (manufacturer) of power distribution equipment
- U User of power distribution equipment
- G General interest in power distribution equipment

Please note that there have been the following changes in the working group membership from the time of the end of the meeting and the publishing of these minutes with this membership list:

- Zero 88 became part of the i Light Group.
- George Sabbi left PRG

**PROPOSAL FOR AN ESTA STANDARD
ON
GROUND FAULT CIRCUIT INTERRUPTERS
VERSION 1.2**

Various National and International Standards exist that address the issue of protection against electrical hazards. Unfortunately, these Standards are limited in scope and fail to address many of the idiosyncrasies of the entertainment industry. High amperage equipment with AC or DC system voltages and adjustable lighting controllers with operating principles based on various power conversion topologies create hazard situations not adequately covered by existing Standards. The welding and semiconductor industries, amongst others, have taken the initiative and created modified Standards that address their peculiar requirements. The time is here for the entertainment industry to adopt a similar approach. There are a myriad of venues associated with the entertainment industry that have the potential for exposing persons/groups to electrical hazards, especially in the presence of water or other fluids. An exhaustive listing would include but not necessarily be limited to the following situations:

- Motion Picture and Television Productions
The following sites and weather conditions greatly increase the exposure to electrical shock hazard:
 - Threat of rain or snow
 - Dew — morning and evenings
 - Cable in street or gutters
 - Swimming pools or tanks
 - Watered down streets or sidewalks
 - Rain or snow effects
 - All water related shows in close proximity to electricity
 - The beach in or around the mean hi-water line
 - The base camp areas where personnel and electrical cables can be contacted (each mobile unit needs to be checked separately)
- Interior Sound Stages
 - With lighting in close proximity to windows subjected to rain effects
 - When there is water on the stage
 - When water is drained with pumps
- Stage Theatres
In the presence of water:
 - Protection for cables and lighting on the floor
 - Protection on the LINE side of dimmers
 - Protection on the LINE side of DC rectifiers.
- Concerts (outdoor live performance areas)
 - All public areas where persons may come in contact with electrical cables
 - Where water is used on stage
 - Stage areas exposed to the threat of rain
- Fairs
 - All public areas where persons may come in contact with electrical cables
 - Any fountain or pool accessible to the public
 - Food court areas
 - Temporary barn area
 - Rides of all types whether or not exposed to water
 - Base camp areas where persons may come in contact with power cables; check each motor home or trailer for ground faults
- Carnivals
 - All public areas where persons may come in contact with electrical cables
 - Rides of all types whether or not exposed to water
 - Concession areas
 - Temporary service food areas
 - Water rides
 - Base camp areas where persons may come in contact with power cables; check each motor home or trailer for ground faults

- Circuses
 - All public areas where persons may come in contact with electrical cables
 - Wherever there is a presence of water
 - Base camp areas where persons may come in contact with power cables; check each motor home or trailer for ground faults
 - Concession areas
 - Live stock areas in vicinity of electrical equipment
- Exhibitions (exterior or interior wet locations)
 - All public areas where persons may come in contact with electrical cables
 - Fountains, pools, or tanks
 - Concession areas
 - Food court areas
- Traveling Attractions

