(Log #4129)

2- 99 - (210-11(d) (New)): Reject
SUBMITTER: David T. Brender, Cooper Development Assn. Inc.
RECOMMENDATION: Add text to read as follows:
(d) Dwelling Unit - Habitable Room Branch Circuits. Branch-circuit conductors shall not be smaller than 12 AWG.
SUBSTANTIATION: As reported in the Eleventh Edition of "Fire in the United States 1987-1996," published by United States Fire Administration National Fire Data Center, fires caused by electrical distribution are the 4th most common cause of fire. The areas where fires most often occur are in the sleeping rooms, lounge areas (living rooms) and kitchens. 20 amp circuits are required in the kitchen, bathroom, and laundry room to address the risk of fire. As homes continue to be built larger and larger, as panelboards are located more often at the end of the house, with an increase in the number of electrical appliances in a typical home, and with appliances having increased power consumption and more stringent power quality demands, the risk of overloaded conductors and occurrence of unacceptable circuit voltage drops have dramatically increased. Recent research (International Telework Association and Council-report released October 27, 1999) indicates that 19.2 million people, or 10 percent of the U.S. workforce, now telecommute, supporting the growing residential use of the computers, printers, fax machines, copiers, etc. In fact, 55 percent of all U.S. households now have one or more computers (Parts Associates, Forum99, October 1999), and this is expected to grow further to 75-80 percent within the next 10 years. Just as the minimum conductor size for bathrooms was increased due to the change in the type of appliances used on the bathroom circuit, the minimum conductor size for all branch circuits should be increased to 12 AWG. The increase in minimum size will increase safety by reducing the risk of overloaded circuits and the need to rewire existing circuits to meet the needs of heavily loaded circuits and sensitive electronic equipment. The increase to 12 AWG will decrease the cable impedance which will cause the overcurrent device to operate more quickly for long runs of cable found in larger dwellings. The overcurrent device ampacity is not intended to be changed by this proposal.
PANEL ACTION: Reject.
PANEL STATEMENT: See panel statement on Proposal 2-98.
NUMBER OF PANEL MEMBERS ELIGIBLE TO VOTE: 12
VOTE ON PANEL ACTION:
AFFIRMATIVE: 12

(Log #4130)

2- 100 - (210-11(d) (New)): Reject
SUBMITTER: David T. Brender, Cooper Development Assn. Inc.
RECOMMENDATION: Add text to read as follows:
(d) Commercial Installations. Branch-circuit conductors shall not be smaller than 12 AWG.
SUBSTANTIATION: The fine print notes let the user know to check the conductor's ampacity rating, temperature limit, and voltage drop. Ampacity rating and temperature limits are addressed in the NEC but are not generally applied. Voltage drop is only addressed through the fine print. As commercial installations continue with an increase in the quantity of electrical equipment and with equipment having increased power consumption and more stringent power quality demands, the risk of overloaded conductors and occurrence of unacceptable circuit voltage drops have dramatically increased. Just as the minimum conductor size for bathrooms was increased due to the change in the type of appliances used on the bathroom circuit, the minimum conductor size for all branch circuits in commercial installations should be increased to 12 AWG. The increase in minimum size will increase safety by reducing the risk of overloaded circuits and the need to rewire existing circuits to meet the needs of heavily loaded circuits, increased harmonic loads and sensitive electronic equipment. As reported in the Eleventh Edition of "Fire in the United States 1987-1996," published by United States Fire Administration National Fire Data Center, the leading causes of 1996 nonresidential structure fires in stores, offices, and basic industry are attributed to electrical distribution. The overcurrent device ampacity is not intended to be changed by this proposal.
PANEL ACTION: Reject.
PANEL STATEMENT: See panel statement on Proposal 2-98.
NUMBER OF PANEL MEMBERS ELIGIBLE TO VOTE: 12
VOTE ON PANEL ACTION:
AFFIRMATIVE: 12

(Log #2032)

2- 101 - (210-12): Reject
SUBMITTER: David A. Kerr, Jr., Friendsville, PA
RECOMMENDATION: Delete.
SUBSTANTIATION: These devices need real-world testing not Greek-alphabet testing. Only sprinklers put fires out.
PANEL ACTION: Reject.
PANEL STATEMENT: See panel statement on Proposal 2-106.
NUMBER OF PANEL MEMBERS ELIGIBLE TO VOTE: 12
VOTE ON PANEL ACTION:
AFFIRMATIVE: 11
NEGATIVE: 1
EXPLANATION OF NEGATIVE:
BROWN: This proposal should be accepted. See my comment on Proposal 2-106.

(Log #2744)

2- 102 - (210-12): Accept in Principle
Note: It was the action of the Technical Correlating Committee that this Proposal be referred to Code-Making Panel 17 for further consideration in Article 517. This will be considered as a public comment.
SUBMITTER: A. Dan Chisholm, Healthcare Circuit News
RECOMMENDATION: Revise as follows:
(b) Dwelling Unit Bedrooms. All branch circuits that supply 125-volt, single-phase, 15- and 20-ampere ~~receptacle~~ outlets installed in dwelling unit bedrooms shall be protected by an arc-fault circuit interrupter(s). This requirement shall become effective January 1, 2002.
(c) Limited Care Facility Bedrooms. All branch circuits that supply 125-volt, single-phase, 15- and 20-ampere outlets installed in limited care facility bedrooms shall be protected by an arc-fault circuit interrupter(s).
SUBSTANTIATION: The 1999 National Electrical Code mandates the protection of the branch circuits that supply the receptacle outlets installed in dwelling unit bedrooms. I can agree that bedroom circuits need to be protected, but I cannot understand the restriction to "receptacle outlets." The objective of the 1999 code change was to increase the fire protection of bedrooms, and in that case all of the bedroom outlets should be protected. Here I note that the code defines an outlet as "A point on the wiring system at which current is taken to supply utilization equipment." Further, utilization equipment is code defined as "Equipment that utilizes electric energy for electronic, electromechanical, chemical, heating, lighting, or similar outlets."
I am proposing that the word "receptacle" be deleted from the present code language. This would then mandate protection, for example, of the permanently installed lighting fixture-outlets within a bedroom.
With respect to my proposed new requirement for AFCI protection of the branch circuits associated with the bedrooms of Limited Care Facilities, I am convinced that these devices will serve a vital fire-protection function. As defined in 517-3, a Limited Care Facility is "A building or part thereof used on a 24-hour basis for the housing of four or more persons who are incapable of self-preservation because of age, physical limitation due to accident or illness, or mental limitations, such as mental retardation/developmental disability, mental illness, or chemical dependency". These facilities, with occupants who are incapable of self preservation, deserve the very finest of fire-mitigating technology. AFCIs, with their demonstrated capability of detecting arcing faults and interrupting these faults, represent such technology and should be mandated for the branch circuits supplying the bedroom outlets of these facilities.
PANEL ACTION: Accept in Part.
The panel accepts the deletion of "receptacle" in (b) of the proposal, and rejects the remainder of the proposal.
PANEL STATEMENT: The limited care facility issue is outside the scope of Code-Making Panel 2 and recommends that the Technical Correlating Committee forward this item to Code-Making Panel 17 for action.
NUMBER OF PANEL MEMBERS ELIGIBLE TO VOTE: 12
VOTE ON PANEL ACTION:
AFFIRMATIVE: 11
NEGATIVE: 1
EXPLANATION OF NEGATIVE:
BROWN: This "Accepted in Part" proposal, in essence adding supposed AFCI protection for any permanently mounted lighting, should be rejected. During an emergency situation, or nuisance tripping of the AFCI device, one would want this type of area lighting to be available to rectify any problems

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(Log #2847)

2- 103 - (210-12): Accept in Principle

Note: It was the action of the Technical Correlating Committee that this Proposal be referred to Code-Making Panel 17 for further consideration in Article 517. This will be considered as a Public Comment.

