Setting Standards for Excellence

A NEMA Low Voltage Distribution Equipment Section Document
ABP 2-2011

Recommendations on AFCI / Home Electrical Product Compatibility

Published by

National Electrical Manufacturers Association
1300 North 17th Street, Suite 1752
Rosslyn, Virginia 22209

www.nema.org

NOTICE AND DISCLAIMER

The information in this publication was considered technically sound by the consensus of persons engaged in the development and approval of the document at the time it was developed. Consensus does not necessarily mean that there is unanimous agreement among every person participating in the development of this document.

NEMA standards and guideline publications, of which the document contained herein is one, are developed through a voluntary consensus standards development process. This process brings together volunteers and/or seeks out the views of persons who have an interest in the topic covered by this publication. While NEMA administers the process and establishes rules to promote fairness in the development of consensus, it does not write the document and it does not independently test, evaluate, or verify the accuracy or completeness of any information or the soundness of any judgments contained in its standards and guideline publications. NEMA disclaims liability for any personal injury, property, or other damages of any nature whatsoever, whether special, indirect, consequential, or compensatory, directly or indirectly resulting from the publication, use of, application, or reliance on this document.

NEMA disclaims and makes no guaranty or warranty, express or implied, as to the accuracy or completeness of any information published herein, and disclaims and makes no warranty that the information in this document will fulfill any of your particular purposes or needs. NEMA does not undertake to guarantee the performance of any individual manufacturer or seller's products or services by virtue of this standard or guide.

In publishing and making this document available, NEMA is not undertaking to render professional or other services for or on behalf of any person or entity, nor is NEMA undertaking to perform any duty owed by any person or entity to someone else. Anyone using this document should rely on his or her own independent judgment or, as appropriate, seek the advice of a competent professional in determining the exercise of reasonable care in any given circumstances. Information and other standards on the topic covered by this publication may be available from other sources, which the user may wish to consult for additional views or information not covered by this publication.

NEMA has no power, nor does it undertake to police or enforce compliance with the contents of this document. NEMA does not certify, test, or inspect products, designs, or installations for safety or health purposes. Any certification or other statement of compliance with any health or safety-related information in this document shall not be attributable to NEMA and is solely the responsibility of the certifier or maker of the statement.

Contents

Figures

Foreword

This is a new NEMA white paper. It was developed to provide the designers of home electrical products (HEPs) with information on the operating parameters of arc-fault circuit interrupters (AFCIs), with the purpose of avoiding conditions in which the HEP could cause the unwanted operation of an AFCI.

To ensure that a meaningful publication was being developed, draft copies were sent to a number of groups within NEMA having an interest in this topic. Their resulting comments and suggestions provided vital input prior to final NEMA approval and resulted in a number of substantive changes in this publication. This publication will be periodically reviewed by the Molded Case Circuit Breaker Product Group of the Low Voltage Distribution Equipment Section of NEMA for any revisions necessary to keep it up to date with advancing technology. Proposed or recommended revisions should be submitted to:

Vice President, Technical Services
National Electrical Manufacturers Association
1300 North 17th Street, Suite 1752
Rosslyn, Virginia 22209

This white paper was developed by the Molded Case Circuit Breaker Product Group of the Low Voltage Distribution Equipment Section of NEMA. Approval of this white paper does not necessarily imply that all members of the Product Group voted for its approval or participated in its development. At the time it was approved, the Molded Case Circuit Breaker Product Group had the following members:

ABB Control, Inc.—Wichita Falls, TX
Eaton Corporation—Pittsburgh, PA
General Electric—Plainville, CT
Siemens Industry, Inc.—Norcross, GA
Schneider Electric USA—Palatine, IL

1 Introduction

Modern technology has helped make homes safer and more convenient, but conflicts in performance criteria between interdependent products can result in inconvenience for the homeowner. Designers of home electrical products (HEPs) seek to meet the demands for improved customer convenience and satisfaction as they design new and improved consumer products. Designers of sophisticated electrical circuit protection products, such as arc-fault circuit interrupters (AFCIs), strive to make homes safer by meeting the legal requirements established by local, state, federal, and national electrical codes and standards. While conflicts in the operation of the two product categories are rare, an understanding of some of the operational requirements of AFCIs can help reduce the possibility that unwanted operation of AFCIs could be caused by HEPs. These recommendations will familiarize the HEP designer with the basic operation of AFCIs to help reduce unwanted operations.

HEPs within the scope of these recommendations are those that operate at 120 Vac and are rated 20 A or less. They may include appliances of all types, power tools, electronic products such as computers, printers, office equipment, audio and video equipment, and communications equipment. In other words, any line powered electrical products that may be used in the home.

2 General Design Recommendations to Reduce AFCI/HEP Conflicts

Conflicts do a disservice to our mutual customers. Consumers will inevitably attribute the problems that they encounter to either the AFCI or the HEP manufacturer. It is in the best interest of all concerned, and especially in the interest of the homeowner, the customer, that products are compatible with each other. The recommendations in this paper will help avert these conflicts.

There are three levels at which to analyze the design of HEPs and how they will interact with AFCIs. The information provided below is a composite of the operating characteristics of the four AFCI manufacturers.

2.1 General Design Considerations

Conflicts between HEPs and AFCIs can be avoided in many instances by keeping current requirements within two simple boundaries, defined as a maximum current leakage to ground (ground-fault current) and maximum peak current. These boundaries are fundamental, as exceeding them can cause conflicts with other protective devices as well.

2.1.1 Ground Fault Currents

If the current leakage to ground does not exceed the limits specified in UL 101, the HEP designer can be assured that the product will not cause the unwanted tripping of AFCIs due to excessive ground fault current.

2.1.2 Peak Current Considerations

The second general design recommendation involves the limiting of the peak current drawn by HEPs. When many electrical products are initially energized, it is common for them to draw a high amount of current for a few cycles as the product reaches its normal operating performance level. This start-up or inrush current is typically several times the operating current of the product. If the maximum current during start-up (or for any short period of time during the operation of the HEP) is kept below 100 amperes RMS, unwanted tripping of AFCIs, and standard circuit breakers, should not occur.

2.2 Other Design Considerations

AFCIs evaluate a number of other parameters. The following table lists these parameters.