All public areas where persons may come in contact with electrical cables
- Events exterior – interior with water
 - All public areas where persons may come in contact with electrical cables
 - Fountains, pools, or tanks
 - Concession areas
- Food Processing Areas
 - All public areas where persons may come in contact with electrical cables
 - Protection at feeder and branch circuit level, as necessary
- Pump Motors Not Doubly Insulated
 - Variable Frequency Drive protection
 - All public areas where persons may come in contact with electrical cables
 - Protection against water-induced pump motor faults
- Portable or Permanent Fountains and Pools
 - All public areas where persons may come in contact with electrical cables
 - Hazard protection when pumps and lighting are located in fountain or pool.
- Water Parks
 - All public areas where persons may come in contact with electrical cables
 - All lighting in or around public access areas
 - Protection of circuits supplying main pump motors in connection with all rides, slides, pools, or tanks.
 - Protection of circuits supplying pool lighting near or underwater
- Amusements Parks
 - All public areas where persons may come in contact with electrical cables
 - Protection of circuits supplying equipment and lighting in all water areas with and without public rides
 - Rides of all types whether or not water-related.
- Exterior Church Gatherings (Damp Locations)
 - All public areas where persons may come in contact with electrical cables
 - Food processing areas
 - Concession areas
- Public Gatherings
 - All public areas where persons may come in contact with electrical cables
 - Temporary power public areas
- Conventions (Large or Small)
 - All public areas where persons may come in contact with electrical cables
 - Any area where machinery is used
 - Any area or booths that have water in conjunction with demonstrations or not

1. Scope

In the entertainment industry, the purpose of an Entertainment Ground Fault Circuit Interrupter (hereinafter referred to as an E-GFCI) is to monitor a circuit for the presence of a ground fault

current and to interrupt the circuit when the presence of such a ground fault current exceeds a predetermined level

This Standard applies to E-GFCIs, for nominal voltages not exceeding 480 VAC and 250 VDC, and full load currents not to exceed 400A for portable and fixed installations, intended principally for protection against shock hazard. E-GFCIs detect ground fault alternating currents and ground fault pulsating direct currents whether suddenly applied or slowly rising as well as non-pulsating ground fault direct currents.

These devices are intended to protect persons against electric shock. They inherently also provide protection against fire hazards created by ground fault currents of a sufficiently low magnitude so as not to trip existing overcurrent protection.

The Standard applies to devices that simultaneously perform the tasks of detecting the ground fault current and opening the protected circuit when the ground fault current exceeds the trip point

2. Referenced Documents

The following documents constitute an integral part of this Standard:

NFPA 70	National Electrical Code
UL 943	Ground Fault Circuit Interrupters
UL 2231	Personnel Protection for Electric Vehicles
IEC 61008-1	Residual Current Operated Circuit Breakers
IEC 62020	Residual Current Monitors
IEC 755	Residual Current Monitors for DC applications

3. Definitions

For the purpose of this Standard, the definitions outlined in the above mentioned Standards apply in addition to the following:

E-GFCI: Ground fault circuit interrupter for the entertainment industry

4. Classifications

E-GFCIs are classified as follows:

- 4.1. According to the type of installation
 - 4.1.1. E-GFCIs for fixed installation and fixed wiring
 - 4.1.2 E-GFCIs for portable installation and corded connections
- 4.2According to the type of system
 - 4.2.1 E-GFCIs for AC and pulsed DC systems
 - 4.2.2 E-GFCIs for AC and pulsed DC and pure DC systems

5. Specification

The specification of an E-GFCI shall reference the following operational and performance parameters:

- Type of installation
- Type of system
- Number of phase conductors
- Rated current
- Ground fault current trip point
- Rated voltage
- Rated frequency
- Time delay
- Response to ground fault currents with DC components

- Degree of protection
- Rated conditional short-circuit current
- Rated conditional ground fault short circuit current
- Behavior of the E-GFCI in case of failure of the line voltage

5.1. Basic Definitions

5.1.1 Rated voltage

The rated operational voltage (hereafter referred to as rated voltage) of a E-GFCI is the value of voltage, assigned by the manufacturer, to which its performance is referred.

5.1.2 Rated current

The value of current, assigned to the E-GFCI by the manufacturer, which the E-GFCI can carry in uninterrupted duty.

5.1.3 Rated ground fault current

The value of ground fault current, assigned to the E-GFCI by the manufacturer, at which the E-GFCI shall operate under specified conditions

5.1.4 Rated frequency

The frequency of the system voltage at which the E-GFCI is designed to operate

5.1.5 Operation of GFCI in response to ground fault currents with DC components

Interruption is insured by E-GFCI for ground fault sinusoidal alternating currents, ground fault pulsating direct currents, whether suddenly applied or slowly rising and ground fault continuous direct currents.