SUBMITTER: Robert J. Clarey, Cutler-Hammer, Inc.

RECOMMENDATION: Revise text as follows:

(b) Dwelling Unit Bedrooms. All branch circuits that supply 125-volt, single-phase, 15- and 20-ampere ~~receptacle~~ outlets installed in dwelling unit bedrooms shall be protected by an arc-fault circuit interrupter(s). This requirement shall become effective January 1, 2002.

(c) Dwelling Unit Living Areas. All branch circuits that supply 125-volt, single-phase, 15- and 20-ampere outlets installed in dwelling units living areas shall be protected by an arc-fault circuit interrupter(s).

FPN: A dwelling unit living area is any space, that can be normally occupied, other than bedrooms, bathrooms, toilet compartments, kitchens, closets, halls, storage, garage or utility spaces.

(d) Guest Rooms. All branch circuits that supply 125-volt, single-phase, 15- and 20-ampere outlets installed in guest rooms in hotels, motels, and similar occupancies shall be protected by an arc-fault circuit interrupter(s) in accordance with the requirements for dwelling units in 210-12(b) and 210-12(c).

(e) Limited Care Facility Bedrooms. All branch circuits that supply 125-volt, single-phase, 15- and 20-ampere outlets installed in limited care facility bedrooms shall be protected by an arc-fault circuit interrupter(s).

SUBSTANTIATION: The 1999 National Electrical Code mandates the protection of all branch circuits that supply receptacle outlets installed in dwelling unit bedrooms. This Code wording was influenced, in part, by Comments during the 1999 Code Cycle, such as Comment 2-65 (1). That Comment addresses the enhanced safety provided by AFCIs in sleeping and living areas; areas that were identified as being most prone to electrical fires as a result of low voltage arcing. The present proposal is aimed at broadening the protection of AFCIs to the branch circuits supplying all bedroom outlets in dwelling units, in guest rooms and in limited care facilities. It is also aimed at broadening the protection of AFCIs to the branch circuits of living areas in dwelling units and in guest rooms.

During the last Code Cycle, Comment 2-65 was Accepted in Principle, and the present Code text in 210-12 of the 1999 National Electrical Code reflects the Panel Action wording on Comment 2-65. The associated Panel Statement (1) reads:

"The Panel has limited the requirements to dwelling unit bedrooms to permit these new devices to be introduced into the public domain on a gradual basis.

The panel also notes that this does not prohibit their use in other circuits throughout dwelling units. An effective date of January 1, 2002 was established to allow industry to accommodate the new requirement and to allow a transition period".

The substantiation for the present proposal is as follows:

With respect to 210-12(b), the present restriction to bedroom receptacle outlets only partially satisfies the intended protection of the circuits supplying dwelling unit bedrooms. These rooms are also associated with lighting outlets, and the branch circuits supplying these lighting outlets should also be protected. The proposal, therefore, is to delete the word "receptacle" in order to provide AFCI protection to the circuits supplying all bedroom outlets.

With respect to 210-12(c), the proposal is the extend AFCI fire protection to the circuits supplying dwelling unit living areas. This change, in conjunction with 210-12(b), would provide AFCI protection to the circuits supplying outlets in all dwelling unit rooms with the exception of bathrooms, toilet compartments, kitchens, closets, halls, storage, garage or utility spaces.

With respect to 210-12(d), the intent is to extend the enhanced safety benefits of AFCIs in dwelling units to comparable occupancy locations (bedrooms and living areas) in the guest rooms (210-60) of hotels, motels and similar occupancies.

With respect to 210-12(e), the intent is to extend the enhanced safety benefits of AFCIs to the bedrooms of Limited Care Facilities as defined in 517-3. These facilities cater to persons who are incapable of self-preservation or who suffer from some form of mental limitation. These handicaps complicate the rapid exiting of buildings, and fire safety needs to be increased by the addition of AFCIs.

This overall Code proposal is justified on the basis of enhanced safety. The U.S. Consumer Product Safety Commission has published (2), for example, 1996 Residential Fire Loss Estimates. CPSC provides estimates of the fires losses, in residential structures, for the total electrical distribution system. For 1996 the estimate is 41600 fires, 370 civilian deaths, 1430 civilian injuries, and $682.5M in property losses. Many of these fires and much of this loss of life could have been prevented by AFCIs. But for AFCIs to be effective, it is necessary to provide arc fault detection and protection to as many dwelling-unit supply-circuits as possible. The Code proposal is also justified by the changes, since the last Code cycle, which demonstrate that industry has indeed accommodated to the new requirements.

First, in February 1999, Underwriters Laboratories published the first Edition of UL 1699 "Arc-Fault Circuit-Interrupters" (3). The branch/feeder AFCIs described in that document are substantially identical to the "AFCIs classified for mitigating the effects of arcing faults" that were available during the 1999 Code cycle, and that were previously described in a draft standard. The branch/feeder AFCIs described in UL 1699 protect the installed wiring, and also provide protection against line to neutral and line to ground arcing faults in the cords connected to the outlets. The existence of this standard, and of the associated branch/feeder products, indicates that the products have matured. Second, many circuit breaker manufacturers now offer combination circuit breakers and branch/feeder AFCIs. Thus AFCI devices are readily available. Third, manufacturers have gained hundreds of millions of operating-hours experience with AFCIs. The consumers have benefited from the enhanced arcing fault protection.

Further, consumers have not experienced "nuisance tripping" due to the false identification of circuit waveforms such as the inrush transients to motors, and the normally occurring arcing waveforms associated with devices such as thermostats, motors, and switches.

Fourth, AFCI manufacturers have made numerous AFCI presentations to fire inspectors, electrical inspectors, and other groups concerned with public safety. This has raised awareness of both the technology and the associated safety potential, and the overwhelming response has been both positive and enthusiastic.

Fifth, in 1999 the Consumer Product Safety Commission has made a brief report (4) entitled "Preventing Home Fires: Arc Fault Circuit Interrupters (AFCIs)". This report includes the statement, "Several years ago, a CPSC study identified arc fault detection as a promising new technology. Since then, CPSC electrical engineers have tested the new AFCIs on the market and found these products to be effective". Thus AFCIs have moved from the conceptual stage, as discussed in the 1995 UL Report for CPSC "Technology for Detecting and Monitoring Conditions that Could Cause Electrical Wiring System Fires" to the practical stage. In particular, AFCIs are available on the market and are effective.

In view of the positive changes that have occurred since the last cycle, and the continuing heavy toll in human lives, in human injury, and in property losses occasioned by electrical distribution fires, the Code Panel is urged to adopt this proposal. The objective is to optimize protection for dwelling unit bedrooms, for dwelling unit living area circuits, for the comparable guest rooms of hotels and motels, and for the bedrooms of limited care facilities.