Common Arc Characteristics (Both Branch Feeder and Combination Types)

Parameter	Magnitude or Trip Threshold	Duration
Current	Greater than 46 peak amps	Longer than 0.4 milliseconds
Number of current pulses	Greater than 2 within ½ second	
Current frequency	Greater than 150 Hz	
Current pulses per half cycle	No more than 1	½ cycle
FCC conductive emissions	Levels exceeding FCC Part 15, Class B conducted emissions	3 cycles or more
High frequency emissions	Greater than 75 KHz	3 cycles or more
Shoulders (see 3.3 below)	Discontinuous current at a zero crossing with respect to the voltage wave	See 3.3 for duration
Missing half cycles (see 3.4 below)	Missing half cycle(s) of current with respect to the voltage wave	½ cycle

3 Additional Recommendations to Reduce AFCI/HEP Conflicts

AFCI designs often evaluate the current waveform of the load in an attempt to identify characteristics that have been found to typify the waveforms generated by arcing faults. In some instances, it has been found that the current waveforms of HEPs also exhibit some of these same characteristics. This makes the task of distinguishing a normally operating HEP from an unwanted arc difficult and has at times led to unwanted tripping and customer dissatisfaction.

The HEP designer should avoid designing a product whose waveform exhibits these characteristics. Some examples are shown below.

3.1 High Frequency Conducted Emissions

One of the key characteristics of arc faults is the presence of high frequency energy when current is flowing through an arcing junction. A significant amount of arc energy spreads throughout a wideband frequency spectrum in a pink-noise pattern that spreads throughout the complete frequency spectrum. AFCI designs take into consideration high frequency content to validate the presence of arcing faults in the line and any source of noise coupled to the line that can potentially affect their performance.

The Federal Communications Commission (FCC) requires certain HEPs connected to the ac power line to not exceed a maximum level of conducted and radiated emissions back into the power line (refer to FCC 47 CFR Part 15 Class B and Part 18 Consumer ISM Equipment). HEP manufacturers must consider following these guidelines as requirements in their designs in order to control the amount of noise emissions in the power line, even if not required to do so by the FCC, to help prevent unwanted action by an AFCI installed on the same circuit.

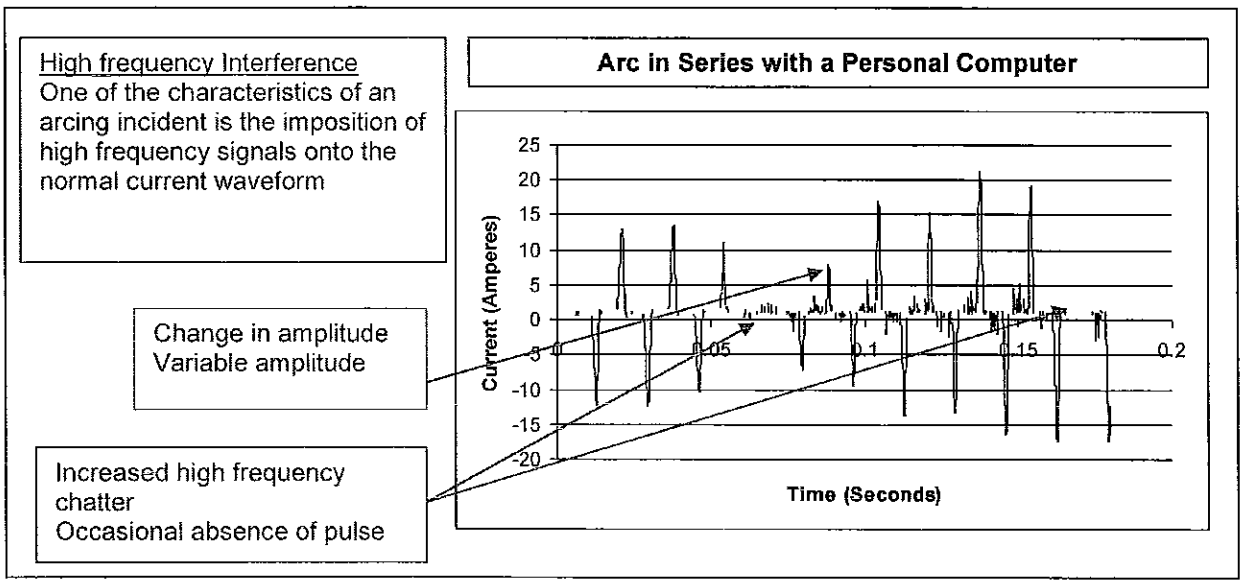


Figure 1
Arc in Series with a Personal Computer

Also, some products, in this case a personal computer (see Figure 1), can exhibit some of the same characteristics as an arcing condition. In the left portion of the graph, the computer is performing in its ordinary manner. It does impress some disturbances on the line, but note that the amplitude of the waveform remains constant from cycle to cycle, and the high frequency noise remains fairly constant. However, when we review the waveform on the right portion of the graph, we note that the high frequency signal becomes much more animated, and that one of the current pulses is missing from the waveform. In this case it is important for the AFCI to recognize the type of signal that the computer emits under ordinary operation, but yet be able to differentiate between the normal signal and the arc signal. UL imposes a lengthy test procedure to ensure that the AFCI can differentiate between these signals and not be masked from responding to the similar (but different) arcing waveform.

3.2 Start-Up Inrush Current with High di/dt

Some electrical products, once turned on, will draw a significant amount of current that will remain high for several cycles until it stabilizes to a steady-state current. This start-up inrush current level will be several times the normal operating current, and decays to the steady state current over several cycles. Certain electronically controlled products may use starting techniques in which the rate of rise in the current (di/dt) may be quite high. This high rate of rise shows as a near vertical leading edge of the waveform, while the trailing edge may assume the partial shape of the ideal sinusoidal waveform. This waveform is typical of products that use thyristor starting controls, and can be interpreted as an arcing fault under some conditions (see Figure 2).