5.1.6 Operating characteristics in case of grounded neutral

Interruption is insured for a grounded neutral on the load side of the E-GFCI.

5.2 Standard and preferred values

5.2.1 Preferred values of rated voltage

The voltages 120V, 120/240V, 208V and 480V.

5.2.2 Preferred values of rated current

Preferred values of rated current are 20A, 40A, 60A, 100A, 200A and 400A

5.2.3 Standard values of rated ground fault current

Standard values for the GFCI trip point when the rated voltage is below 250V is 6mA when the rated current is 20A, 40A, 60A or 100A and 20mA when the rated current is 200A or 400A. Additionally, the GFCI trip point when the rated voltage is greater than 250V is 20mA.

5.2.4 Preferred values of rated frequency

Preferred values of system frequency are 50Hz and 60Hz. If another value is used, the rated frequency shall be marked on the device and the tests carried out at this frequency.

5.2.5 Standard and preferred values of the rated conditional short-circuit current

(A table is being prepared to account for this parameter)

5.2.6 Maximum interrupting time

The interrupting time for ground fault currents in excess of the trip point (up to 264mA) shall be expressed as follows:

$T = (20/I)^{1.43}$ in which T is in seconds and I is in milliamperes.

5.3 Coordination with short-circuit protective devices

5.3.1 General

E-GFCIs shall be protected by means of fuses that prevent welding of the contacts in the event of a short-circuit.

5.3.2 Rated conditional short-circuit current

(To be determined)

5.3.3 Rated conditional ground fault short-circuit current

(To be determined)

6. Markings and other product information

Each E-GFCI shall be marked in a durable manner with all of the following data:

- a. the manufacturer's name or trademark
- b. type designation, catalogue number or serial number
- c. rated voltage(s)
- d. rated frequency, if the E-GFCI is designed for frequencies other than 50Hz and/or 60Hz
- e. rated current
- f. rated ground fault current setting
- g. enclosure rating (if used)
- h. operating means of the test device, by the word TEST
- i. operating characteristics in presence of ground fault currents with DC components, both pulsating and pure DC.
- j. Distinguish between the line side and the load side of E-GFCI

7. Standard conditions

E-GFCIs complying with this standard shall be capable of operating under the following standard conditions:

7.1. Ambient temperature

The E-GFCI shall operate within a temperature range of -35°C to $+66^{\circ}\text{C}$.

7.2 Relative humidity

(Being developed)

8. Requirements for construction and operation

8.1. Mechanical design

8.1.1. General

It shall not be possible to alter the operating characteristics of the E-GFCI by means of external interventions

8.1.2 Features

The E-GFCI shall be provided with a visual "Power ON" indicator which shall be GREEN. The E-GFCI shall be provided with means for interrupting the supply, when a fault condition exceeds the trip point, and displaying a visual "Fault Alarm" indication which shall be RED. The visual indication shall be an integral part of the E-GFCI and shall be easily discernible. It shall not be possible to override the visual alarm or activate the GFCI while the fault is present.

Note – A visual alarm may also be part of a remote alarm unit, and shall be clearly visible.

E-GFCIs shall be fitted with a resetting means to manually reset the E-GFCI to the non-alarm state after removal of the fault.

8.2 Correct operation of E-GFCI within the rated voltage range

E-GFCI shall function reliably at any voltage between 85% and 110% of the rated voltage.

8.3 Test Operator

The E-GFCI shall be provided with a test operator in order to allow for periodic testing of the GFCI. The test circuit shall be designed for continuous operation at 1.1 times the rated voltage. The test circuit shall be designed to provide an internal ground fault test current that does not exceed 1.5 times the GFCI trip point.

The equipment grounding conductor of the installation shall not pass the test current when the test operator is engaged.