References:

(1) National Electrical Code Committee Report on Comments, Comment 2-65, pages 99-100, 1998.

(2) "1996 Residential Fire Loss Estimates", U.S. Consumer Product Safety Commission Report, 1998.

(3) "Arc-Fault Circuit-Interrupters", Underwriters Laboratories Inc., UL 1699 Standard for Safety, First Edition, February 26, 1999.

(4) "Preventing Home Fires: AFCIs", Consumer Product Safety Review, Volume 4, #1, page 6, Summer 1999.

Note: Supporting material is available upon request at NFPA Headquarters.

PANEL ACTION: Accept in Part.

The panel accepts the deletion of the term "receptacle" in (b) of the proposal. The panel rejects the remainder of the proposal.

PANEL STATEMENT: The panel rejects the submitter's requested expansion of the AFCIs usage beyond the dwelling unit bedroom circuits.

The panel continues to support the introduction of this product, based on the data received and reviewed on this subject, but believes it is prudent to limit the requirement to bedrooms to gain further experience.

The limited care facility issue is outside the scope of Code-Making Panel 2 and recommends that the Technical Correlating Committee forward this item to Code-Making Panel 17 for action.

NUMBER OF PANEL MEMBERS ELIGIBLE TO VOTE: 12

VOTE ON PANEL ACTION:

AFFIRMATIVE: 11

NEGATIVE: 1

EXPLANATION OF NEGATIVE:

BROWN: See my Explanation of Negative Vote on Proposal 2-102.

COMMENT ON AFFIRMATIVE:
MOORE: The EEI/ELP Group continues to support the introduction of this product, but questions the effectiveness due to the pickup level of the two types of AFIs. The parallel device is tested for a minimum pickup level of 75 amperes and the series device is tested for a minimum pickup of five amperes. The series device would require a five ampere load to be energized during operation. Most bedroom circuits would not have a load of that amplitude, especially while the occupant is asleep. Additional data and further product development is needed prior to extended usage.
NISSEN: The increased use of AFCIs as an effective means of reducing arcing-fault fires should be supported. The gaining of experience with these devices in all bedroom circuits is encouraged so that their usage can be expanded to other rooms and facilities that could benefit by the added protection which they would afford.

(Log #3010)

2- 104 - (210-12): Reject
SUBMITTER: Bernard A. Schwartz, Schwartz Fire Specialists/Rep. Nat'l Multi-Family Housing Council
RECOMMENDATION: Revise as follows:
(b) All branch circuits that supply 125-volt, single phase, 15- and 20-ampere receptacle outlets installed in dwelling unit bedrooms shall be protected by an arc-fault circuit interrupter(s). This requirement shall become effective January 1, 2002. For purposes of this section, the installation of an arc-fault circuit interrupter at the receptacle with all receptacles in the bedroom supplied through that protected receptacle shall be deemed compliant.
SUBSTANTIATION: The available fire data, as well as 30 years of investigating fires and 15 years with the Consumer Product Safety Commission indicates that statistically valid information regarding electrical fires and their causes is lacking and that the number of fires starting inside the walls, in straight runs of cable is insignificant. This belief is also supported by:
a. Comments to Log #2276 in 1998 NEC comments
b. Comments to Log #1820 in 1998 NEC comments
c. Comments to Log #2525 in 1998 NEC comments
d. Comments to Log #2524 in 1998 NEC comments
e. CPSC report dated December 1987 "Residential Electrical Distribution System Fires."
The load center device provides a high level of fault protection for the wires in the wall and a lower level of protection for devices plugged into the receptacle. The receptacle device provides a high level of protection for devices plugged into the receptacle and a lower level of protection for the wiring in the wall. Since neither device is perfect, if one device is to required, than both devices should be allowed to accumulate field experience to demonstrate which is most effective.
PANEL ACTION: Reject.
PANEL STATEMENT: See panel actions and statements on Proposals 2-108 and 2-110. The panel does not agree that the data submitted for the 1999 NEC did not support the present AFCI requirement for branch circuit wiring.
NUMBER OF PANEL MEMBERS ELIGIBLE TO VOTE: 12
VOTE ON PANEL ACTION:
AFFIRMATIVE: 12

(Log #3145)

2- 105 - (210-12): Reject
SUBMITTER: Brent Nurenberg, Pewamo, Mi
RECOMMENDATION: Delete this section.
SUBSTANTIATION: No accident data was ever presented that justified 210-12 in the NEC. Arc-fault interrupters are expensive, which will lead to wiring methods being altered, resulting in fewer circuits serving bedrooms. I have witnessed a series load arc-fault test which resulted in a fire, without the arc-fault interrupter opening the circuit.
PANEL ACTION: Reject.
PANEL STATEMENT: See panel statement on Proposal 2-106.
NUMBER OF PANEL MEMBERS ELIGIBLE TO VOTE: 12
VOTE ON PANEL ACTION:
AFFIRMATIVE: 11
NEGATIVE: 1
EXPLANATION OF NEGATIVE:
BROWN: Please read the substantiation submitted by the submitter. This proposal should be accepted. Also, see my comment on proposal 2-106

(Log #4348)

2- 106 - (210-12): Reject
SUBMITTER: Lawrence Brown, Nat'l Assn. of Home Builders
RECOMMENDATION: Delete Section 210-12 in its entirety.
SUBSTANTIATION: The acceptance of this requirement during the 1999 NEC development cycle was based on a CPSC study that was too limited in the scope of its analysis of losses in residential dwelling environments. Fire damage resulting from arc-fault causes is only a very small percentage of total residential property losses. The data should have included losses from all perils including other causes of fire losses (cooking, arson, etc.) and natural disaster-related damage from wind, earthquake, and flooding. The percentage and actual dollar losses from fires that originates in electrical wiring within the walls is substantially lower than originally perceived. Further, the data did not address the issue of whether the lack of a working smoke alarm contributed to the death.
Also missing is data that relates directly to the year the dwelling was built. This should be shown in relationship to the percentage of related electrical fires from all yearly periods. This directly relates to the wiring methods (open wiring, loom, cloth covered NM Cable) associated with each fire. This also relates to the edition of the building, fire and electrical codes in force at that time. Complete data would show that the Nonmetallic Sheathed Cable within the walls of buildings constructed to today's standards and codes is extremely low compared to the type of electrical wiring installed ten or twenty years ago. It would seem from the proposals submitted during the 1999 cycle that all of the electrical wiring materials manufactured, sold and installed today is defective. This is not true.
Another basic problem is that the technology used for the AFCI breaker will only detect an arc in the wiring up to, and possibly including the receptacle. The receptacle and any equipment pluged into the receptacle are unprotected by the breaker. The installation of an AFCI breaker seems to be only a partial fix to a very small percentage of all residential fires. With this requirement being applied only to bedrooms, the percentage is even smaller.
The cost-benefit to society of installing these breakers should also be considered. The committee was told these breakers would cost the same as a GFCI breaker. This is not true. The wholesale cost is approximately $85.00. It may be that society ends up spending $5.00 to save $1.00. Society may be better served, and save more lives, if this money was spent to upgrade smoke alarms in all existing dwellings.
All told, there are many problems with this new requirement. Incomplete and inaccurate data should not be the basis for an NEC code change. Before complete and accurate data is analyzed, and the electrical manufacturing industry addresses all of the technical problems to produce a more complete device, this requirement should be removed from the NEC.
PANEL ACTION: Reject.
PANEL STATEMENT: AFCIs Listed to UL 1699 are available, and the standard addresses efficacy, unwanted (nuisance) operation and operation inhibition. Cost should not be an issue for the panel to resolve. The panel reviewed a large amount of data, heard presentations on various positions on AFCIs, and received public comment on the topic. Upon that review, the panel arrived at the requirements in the 1999 NEC and continues to support that established position.
NUMBER OF PANEL MEMBERS ELIGIBLE TO VOTE: 12
VOTE ON PANEL ACTION:
AFFIRMATIVE: 11
NEGATIVE: 1
EXPLANATION OF NEGATIVE:
BROWN: This proposal should be accepted. Wrong. It was wrong for the Panel to accept this requirement during the 1999 NEC ROC. To have a better understanding of the many basic problems, you need to read the negative comments on the original proposal. These can be found on pages 111 through 116 of the 1998 Annual Meeting, National Electrical Code Committee Report on Proposals.
These comments, pointing out the fundamental problems with the device, still hold truth today. The standard by which they are developed and tested, the CPSC and other studies used by the proponents to force this product into the NEC are still of concern. Though, most important is the fact that this device will NOT solve the problems the manuacturer's stated was the real intent of pushing these devices into the marketplace through a mandate in the NEC.
It was the engineer from Underwriters Laboratories who showed the panel the basic techncal problems with the device. It will not be able to detect all arcs that may produce a fire. Asked if the device will detect and trip all arcs between the breaker and the first outlet the answer was NO! The same held true for the area of the device,