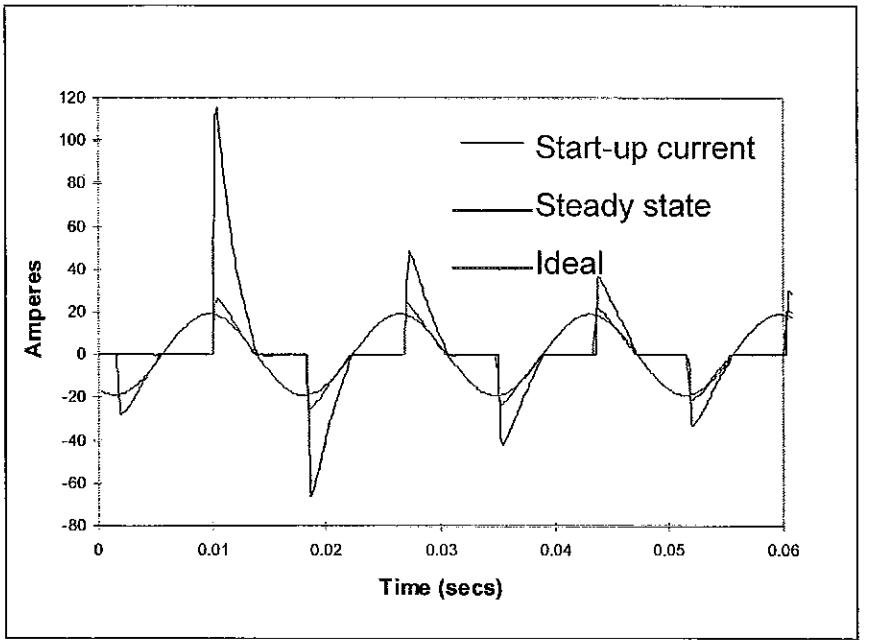


Figure 2
Start-Up Inrush Current with High di/dt

3.3 Shoulders

Another characteristic of arc faults that could be duplicated by a HEP is the appearance of periods of no current for ± 1 millisecond or less at the zero crossing of the ideal waveform. An arc fault can extinguish briefly when there is enough of a drop in source voltage and the conditions are not capable of sustaining the arc. This phenomenon is referred to as "shoulders." Typically, the arc reignites when the source voltage is available in the next ac half cycle. The current waveform for this occurrence is shown in Figure 3, with the ideal current shown in red, and the arcing current, exhibiting shoulders, shown in blue.

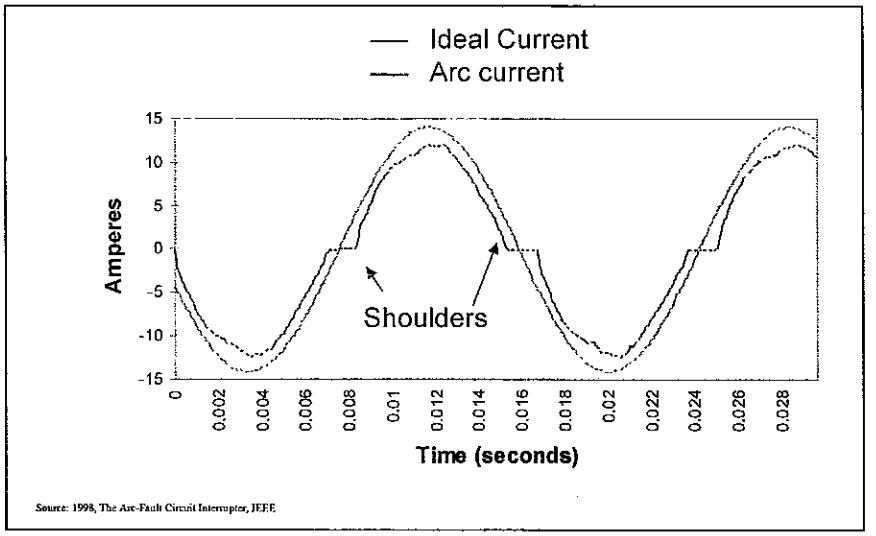


Figure 3
Shoulders

The relationship between the voltage and the current during an arcing event is shown in Figure 4. Note the shoulders at the zero crossings.

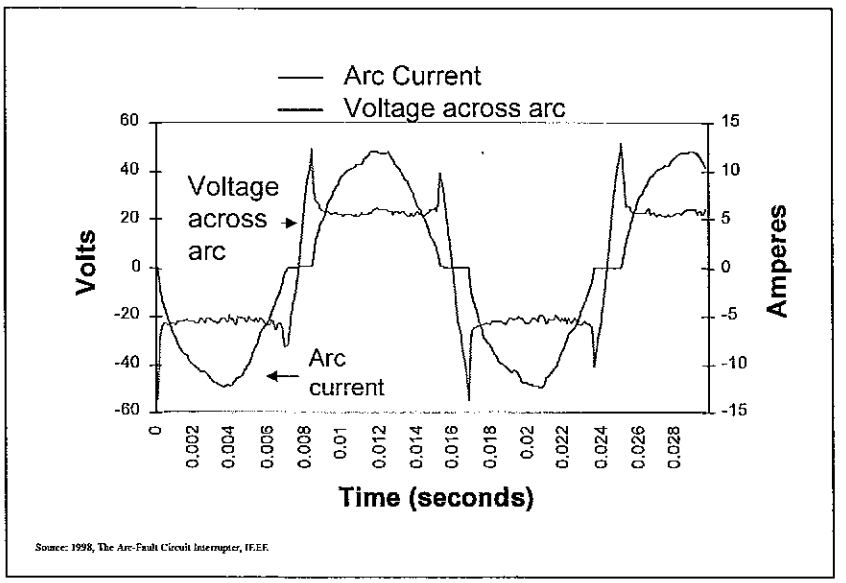


Figure 4
Arc Current and Voltage

An extension of that behavior is seen with loads with a crest factor. A typical sinusoidal current will have a crest factor of 1.414. As the crest factor increases, the shoulders are more pronounced. Figure 5 shows a

typical load with those characteristics. A vacuum cleaner is one example of how the current waveform of a HEP can mimic the characteristics of an arc, much like those observed during UL 1699 testing.

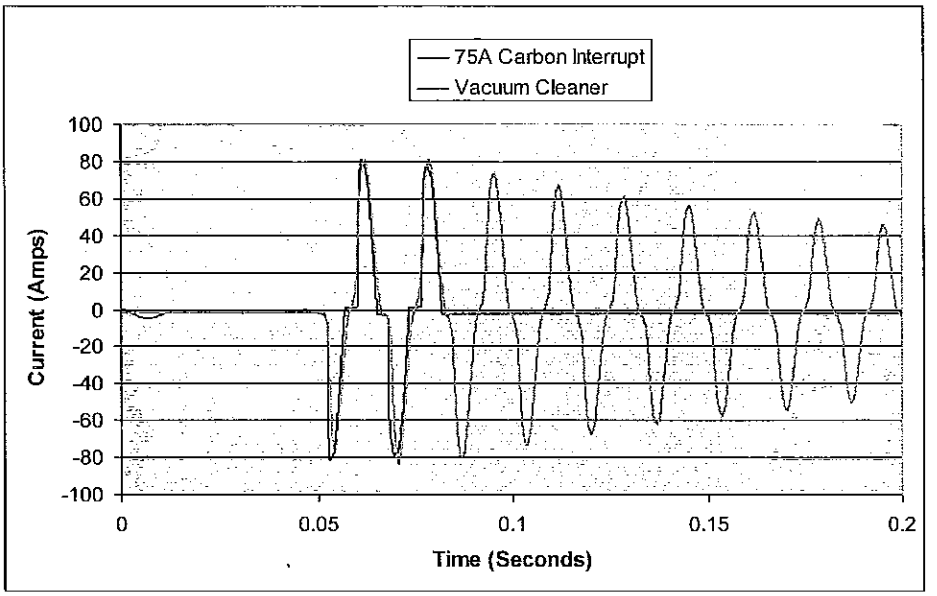


Figure 5
Typical Arc Current vs. that of a Vacuum Cleaner

3.4 Missing Half Cycles

In Figure 6, this laser printer had missing half cycles and high current peaks when warming up. Both of these are arc characteristics.