the area from the device to the appliance, and of the appliance itself. Asked what percentage of arcs may be detected, and the answer is they do not know.

This could partly be caused by the inability for manufacturers to produce a product that solves all of the problems as shown in the UL study performed for CPSC. UL developed 14 test methods for the devices to pass to be reliable. These tests were developed based on identifiable causes of residential electrical wiring fires. The UL standard used to manufacture and test this product is only over a year old. It was rushed through development only to satisfy the needs of the manufacturers as it relates to their specific product. As it turns out, the devices can pass only 4 of the tests. Not the full 14 test methods needed for this product to protect residential occupancies as outlined in the UL-CPSC study. More to the point, the tests only use nonmetallic sheathed cable with a grounding conductor. Not the common single conductor concealed wiring method installed on older dwellings.

Another problem with the CPSC study is the inability of the data to accurately ascertain the specific area of origin of the electrical fire. The study also did not indicate the actural type of wiring method, or the age of the dwelling. If all of this information is known, it would better indicate where the real problem exists. It would be hard to believe that the nonmetallic sheathed cable - ROMEX - being installed today is the overwhelming cause of residential electrical fires. The CPSC study did reach the conclusion that further testing needed to be performed. So we now have a mandate for a product that is unreliable in its ability to protect.

The high cost of this product is also a concern. The manufacturers repeatedly stated at the ROC meeting that the cost of this product would be the same as a GFCI device. This is not true. The manufacturer's catalog lists the devices at around $160.00 each. A check of the wholesale price was approximately $95.00.

So now we have an unreliable product at a high price.

Then we have the manufacturers statements on losses due to concealed electrical wiring. Square-D in their product brochure states "CPSC estimates electrical equipment causes 155,100 or 34 percent of the 451,000 fires in residential structures." This is very misleading. Using current NFPA estimates based in the U.S. Fire Administration's National Fire Incident Reporting System (NFIRS), the total residential fire losses due to all electrical causes is only 13.75 percent of the total residential fire losses. Now, using the same data, the losses due to electrical wirng within the walls is only 5.49 percent of the total residential fire losses. This is not the 34 percent insinuated by the manufacturers.

Now, we have an unreliable product, at a very high price compared to the losses it may save.

Using the NFPA data and the 1999 NEC requirements, if the devices were 100 percet reliable, consumers will spend $240,000,000 to cover losses of ony $30,900,000. Well over seven (7) times the total losses. If this product is expanded to include all circuits in a dwelling, the public would spend over $2,400,000,000 to prevent losses of $253,600,000. This is approximately 9.5 times the actual loss. And, this is based on 100 percent effectiveness. As noted, above, UL cannot determine the effectiveness of the product. Even more disturbing is a recently published article by UL stating property losses of over $1.5 billion. From the standpoint of cost-effective regulatory mandates, the requirement in the NEC for this product is unacceptable.

This whole situation reminds one of the mandates for CO detectors. All studies have shown the location for installation of the detector to be reliably effective canot be determned. Furthermore, there are numerous problems with the technology and the manufacturing of the detector. Recalls and public announcements as to the problems are constant. It may be partly due to a rush by manufacturers to get the detectors into the marketplace.

The AFCI is also a product that is untested in relationship to the actual problem that may exist, or its ability to effectively control them. Until a more complete study of the actual causes of residential electrical fire is available, and a product can be developed to meet those needs, mandates for AFCIs should not be included in the NEC. Society should not be mandated to spend 10-20 times the amount of money that may be saved without a solid basis for the expense.

(Log #2881)

2- 107 - (210-12(a)): Reject

Note: It was the action of the Technical Correlating Committee that this Proposal be reconsidered and correlated with the action on Proposal 3-124. This action will be considered by the Panel as a Public Comment.

SUBMITTER: Robert R. Kent, Electrical Contracting, Inc.

RECOMMENDATION: Remove the definition of arc-fault circuit interupter from this section and put it in Article 100 DEFINITIONS.

SUBSTANTIATION: This definition should be in Article 100. As I understand, the thought behind the many changes in the '99 NEC was to make it more user friendly. This then would also be a step to help in that direction.

PANEL ACTION: Reject.

PANEL STATEMENT: Based on the NEC Style Manual 2.2.2.1, the definition of AFCI should not be included in Article 100, unless the term is used in more than one article.

NUMBER OF PANEL MEMBERS ELIGIBLE TO VOTE: 12

VOTE ON PANEL ACTION:

AFFIRMATIVE: 12

(Log #3308)

2- 108 - (210-12(a) and (b)): Reject

SUBMITTER: Jack Wells, Pass & Seymour/Legrand

RECOMMENDATION: Revise to read as follows:

210-12. Arc-Fault Protection.

(a) Definition. An arc-fault circuit-interrupter is a device intended to provide protection from the effects of arc faults by recognizing characteristics unique to hazardous arcing and by functioning to deenergize the circuit when an arc fault is detected. An arc fault that occurs between the line and neutral or the line and ground conductors is a parallel arc fault. An arc fault that occurs in a single conductor, either line or neutral, is a series arc.

(b) Dwelling Unit Bedrooms. Arc-fault circuit-interrupter(s) shall provide protection for dwelling unit bedrooms as specified in either (1) or (2).

(1) All branch circuits that supply 125-volt single phase, 15 and 20-ampere receptacle outlets installed in dwelling unit bedrooms shall be protected by arc-fault circuit-interrupter(s) installed in the panelboard at the origin of the branch circuit. The arc-fault circuit-interrupter shall provide arc fault protection for the branch circuit wiring.

(2) All 125-volt, single phase, 15- and 20-ampere receptacles in dwelling unit bedrooms shall be protected by a receptacle type combination arc-fault circuit-interrupter installed as the first receptacle in all branch circuits serving dwelling unit bedroom receptacles. The receptacle type combination arc-fault circuit-interrupter shall provide series arc fault protection for the branch wiring and the extension wiring on the line and load side of the receptacle and parallel arc fault protection for the branch circuit wiring and the extension wiring on the load side of the receptacle for all 125-volt single phase, 15- and 20-ampere receptacles in dwelling unit bedrooms.

SUBSTANTIATION:

° Section 210-12(b) in the 1999 NEC requires protection of only the circuit conductors between the final overcurrent device and the outlet. This section states that branch circuits dwelling unit bedroom receptacles shall be protected by arc-fault circuit-interrupters. Branch circuits are defined in Article 100 as "The circuit conductors between the final overcurrent device protecting the circuit ad the outlet(s)."

° Since the adoption of this requirement, two significant events have occurred.

1. UL 1699 covering AFCIs has been finalized and published. This standard establishes several different types of AFCIs that provide differing levels of arc fault protection for different types of arc faults.

2. A new type of receptacle arc-fault circuit-interrupter has been developed. This device is listed by UL as a combination arc-fault circuit-interrupter embodies in an outlet receptacle type device.

° As a consequence of these developments not contemplated by CMP 2 during the initial deliberation concerning AFCIs, the current requirement needs to be revised to recognize the various types of AFCIs.

° The addition of the definition of series and parallel arcs will assist users in understanding the type of arc fault that may occur and provide a basis for understanding of the application of various types of AFCIs.

° The following are definitions of permanently wired arc fault circuit-interrupters that appear in UL 1699:

Branch/Feeder Arc Fault Circuit Interrupter. A device intended to be installed at the origin of a branch circuit or feeder, such as a panelboard. It is intended to provide protection of the branch circuit wiring the feeder wiring, or both, against unwanted effects of arcing. This device also provides limited protection to branch circuit extension wiring. It may be a circuit-breaker type device or a device in its own enclosure mounted at or near a panelboard.

Outlet Circuit Arc-Fault Circuit-Interrupter - A device intended to be installed at a branch circuit outlet, such as at an outlet box. It is intended to provide protection of cord sets and power supply cords connected to it (when provided with receptacle outlets) against the unwanted effects of arcing. This device may provide feed through protection of the cord sets and power supply cords connected to downstream receptacles.

Combination Arc-Fault Circuit Interrupter - An AFCI which complies with the requirements for both branch/feeder and outlet circuit AFCIs. It is intended to protect downstream branch wiring and cord sets and power supply cords.

The following table is an excerpt from Table 50.2 in UL 1699. It shows the arc fault test requirements that permanently wired AFCIs are required to meet.

Tests	Branch Feeder AFCI	Combination AFCI	Outlet Circuit AFCI w/Feed	Outlet Circuit AFCI w/o Feed
(a) CarbonizedPath Arc Ignition NM-B Insulation Cut	X	X		
(b) Carbonized Path Arc Interruption Test	X	X	X	
SPT-2 Insulation Cut	X	X		
NM-B Insulation Cut				
(c) Carbonized Path Arc Clearing Time Test		X	X	X
SPT-2 Insulation Cut				
(d) Point Contact Arc Test				
SPT-W Insulation Cut	X	X		X
NM-B Insulation Cut	X	X		

It is important to recognize the type of arc fault each of these test represent in order to understand the level of protection provided by different types of AFCI.

The carbonized path arc ignition test (a) is test for detection of a series arc. This test represents an arc fault in a single conductor of a 3-conductor NM-B cable. The time to clear the arc fault is not specified. The cable used as test sample is wrapped with tape in the area where the arc occurs. The taped area is loosely wrapped with a cotton indicator. The AFCI must clear the fault before a cotton indicator ignites. In the case of a branch/feeder AFCI which may only detect parallel faults, this test is likely to be satisfactorily complied with because the series fault quickly develops into a parallel fault to the equipment grounding conductor. In the case of the combination and outlet circuit AFCI, the fault is detected as a series fault.

The carbonized path arc clearing time test (c) is also a test for detection of a series arc. However, this test represents an arc fault in a single conductor of a 2-conductor SPT-2 cord. The AFCI must clear the arc fault in 1 second or less. A branch/feeder AFCI is not required to provide protection for this type of fault.

Both the carbonized path arc interruption test (b) and the point contact arc test (d) are intended to detect parallel arcs. Although the arcing paths are created by a different methods for each test, both tests create a condition of arcing between two conductors of either a 3-conductor NM-B cable or a 2-conductor SPT-2 cord. In both tests the AFCI must clear the arc fault within 8 half cycles of arcing that occur within a period of 0.5 seconds.

° An issue not directly addressed in the UL standard is series type arcing faults that may occur at loose binding screw terminals, push-in terminals, twist-on wire connectors and similar terminations in the fixed branch circuit wiring. An roc that occurs at this type of termination will appear to an AFCI as very similar to a series arc fault in a single conductor. The closest related case to a termination type of arc fault in the UL test table is the carbonized path arc clearing time test (c) which is used to detect a series arc in a single conductor of an SPT-cord. A combination AFCI and outlet circuit AFCI are subjected to this test but a branch/feeder AFCI is not. These two arcing conductors are closely related because an arc fault in single conductor occurring either in a cord, or at a terminal, occurs at a location where the arc cannot easily develop into a ground fault or into a parallel arc to another conductor. The ignition of combustible material in close proximity will likely occur by the time this type of series arc progresses to a parallel arc or a ground fault. Consequently, the UL test that requires clearing the series arc fault in 1 second or less is critical in preventing the development of a fire hazard created by allowing the series arc to progress to either a parallel arc or a ground fault.

Detection of series type arc faults at terminations by the receptacle type combination AFCI is an important features that must not be overlooked when specifying an AFCI for arc fault protection. This proposal permits selection of a receptacle type combination AFCI that provide this type of series arc fault protection.

° It is evident from the test table that the different types of AFCIs provide different levels and types of arc fault protection. For example, the branch/feeder AFCI is not required to provide series arc fault protection for SPT-2 cords although parallel arc fault protection for an SPT-2 cord must be provided. Likewise, a branch/feeder AFCI in UL 1699 states that this device provides only "limited protection" of branch circuit extension wiring such as extension cords ad power supply cords.

The levels of protection provided by different types of AFCIs must be considered when selecting a device to provide arc fault protection.

° Section 210-12(b) in the 1999 NEC requires protection of the branch circuit conductors from the final overcurrent device to the outlet. This protection is most likely to be provided by the installation of the branch/feeder AFCI at the panelboard. Although the branch-feeder AFCI provides protection for the branch circuit conductors and "limited protection" for parallel arc faults in cords, the UL test program does not require this type of AFCI to p protect against a series arc fault in a 2-conductor extension or power supply cord used to connect a load to the branch circuit.

There are many loads used in dwelling unit bedrooms and other rooms in a home that are cord connected to the branch circuit. Some of these loads such as clothes irons, space heaters, and multiple loads on extension cords can create a serious arcing hazard when connected to the branch circuit by a extension or power supply cord that has a damaged single conductor. The damaged single conductor in the cord used with these types of loads can easily develop into arc fault condition that must be cleared quickly before it becomes fire hazard.