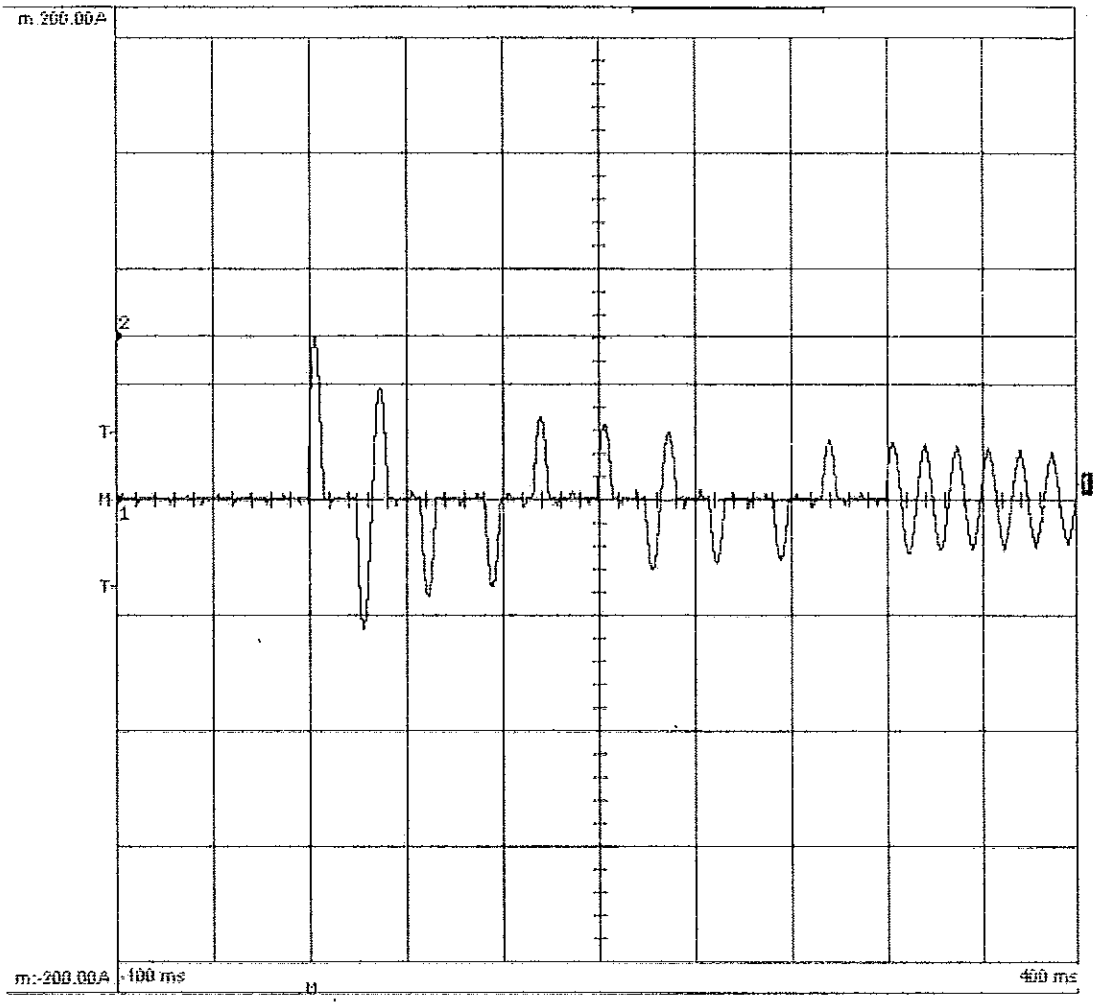


Figure 6
Laser Printer

In Figure 7, this vacuum cleaner, with an electronic control, also had missing half cycles and inconsistent starting current decay when starting up.

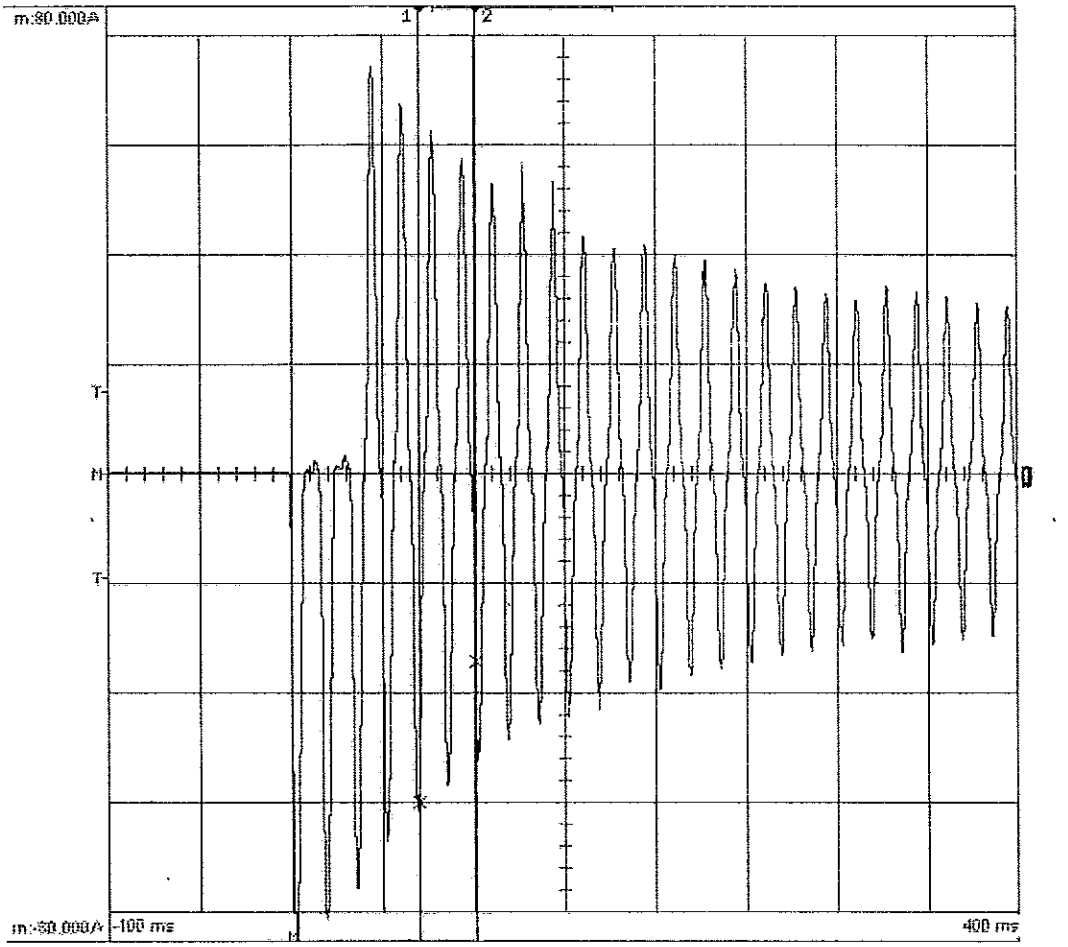


Figure 7
Vacuum Cleaner with an Electronic Control

4 Conclusions

The need for better, safer homes and increasingly efficient and convenient operation of HEPs can result in the rare conflict between the home electrical product and the operation of AFCIs. It is vitally important that the operation of the AFCI be understood in order to avoid operational conflicts, and that designers of both products work together to resolve these operational conflicts. By recognizing the operational characteristics outlined above, it is anticipated that even these rare instances of unwanted tripping of the AFCI can be eliminated.