One result of this proposal is to permit selection of an AFCI that provides protection for a series arc in a 2-conductor cord.

° The arc fault tests in UL 16999 have been developed to demonstrate the ability of an AFCI to detect an arc fault on the downstream side of the AFCI. However, the nature of series arcs and the technology used in the design of the UL listed receptacle type combination AFCI results in the ability of this type of AFCI to clear series arc both on the upstream and downstream side of the AFCI. Thus, the receptacle type combination AFCI provides series arc fault protection for the fixed branch circuit wiring from the panelboard to the outlet as well as series and parallel arc fault protection on the load side of the AFCI for the fixed branch circuit wiring, extension cords and power supply cords.

° This proposal provides the option of installing either a receptacle type combination AFCI or a branch/feeder AFCI. Both of these products offer effective arc fault protection. The NEC should be revised to permit the installation of either product.

PANEL ACTION: Reject.

PANEL STATEMENT: See panel statement on Proposal 2-110.

NUMBER OF PANEL MEMBERS ELIGIBLE TO VOTE: 12

VOTE ON PANEL ACTION:
AFFIRMATIVE: 10
NEGATIVE: 2
EXPLANATION OF NEGATIVE:
MERICLE: I vote no on the Panel Action. There exists a wealth of testing data which attests to the effectiveness of these devices in helping to prevent fires.
NISSEN: The concept present in this proposal should be accepted. The submitter has not suggested expanding AFCIs beyond the bedroom branch circuits. The substantiation addresses an alternate method of protecting bedroom circuits with a combination type AFCI. See also my comment on Proposal 2-110.

(Log #2102)

2- 109 - (210-12(b)): Reject
SUBMITTER: Chip Pudims, Hubbell Inc.
RECOMMENDATION: Revise text to read as follows:
Dwelling Unit Bedrooms.
(1) All branch circuits that supply 125-volt, single-phase, 15 and 20-ampere outlets installed in dwelling unit bedrooms shall be protected by a Branch/Feeder arc-fault circuit interrupter(s).
(2) All 125-volt, single-phase, 15 and 20-ampere receptacle outlets installed in dwelling unit bedrooms shall be protected by an Outlet/Circuit arc-fault circuit interrupter(s).
Exception: A combination unit shall be permitted to provide both Branch/Feeder and Outlet/Circuit arc-fault protection required by (1) and (2) above.
SUBSTANTIATION: Existing Code requires arc-fault protection solely for branch-feeder circuits and does not require protection for extension or power-supply cords. Independent studies have cited extension wiring as potentially significant sources of residential electrical fires, that result from arc-faults. Extension and power-supply cords are more susceptible to abuse than branch circuit wiring and can be of far less robust construction; such as 18 AWG SPT flexible cord (i.e., zip cord). Additional requirements will provide a significant increase in the level of safety.
UL 1699 identifies different levels of protection for "branch/feeder" vs. "outlet" type arc-fault circuit-interrupters and "expects a coordinated system of protection". By definition UL recognizes Branch/Feeder AFCIs provide "limited" protection to extension wiring, while Outlet AFCIs are intended to protect "cord sets and power supply cords". Branch/Feeder AFCIs do not protect against series arcs in extension wiring and series arcs are likely to occur because they only require a single break in the wire. UL 1699 requires different levels of performance testing for each type of protection and allows for a "combination" AFCI if all elements of the coordinated system are met.
As of submittal of this proposal, Outlet AFCIs, Listed to UL 1699, are not available, but are being developed and will become available by the NEC effective date of January 1, 2002. In the interest of safety, NEC Section 90-4 specifically permits "new products, constructions, or materials that may not yet be available at the time the Code is adopted." In the interim, Section 90-4 allows the enforcement of previous adopted editions of the Code. The 1984 NEC Handbook rationalizes Section 90-4 because of the greater than 2 year time lag between proposal and adoption of the Code. This Code proposal provides for an increased degree of safety in dwelling unit bedrooms, due to the additional protection for extension and power-supply cords.
The submitter requests the opportunity to present this proposal and any advances in Outlet/Circuit AFCI technology, that may occur in the next few months, to the CMP at the January 2000 meeting.
PANEL ACTION: Reject.
PANEL STATEMENT: See panel action and statement on Proposal 2-110.
NUMBER OF PANEL MEMBERS ELIGIBLE TO VOTE: 12
VOTE ON PANEL ACTION:
AFFIRMATIVE: 9
NEGATIVE: 3
EXPLANATION OF NEGATIVE:
MERICLE: See my Explanation of Negative Vote on Proposal 2-108.
NISSEN: See my Explanation of Negative Vote on Proposals 2-108 and 2-110.
PAULEY: See my Explanation of Negative Vote on Proposal 2-110.

(Log #2262)

2- 110 - (210-12(b)): Accept in Part
SUBMITTER: Steve Campolo, Leviton Manufacturing Co., Inc.
RECOMMENDATION: Revise text as follows:
210-12(b) Dwelling Unit Bedrooms. All branch circuits that supply 125-volt, single-phase, 15- and 20-ampere receptacle outlets installed in dwelling unit bedrooms shall be protected by a Branch/Feeder arc-fault circuit interrupter(s). All 125-volt, single-phase, 15- and 20-ampere receptacles in dwelling unit bedrooms shall be protected by an Outlet/Circuit arc-fault circuit interrupter(s). ~~This requirement shall become effective January 1, 2002.~~
SUBSTANTIATION: Article 100 defines the branch circuit as "The circuit conductors between the final overcurrent device protecting the circuit and the outlet(s)." Applying this definition to Section 210-12(b) of the NEC and the definitions of UL 1699 results in a requirement that provides arc fault protection only for the fixed wiring from the overcurrent device to the receptacle outlet. This indicates that branch circuit extensions may remain unprotected. Expanding the requirement to provide arc fault protection for the receptacles and the wiring extending from the receptacles (e.g., extension cords and power supply cords) greatly increases the level of safety afforded by AFCIs. In fact, it may be argued that exposed extension cords and power supply cords are subject to considerably greater abuse than fixed wiring and are more susceptible to abuse resulting in an arcing condition.
Underwriters Laboratories Inc. issued the first edition of UL 1699, UL Standard for Safety for Arc-Fault Circuit-Interrupters, on February 26, 1999. This standard defines different types of arc-fault circuit-interrupters. The definitions include the following:
A Branch/Feeder AFCI "...is intended to provide protection of the branch circuit wiring, feeder wiring, or both, against the unwanted effects of arcing. This device also provides limited protection to branch circuit extension wiring." Simply, a Branch/Feeder AFCI is not required to offer low current arcing fault protection for branch extensions.
An Outlet Circuit AFCI "...is intended to provide protection of cord sets and power-supply cords connected to it (when provided with receptacle outlets) against the unwanted effects of arcing."
UL has indicated that a coordinated system of protection should emerge where combinations of the various types of AFCIs are used to increase the likelihood of the greatest possible degree of overall protection. This perspective is reinforced by the definitions of various types of AFCIs contained in UL 1699, which explains several different types of AFCIs.
It is apparent that the UL standard considers arc fault protection is important for both the fixed wiring of the branch circuit and the branch circuit extension wiring (Power Supply and Extension Cords). Based on the AFCIs that are defined in UL 1699, a complete system of arc fault protection may be provided by installing a Branch/Feeder AFCI in the panelboard and an Outlet Circuit AFCI at the receptacle. The branch is protected as well as branch extensions.
Adopting the proposed revision to 210-12(b) will result in a system that provides complete arc fault protection for both the fixed wiring and the branch circuit extension conductors by requiring installation of a coordinated system of AFCIs.
PANEL ACTION: Accept in Part.
The panel accepts the deletion of the last sentence in the proposal, and rejects the remainder of the proposal.
PANEL STATEMENT: The panel rejects the expansion of AFCIs beyond the bedroom branch circuits at this time. The panel continues to support the introduction of AFCIs, but intends at this time to limit the requirement to bedroom branch circuits until further data can be obtained and evaluated.
NUMBER OF PANEL MEMBERS ELIGIBLE TO VOTE: 12
VOTE ON PANEL ACTION:
AFFIRMATIVE: 10
NEGATIVE: 2
EXPLANATION OF NEGATIVE:
NISSEN: The submitter has provided adequate substantiation for the need for both branch/feeder and outlet circuit AFCI protection I dwelling unit bedrooms, and that concept should be accepted.
PAULEY: NEMA supports the increase in protection that could be afforded by the addition of the outlet AFCI to Section 210-12. This addition would provide increased protection of cords and appliances connected to receptacle circuits and would enhance safety.

(Log #2745)

2- 111 - (210-12(b)): Reject
SUBMITTER: George D. Gregory, Square D Company
RECOMMENDATION: Revise as follows:
(b) Dwelling Unit Bedrooms. All 15- and 20-ampere, 125-volt, single-phase branch circuits that supply bedrooms shall be protected by a branch/feeder arc-fault circuit interrupter(s). Bedroom receptacle outlet circuits shall additionally have outlet circuit arc-fault circuit interrupter protection.
SUBSTANTIATION: This proposal is intended to accomplish four items:
1. Delete the effective date of January 1, 2002 since it will be redundant with the 2002 edition of the NEC.
2. Add protection at the branch for all 15- and 20-ampere circuits feeding bedrooms, not only receptacle outlets. This will add for protection for lighting circuits.
3. Clarify that protection is "branch/feeder" protection in correlation with the product listing.
4. Add a requirement for specific "outlet circuit" protection of receptacle outlets.
Regarding item 2, AFCI protection of lighting circuits or other dedicated circuits is needed since numbers of residential fires are initiated in lighting circuits. In fact, arcing faults can occur in any circuit.
Regarding item 3, the name branch/feeder AFCI was assigned to the device intended to protect branch or feeder circuits under the new UL 1699, Standard for Safety for Arc-Fault Circuit Interrupters.
Regarding item 4, the new UL 1669 Standard also identifies an outlet circuit AFCI that will add protection specific to protection of receptacle loads. The proposer recognizes that protection at the branch will provide protection against arcing causes of fires in fixed wiring system and considerable protection against such causes in cords and appliances. Outlet circuit protection can enhance the degree of protection.
What's New
Since Section 210-12 was added in the 1999 NEC, three significant things have occurred:
• UL 1699, Underwriters Laboratories, Inc. Standard for Safety for Arc-Fault Circuit Interrupters, dated 2/26/99, was published.
• AFCI products of at least three major manufacturers have been continuously available commercially in circuit breaker form.
• Circuit breaker AFCIs of at least three manufacturers have been Listed under UL 1699 as "Branch/Feeder AFCIs", intended for installation at branch circuits. Original products were classified by UL to an outline of investigation in the form of a proposed standard.
AFCIs have been installed in a number of homes since they were commercially introduced in 1997 as UL Classified products. There have been no reports of nuisance operation or fires of electrical origin in the homes in which they have been installed, to the knowledge of the proposer's employer. There have been testimonies of a number of users to their effectiveness in clearing hazardous circuit conditions and leading to corrections.
Electrical Fire Cause Reports
A report titled, "The U.S. Fire Problem Overview Report" dated March 1998 and published by NFPA discloses that there were 39,400 fires in residences caused by the electrical distribution system as an annual average in the period 1991-1995. [1] These fires are associated with 350 annual civilian deaths. Another 30,700 fires are caused by appliance operation in residences. Of these appliance-related fires, over 40 percent are from heat developed in electric dryers and are not from electrical causes directly. Of the remaining 60 percent, some portion of causes would be detected by the circuit breaker AFCI.
Of the 39,400 fires attributed to the distribution system, 36 percent are in fixed wiring, 18 percent are in cords and plugs, 11 percent are in switches or receptacle outlets, 11 percent are in lighting fixtures, according to the NFPA report. This data breakdown is corroborated by a report published in the January 1990 Fire Journal titled, "What Causes Wiring Fires in Residences" by Smith and McCoskrie of CPSC. [2] That report studied 149 fires in detail and found initial causes: 34 percent in fixed wiring, 19 percent in cords and plugs, 19 percent in switches and outlets, and 13 percent in lighting fixtures. In either set of data, over 60 percent of fires are from causes in the fixed wiring, switches, receptacle outlets and lighting fixtures that are part of the fixed electrical system of a residence.
In summarizing the above paragraphs, over 60 percent of fires attributed to the distribution system are in the fixed wiring system. Combining the distribution system and appliance related fires, over 35 percent of the total is in the fixed wiring system. This data soundly supports the present NEC language that requires AFCI protection at the branch.
Dwelling Rooms Affected
Fires from electrical causes originate in every room in residences. The three areas of most frequent origin, according to the National Fire Institute Reporting System (NFIRs) database for all recent years, are kitchens, bedrooms and living areas. Following these areas in frequency of fire origin are the unimproved areas such as attics, basements and crawl spaces. A convenient, but somewhat dated, breakdown of supporting data appears on page 11 of "CPSC Residential Electrical Distribution System Fires" report dated December 1987 by Smith and McCoskrie. [3] A more recent corroboration appears in "The U.S. Fire Problem Overview Report."[1]
This proposer understands that AFCI protection is needed for nearly all circuits in residences and not just those to bedroom circuits. However, this proposal suggests that the NEC continue to hold with the Panel's intent to initiate this section with protection of one of the most vulnerable locations in a residence, the bedroom. This action will permit an orderly introduction of a new product to the industry. With testimonials of protection already received, we can expect that justification for protection in other areas of residences will naturally follow.
Arcing Faults Cause Fires
Electric arcs can and do occur in damaged or uninsulated conductors from line to neutral, line to ground or within a single broken or separated conductor in series with a load. Electric arcs operate at temperatures of between 5,000 and 15,000°F and expel small particles of molten or burning materials from the center. An arc is clearly capable of igniting nearby materials, including electrical insulation, if it persists. The AFCI removes the potential cause of ignition by opening the arcing circuit within the parameters of the standard, greatly reducing the probability of fire from an electric arc.
Higher current arcs are more likely to cause a fire because of the higher energy in the arc disturbance. Greater current will melt more of the conductor metal and therefore expel more molten particles. The volume of hot, ionized gas emitted increases proportionally with energy. The branch/feeder AFCI in circuit breaker form is specifically oriented toward detecting these higher current arcs above 75 amperes and line-to-ground arcs of current levels from 5 amperes and greater under UL 1699. Commercially available B/F AFCIs will detect line-to-ground arcs of 30 milliamperes and above.
Discussion may point out that fires can be started by series arcs at lower current values, such as 5 amperes and even below. Research done by UL during the development of the standard revealed fire causes at 5 amperes and above under repeatable conditions. Following that research, it was demonstrated that arcs could cause fires with lower current arcs down to 1 ampere and possibly below. However, conditions that allow arc initiation to cause fire for the lower current arcs are difficult to establish.
AFCI Product Standard
The UL 1699 Standard requires testing of the AFCI through a rigorous set of tests for arc detection ability, unwanted operation tests (to avoid nuisance operation), and operation inhibition tests. The operation inhibition tests assure that the AFCI will detect an arc even though it may be connected electrically in series or parallel with loads that might attenuate, mask or otherwise tend to hide the arc signal.
Prior to the development of the AFCI Standard and before products were offered commercially, Square D Company conducted research to learn what arcing conditions cause fires. A part of that research involved collection of evidence from fires to which municipal fire fighters were called. Other evidence was collected from homes of Square D employees. Some of that evidence is discussed in an article published in the November 1997 EC&M Magazine. [4] The research disclosed a number of occurrences involving either short circuit (line-to-neutral faults) or arcing ground faults. The results of this internal research guided our decisions regarding input to the development of UL 1699 and to the development of a product that will address the kind of occurrences we found in the field.
An AFCI must detect potentially hazardous arcing conditions and open to denergize the hazard. It must also distinguish between normal energy and potentially hazardous energy. One method of distinguishing normal from hazardous conditions is by recognition of arcing characteristics in the electrical signal. A brief review of this approach is discussed in an IEEE paper titled "The Arc-Fault Circuit Interrupter: An Emerging Product." [5] This paper also clarifies that two primary methods of arc initiation are addressed in standardized testing. The first method is carbonized path arcing in which carbon tracking supports lower energy arcs and leads to pyrolyzation or