The above discussions on the design and operation of AFCIs are intended to familiarize the HEP designer with the operation of AFCIs, and to help reduce the potential that the normal operation of a HEP will cause unwanted tripping of the AFCI. While designing with these parameters in mind should greatly reduce the probability that a newly designed HEP will cause unwanted tripping of an AFCI, further testing with the available brands of AFCIs will help identify any compatibility issues with existing AFCI

technology. In the event that unwanted tripping does occur, it is recommended that the HEP designer contact the AFCI manufacturer to analyze the compatibility issue.

5 Additional Information

5.1 About AFCIs

Additional information about AFCIs may be found at www.afcisafety.org.

5.2 AFCI Manufacturers

AFCI circuit breakers are manufactured by the following companies:

Eaton Corporation
1000 Cherrington Parkway
Moon Township, PA 15108

GE Industrial Solutions
41 Woodford Avenue
Plainville, CT 06062

Schneider Electric
1415 S. Roselle Rd.
Palatine, IL 60067

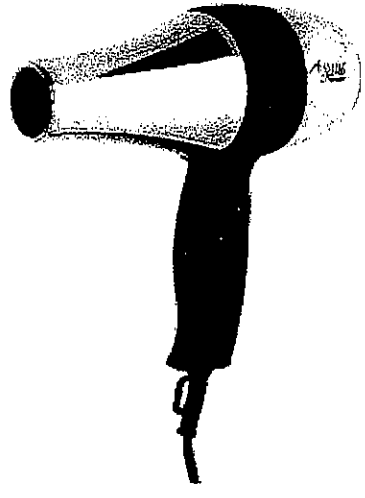
Siemens Industry, Inc.
5400 Triangle Parkway
Norcross, GA 30092

§

5A Threshold

"It only trips when I have a light on and the fan and..."

- 5A minimum threshold per UL 1699
- Not enough energy in < 5A arc to create a fire
- Use a hairdryer on the same circuit to create load on the circuit to determine the device causing the issue



EATON
Powering Business Worldwide

AFCI Problems Pertaining to HEP

Soon after the implementation of the NEC 2005 Code change requiring the use of AFCI breakers to be installed in all bedroom/sleeping quarters we started experiencing problems related to the use of said AFCI breakers. The first noticed problem was the "infamous " neutral to ground short anywhere in the circuit would trip the breaker when any light was turned on or HEP used. This was just a matter of us retraining our crews on trouble shooting AFCI circuits. Next I got a phone call from a builder stating that the electrical final had been denied because one of the AFCI breakers would not reset when tripped at panel. Called up inspector involved and he said the breakers where acting funny when tripped at the panel, like maybe the neutrals where tied together. H e said that when he tripped both breakers using the trip button that one would not reset if the other one was reset. So if A breaker was reset B breaker would not reset until A breaker was tripped, than when B breaker was reset, A would not reset as long as B breaker was on. Went to job site and verified that the neutral and ground wires where isolated. Reinstalled wiring and tested breakers, same problem. We had just started running a wire called a 14/2/2 NMB which consists of a black, red, white, white with a red stripe and a bare ground wire for our homeruns from electrical panel to various parts of the house, this wire gives each ungrounded conductor its own neutral, thus eliminating the need of using a two pole breaker and eliminating the possibility of dropping the neutral and sending 240 volts through the circuit. With this is mind I was wondering if it could be induced voltage causing the second breaker not to reset if first breaker was on. Out came the "fluke" and sure enough there was significant induced voltage in the circuit that would not reset. Ran upstairs and turned on a light on in circuit that was energized thus bleeding off the induced voltage in second circuit and the breaker would than reset as it should. Called up the factory and talked with one of their technical representatives and after checking with other tec's they came to the conclusion that yes, induced voltage from one isolated AFCI circuit to another isolated AFCI circuit would cause the second breaker to not reset until a load was put on the first circuit, this eliminating the problem. Of course we knew that we could not share a neutral on two AFCI circuits, but had heard nothing from the factory about a possible induced voltage problem. From my interaction with the factory tec's it is my conclusion that they were unaware of the problem. We immediately stopped using the 14/2/2 wire on AFCI circuits. Had to rewire three houses that had already been completed and were lucky enough not have that problem on several other houses that were wired in the same way. Some had long homeruns and some had short homeruns and there appeared to no rhyme or reason as to why some AFCI's would reset and other s would not. This immediately gave me a bad feeling about AFCI breaker technology.

As soon as people started moving into the residences we wired under the new code and started plugging in their "flat screen" tv's and computers we started getting calls about nuisance tripping. Had multiple problems going on at the same time with the only common denominator being electronics (flat screen tvs, computers, vacuum cleaners) it

was never a overload situations, although we did have several instances where everything was fine until enough lights or HEP's were turned on to reach the 5 amp threshold and the breaker would trip. We literally had people in multimillion dollar homes running their flat screen tv's and computers off extension cords. Very classy!!! And everyone was upset with us as we could not solve their problems, other than telling them they could not run their HEP's off their AFCI protected bedroom outlets. Again, very classy!!!!!!!!

When we explained to our factory rep the problems we were having and had narrowed it down to electronic HEP's . We asked him if anyone else was having the same problems, his comment was "not that I know of and are you sure you are wiring them right" that went over real well as I "exploded like a rocket" over his comment. With in a few hours he called us back and said that "yes" the factory informed him that they were having a major problem with electronic HEP's and asked if we could get the "make model and serial number of the offending HEP's so they could purchase said HEP and test them at their factory. It was very apparent to us that the factory had not even came close to doing their due diligence on this product before "dumping" it on the public

After a lot of phone calls and frustration we had finally convinced everyone involved that the "factory" was working on a new version of the faulty product and we would let them know as soon as we heard them when the new product would be available.

When the "new improved" product arrived Bear Electric replaced over 400 AFCI breakers. 250 at a University of Portland dorm, 80 at "The Stone Place Apartments" and the rest at various one and two family dwellings. Sorry to report that upon investigation of our paperwork on the subject, we come up missing a lot of it. As the person in charge of scheduling the replacement of the faulty AFCI's in our one and two family projects, I can honestly say that it seemed like we were replacing them forever and had box's and box's of faulty AFCI breakers stacked in our purchasing agents office for return to the factory.

In mid February of this year I got a call from a Renaissance Homes customer located at 5148 Wood Crest Lane, Lake Oswego. Greg and Liiza Boyd that their new 73" big screen tv they just install in their master bedroom was tripping the bedroom AFCI after being on for about 30 minutes.. Went to site found nothing wrong with circuit, changed out breaker and told homeowner to turn on tv and call me if it tripped , sure enough I got the call and it had tripped. At that time I told her she would have to run an extension cord from the bath or hall outlet until I could get back to her on her situation. Admittedly this was one of the first AFCI nuisance tripping problems we had had in a while and we where at a lose as to how to fix it. Got the make, model and serial number off their TV to send it back to the factory. While discussing the problem over the phone, I was informed that they were using a power strip to plug everything into at the bedroom entertainment

center. Told them to remove the power strip to see if TV held, and it did. Have not heard back from them so that must has solved the problem. A faulty power strip Need less to say we were not reimbursed for time spent figuring out this problem as it was not the AFCI's breakers fault

The above scenario leads right into this next conversation: one we had with our suppliers and his factory rep.

Mid March we had a four way conference call with our Square D. rep, his AFCI factory rep., Carl Redman, VP at Bear and myself. The factory rep admitted that they had not anticipated all the problems that they encountered with their first series AFCI breakers pertaining to electronic equipment and HEP's. From our end it appears to us that they did very little testing of their product on how it would be effected by standard house hold products, such as vac's, big screen tv's,, computers, not to mention, fluorescent lighting, low voltage light, CFL's. That being said the factory rep said they were on their third generation AFCI and he felt very adamant about the fact that his new breaker would not be affected by nuisance tripping from a NEMA approved HEP and he said he would physically "eat" the breaker if it trip on "here is the phrase again: a NEMA approved HEP"

So here is what we are hearing from the manufactures of these AFCI devices is that they will only stand behind their product, when it comes to nuisance tripping, if their product is used in conjunction with a NEMA approved HEP (house hold electric product)

Was in Radio Shack the other day and could not find one electronic product that stated that it was a NEMA Approved product. Just this week Carl Redman, VP at Bear Electric had a long conversation with an Eaton Electric rep over the fact that we could not find a NEMA Approved HEP and he was told that NEMA Approved HEP's are not marked as such. Great, we are supposed to tell our contractors and homeowners that we can only guaranty the function of their AFCI protected circuits if they only use NEMA Approved HEP's on them an that we/they have no way of knowing if it is a approved product just by checking the labeling.

In a discussion with Bob Scott, chairman of the Idaho Electrical Board, as to why Idaho was still under the NEC 2008 code and had not yet implemented the 2011 code change and was told that the reason was due to the opposition to the implementation of the whole house AFCI wiring from electrical contractors and Home Builder Association. Main opposition from the electrical contractors was the problems they were having with nuisance tripping from electronic HEP's

Although it appears that we are not having the AFCI problems that we have had in the past and the current product appears to be doing its job, lets also keep in mind that we are not doing anywhere near the volume of residential work we were doing before the recession.

As it appears in it's current form the implementation of the "whole house" AFCI wiring system will require the use of AFCI protection on all outlets not already required to be GFCI protected. I would assume that the Oregon Electrical Specialty Code would allow us to install single shot outlets on appliances such as refers, wine coolers, micro waves, trash compactors, warming drawers, insta hots, dish washers and disposals and such. What about the dedicated circuits we now run to massive entertainment centers?

Bear Electric is adamantly opposed to the implementation of the "whole house" AFCI wiring requirement and we feel it is being pushed hard by the manufactures of said products to recoup the money they lost in selling you and us a faulty product to begin with

David E Renoud

Senior Supervisor
Bear Electric Inc.

For about a month now, the one for my entry from the garage, guest bathroom, and several wall receptacles trips on its own, without fail, after 20-40 minutes. There is no reason for this -- nothing is being turned on or off when this happens, ever.

House is under warranty. I've had them out twice now, and both times they've taken all the receptacles and switches out, looked them over, put them back in the walls, turned on the breaker, and pronounced it fixed. Both times I've left to go back to work thinking it was fixed, only to come home and find it tripped again. And resetting it gives proper function for the same 20-40 minutes before it's cut again.

Now I just want it to work.
--Can I replace it with a regular circuit breaker?
--What would I need to know to do that?
--Is it dangerous even if the main breaker is off?
--Is there any way to keep the AFCI but disable its constant tripping (the "protection")?

Thanks!

I recently completed a house (Dec 2010) and on the day of final inspection, there was one AFCI combo breaker that would trip and not reset for the inspector (I wasn't present). Every time I went there it would reset and not trip again despite several attempts to cause a fault by switching lights on/off, hitting walls/ceilings/floors, checking all light and receptacle wiring, replacing the breaker, etc. The following day I stopped by the house at 5am to check on the circuit before my inspection-all was ok. Later that day during inspection it tripped again and would not reset. This went on for at least a week until I was ready to re-wire the entire circuit. This was a 6,000 sq. ft. house and the circuit in question was on the second floor hallway, all finished and painted. Not to mention the young couple's desire to have Christmas in their new home. When I returned the following day to pull new wire, the circuit finally would not reset-alas I have a starting point. I had also realized that each time I came to check on the problem was always after 5pm when it was dark or in the early morning before sunrise. I started checking outdoor photo lighting and found a loose neutral crimp wire nut from the light manufacturer. This light was on a **completely separate** afci combo breaker and as it happens, this breaker also would not test when the button was depressed. After fixing the crimp and replacing the afci combo breaker all was ok and they were able to spend Christmas in their new home.

I purposely wired this house all with #12 wire (lighting and receptacle circuits) and generously provided circuits because these newlyweds are friends of mine and they plan on living in this house for 30+ years. To say this situation was an embarrassment would be an understatement.

Now, 4 months later, the homeowner is begging me to change out all the afci combo breakers with standard trip breakers, of which, I will not do. They are complaining that during electrical storms many of the afci breakers trip and intermittently an afci breaker will trip at random-making a frustrating and embarrassing moment while watching the game with friends over. There is no apparent pattern for this occurrence nor a dedicated circuit causing the trip. They are a young couple and have several electronics throughout the house including a home theatre system.

I am at a loss as to how to fix or determine this problem. I cannot recreate it, it is intermittent, and it is not a constant circuit. With a standard breaker it is either fail or no fail and when it fails there is a clear and precise reason for the failure. There is no testing tools, that I am aware of, that can test this circuit unless is stays failed. I'm afraid this couple will have someone else replace these breakers which can cause the insurance company to refuse payment if something were to happen (i.e. lightning strike). Is it possible that "dirty" power from the utility company is causing this failure? Any suggestions or references would be greatly appreciated.

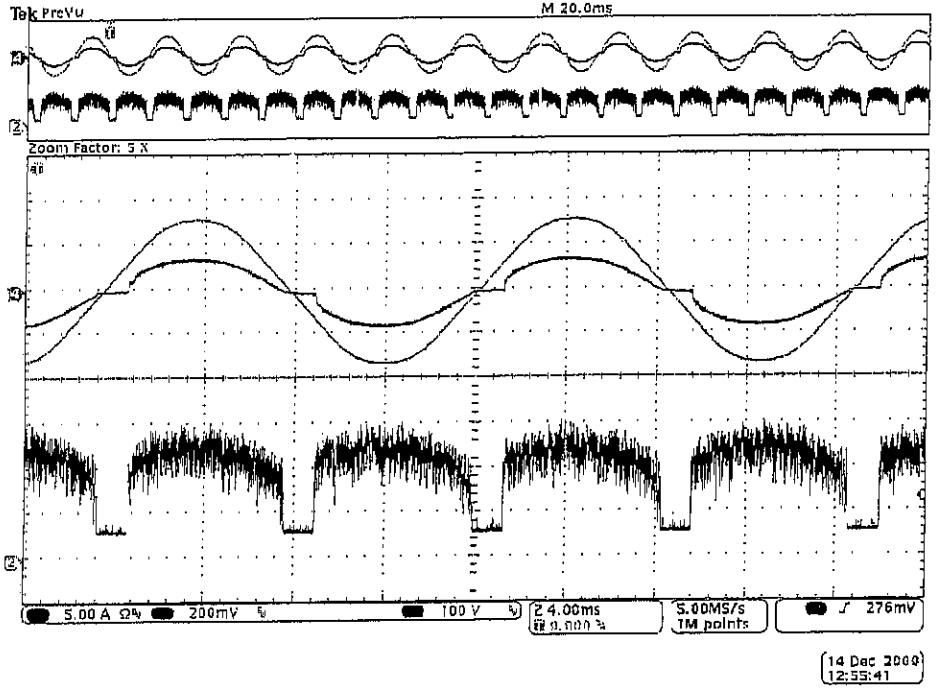
Note: these are type Cutler Hammer 20a combo afci breakers.

Last edited by Sam C; 03-14-2011 at 09:10 PM.

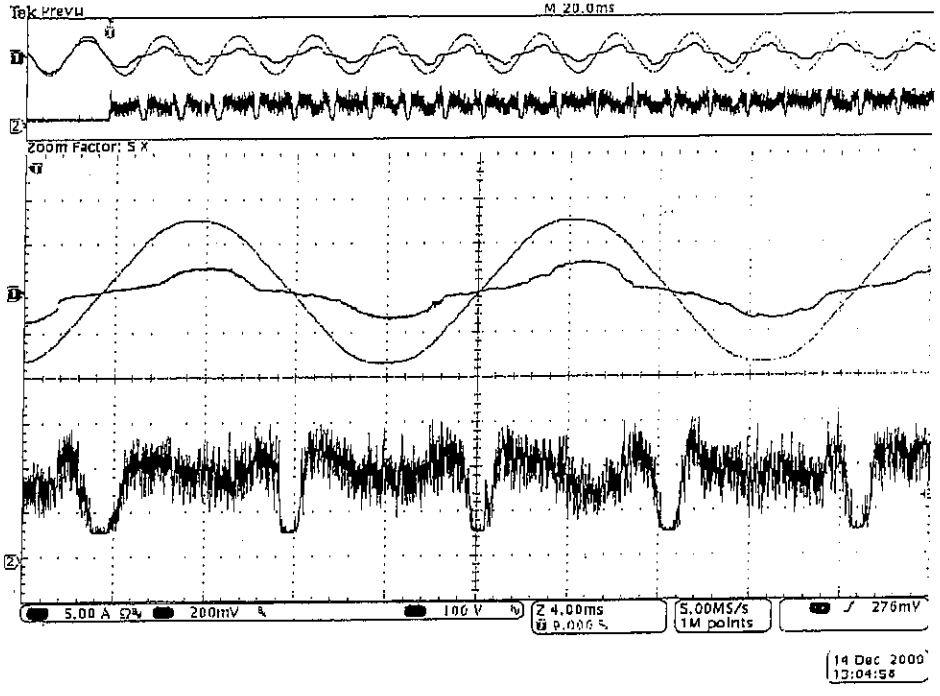
Arc-Fault Circuit Interruptor <----> 

Case Study
Manmade vs Hazardous Arcs

High Frequency Noise
Electronic Transformer
(low voltage lighting)



Arc Signature
Series Arc Test per UL 1699



CANBY ELECTRIC, INC.

796- S. IVY ST
CANBY, OREGON 97013
PHONE 503-266-7878 FAX 503-266-5543
BB #28071

April 17, 2012

To: BCD E&E Board

From: Doug Onion, VP

Re: AFCI Protection

This letter is to state our opinion on the upcoming code change to require AFCI protection to most of the outlets in a dwelling unit. We are highly opposed to this code change. AFCI's have cost us too much grief and will continue to drive up the cost of new home construction and remodeling.

AFCI breakers have cost electrical contractors and homeowners a great deal of money since their inception into the NEC. Dwellings need more homeruns, the cost of the breaker is 1200% more than a standard breaker, and in some cases a sub-panel is added due to the fact that AFCI breakers are not manufactured for obsolete/older panels. This comes at a large cost to the homeowner. It's easy to say that a contractor shouldn't gripe about the cost because they pass it on to the customer. On the contrary, it's up to the contractor to actually collect this extra cost. This can be difficult in a poor economy. It's also easy to say that AFCI's protect people and you can't put a price on safety and human life. On the contrary, how safe can electricity really be? We all need to realize that electricity is dangerous and the safest we can ever be is to not have it at all. If you take a close look at the people that are on the boards that make code revisions to the NEC they a lot of times work for the manufacturer's of the products they're pushing. They have a vested interest in getting the code changed so that they can have higher revenues. This is unethical and applies in this case.

I will admit that my biggest concern with AFCI protection is the money. We have eaten countless hours, fuel, and money going back out on warranty calls when AFCI breakers trip. We generally do get reimbursed for the replacement breaker but have never been reimbursed for our time and other expenses making these service calls. Along with this letter is documentation of some the wasted labor that we've eaten on calls for problems with AFCI's. When we go on these calls we have always stayed until we've diagnosed/corrected the problem. Sometimes this can take multiple hours to troubleshoot. Multiple devices must be pulled apart and checked. We even have to pull down light fixtures. In our documented cases, the problem has rarely been the breaker although we generally change them out anyways just to rule out the possibility of a defective breaker. We don't want to go back.

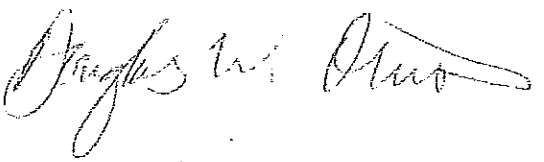
The other factor that we must deal with is the fear from the customer. When someone moves into a new home and begins having problems with circuit breakers they tend to show fear and even anger that they're having problems. We have to keep them calm and explain to them about AFCI's and what's going on. These problems can give off a bad impression on the electrical contractor. I do know of no

cases where the customer or electrical contractor replaced an AFCI breaker with a standard breaker but I do believe that this goes on.

The biggest issue that Canby Electric has had to deal with regarding AFCI protection was on a recent Fire Station project that we completed. The engineered plan and specs made no mention of any AFCI breakers. It being a commercial project and a competitive bidding situation we obviously did not add this in to our bid price. When we wired the building we used multi-wire branch circuitry as was allowed in the specs. We failed final inspection because the inspector wanted AFCI protection for the devices in the "sleeping rooms". The customer refused to agree to a change order for this added expense saying that we should have known this would be required even though it wasn't on the engineered plan. We were forced to have overnight shipment of (7) bolt on AFCI's and pull in extra neutrals for the (7) circuits to pass final inspection. We have since been back (3) different times and have 8 man hours at prevailing wage troubleshooting the nuisance tripping of these breakers. This has cost our company $3725.00 in lost revenue as well as grief on the part of the customer. The head of maintenance for this fire district even admitted that he hates having AFCI protection in the stations that he oversees.

Overall, I cringe at the thought of more AFCI protection being required. AFCI protection drives up the cost of doing an electrical project in a dwelling or fire station and causes the homeowner and the electrical contractor too much grief and money. We hope that the BCD will change their opinion and not require AFCI protection at all in a dwelling or at least not expand the requirement.

Thank you for your consideration,



Douglas W. Onion, VP

Canby Electric, Inc.

Canby Electric Inc.
790 S. Ivy St.
Canby Oregon 97013

AFCI Issues

Job Address	City	Date	Problem	Cost
13351 SE Parkside Dr.	Happy Valley	12/12/2006	Random tripping	$ 187.50
21324 S. Leland Rd.	Oregon City	12/14/2006	Vacuum tripping AFCI	$ 150.00
7024 SW Raz Ct.	Portland	1/6/2007	Random Tripping	$ 225.00
2084 N. Walnut St.	Canby	1/12/2007	Bad AFCI	$ 112.50
1489 NE 15th Ave.	Canby	2/11/2007	Random Tripping	$ 112.50
2595 SW Ek Rd	West Linn	2/15/2007	Light fixture tripping	$ 187.50
451 N. Fir St.	Canby	3/6/2007	Ground/Neutral	$ 150.00
155 NW 6th Ave	Canby	5/16/2007	Random Tripping	$ 150.00
1495 NE 16th Ave	Canby	6/11/2007	Random Tripping	$ 112.50
25200 S. Central Pt. Rd	Canby	6/21/2007	Fan motor tripping	$ 150.00
27000 S. Harms Rd.	Canby	8/15/2007	Vacuum tripping AFCI	$ 112.50
18887 S. Elder Rd	Oregon City	9/20/2007	Light fixture tripping	$ 150.00
1441 S. Ivy St. #1305	Canby	11/8/2007	Ground/Neutral	$ 150.00
824 N. Grant St	Canby	12/6/2007	Ground/Neutral	$ 112.50
2750 SW Bertha Blvd	Portland	2/10/2008	TV tripping	$ 187.50
4645 Exeter St.	West Linn	3/10/2008	Random Tripping	$ 150.00
599 NE 22nd Ave	Canby	3/13/2008	Random Tripping/multiple calls	$ 300.00
2360 E. Madrona Ln	Canby	4/4/2008	Random Tripping	$ 150.00
515 N. Locust St.	Canby	5/15/2008	Random Tripping	$ 112.50
1390 N. Fir St	Canby	7/11/2008	Vacuum tripping AFCI	$ 150.00
4045 Eastgate Ln.	Wilsonville	11/15/2008	Light fixture tripping	$ 225.00
2512 N. Holly St.	Canby	1/14/2009	Random tripping	$ 225.00
1101 SW Crestline Dr.	Lake Oswego	2/22/2009	Random tripping	$ 187.50
36278 SE Douglass Rd.	Estacada	3/22/2009	Light fixture tripping	$ 300.00
1275 Newberg Hwy	Woodburn	4/6/2009	Random Tripping/multiple calls	$ 450.00
33312 S. Needy Rd.	Canby	6/15/2009	Paddle fan tripping	$ 225.00
01733 SW Riverdale Rd.	Portland	10/15/2009	Random Tripping	$ 225.00
19484 Lorna Ln.	Lake Oswego	12/21/2009	Cell phone charger tripping	$ 187.50
38164 NW Hahn Rd.	Banks	12/24/2009	Random Tripping	$ 300.00
10425 SW Summerville	Portland	4/1/2010	Light fixture tripping	$ 225.00
21740 S. Parkview Ln.	Estacada	6/29/2010	Humidifier tripping/multiple calls	$ 450.00
28901 SW 60th Ave.	Wilsonville	4/10/2011	Fan motor tripping	$ 187.50
535 N. Locust St.	Canby	4/19/2011	Random Tripping	$ 150.00
3056 Wembley Park Rd	Lake Oswego	6/2/2011	Random Tripping	$ 225.00
42240 Mt. Pleasant Dr	Scio	2/11/2012	Random Tripping	$ 300.00
8720 SW 30th Ave	Portland	Continuing	Multiple Calls	$ 3,725.00
			Expense/Lost Revenue	**$ 10,700.00**

From: "Stu Jarmer" <Stu@jarmer.com>
Date: Fri, 6 Apr 2012 08:08:19 -0700
Subject: RE: AFCI's

Hi Dave,

I've been sort of tied up lately. No, I don't have any documentation. Yes, we have had our share of failed arc-fault breakers but nothing like Bear. They have a lot of them simply because they do so much more work than we do. Maybe the best idea would be to ask all member contractors to keep as accurate record of the number of failures as possible. It might alarm people to know just how often the arc fault breakers fail and how much it is really costing those of us in the industry.

Stu