organic materials in the arc path. The second method is the short circuit such as might be caused by insulation damage.

Branch/Feeder and Outlet Circuit AFCIs

An AFCI intended for branch circuit application is called by UL 1699 a branch/feeder AFCI. The circuit breaker version is the only presently available form of the branch/feeder AFCI. The standard states that the branch/feeder AFCI "is intended to provide protection of the branch circuit wiring, feeder wiring, or both, against unwanted effects of arcing. This device also provides limited protection to branch circuit extension wiring." The branch/feeder AFCI provides full short circuit and ground-fault arc detection for all 2-wire cords and circuits as well as cords and circuits with a grounding conductor. However, it is not required to provide low-level series arc-fault protection that is desirable for 2-wire cords without a grounding conductor. It is therefore considered to provide limited protection of extension wiring.

The 2-wire protection does not seem so limited when we consider this fact from "The U.S. Home Product Report, 1992-1996 (Appliances and Equipment)" by Kimberly Rohr of NFPA. [6] On page 7, it clarifies that "The leading cause of cord and plug fires was short circuits and ground faults, which accounted for half or more of these fires, injuries and direct property damage. Fires caused by short circuits and ground faults also accounted for 38 percent of civilian fire deaths." The Branch/Feeder AFCIs are intended and tested for detecting these arcing short circuits and ground faults. That degree of protection extends to cords and plugs and appliances.

The UL 1699 Standard for AFCIs identifies an outlet circuit AFCI (outlet receptacle form) in addition to the branch/feeder AFCI (circuit breaker form). The two types are tested differently. Outlet circuit AFCIs are tested to detect low-level faults between 5 and 30 A such as might be found in series arcs. The branch/feeder AFCI is not tested for the low-level arcs in series with a load. On the other hand, the branch/feeder AFCI is tested with construction cable and wire in addition to cords. Outlet circuit AFCIs are not tested with building wire and cable. Having both devices in a circuit would provide protection for the greatest number of conditions. However, if one device were chosen, it must be the branch/feeder AFCI for the following reasons.

- The branch/feeder AFCI protects the fixed wiring system where the greatest numbers of fires from electrical causes originate.
- The branch/feeder AFCI provides good protection against effects of short-circuit and ground-fault arcing in extension and appliance wiring, though protection is considered limited because it is not required to detect series arcs at lower levels.
- The branch/feeder AFCI has been available for several years from three manufacturers and has exhibited good field experience.

Testimonials

1. An engineer employed by Underwriters Laboratories had circuit breaker AFCIs installed in a number of circuits in his house. When energized after installation, two of them tripped open. On the first, he unplugged all appliances connected to the circuit and then turned the AFCI on. He found a damaged lamp with line-to-ground arc that caused the AFCI to trip. On the second, he replaced the AFCI after unplugging all appliances and repeated attempts to energize it, unsuccessfully. The replacement AFCI also tripped open. After further examination of the circuit, he found a poor connection to an outlet receptacle to which the wire insulation had burnt back from the connection. After repairing it, the AFCI was energized successfully.

2. AFCI circuit breakers were installed in a number of houses in Florida near the Gulf coast in 1998. After installation, only two of these units tripped. In both cases, damage to conductor insulation was found to be the cause of low-level faults that were detected.

3. After AFCI circuit breakers were made commercially available, they were installed in a number of circuits in Square D plants. In one plant an appliance was pushed against its plug, damaging the plug. The AFCI tripped to protect the circuit. When the plug was examined afterward, it was found that the grounding pin connection had been twisted toward the line connection inside the plug housing and that arcing from line to ground had occurred. A second appliance had been jarred in the same situation. After a period of days the AFCI tripped again. No damage was apparent so the AFCI circuit breaker was turned on again to restore power. It was tripped again and was reset several times before the cause was located and corrected. The cause was an intermittent arc from line to ground within the second appliance. This second arcing condition was increasing in continuity as the arcing path became carbonized.

4. Since its commercial introduction, the AFCI circuit breaker has gained considerable respect. In the State of Vermont, an amendment to Section 210-12(b) was adopted to add branch AFCI protection for outlet receptacles in both living areas and bedrooms. Their effective date is January 2001 rather than 2002.

References

[1] John R. Hall, Jr., The U.S. Fire Problem Overview Report, National Fire Protection Association, March 1998, pages 66-88 relating to causes of home fires.

[2] Linda E. Smith and Dennis McCoskrie, "What Causes Wiring Fires in Residences?" Fire Journal, January 1990.

[3] Linda Smith and Dennis McCoskrie, Residential Electrical Distribution System Fires, U.S. Consumer Product Safety Commission, December 1987, the executive summary and page 11.

[4] George D. Gregory, "Using Arc-Fault Circuit Interrupters to Reduce Residential Fires," EC&M Magazine, November 1997.

[5] George D. Gregory and Gary W. Scott, "The Arc-Fault Circuit Interrupter, An Emerging Product," IEEE Transactions on Industry Applications, September/October 1998, pp. 928-933.

[6] Kimberly Rohr, The. U.S. Home Product Report, 1992-1996 (Appliances and Equipment), NFPA, February 1999, pages 4 through 9.

Note: Supporting material is available for review at NFPA Headquarters.

PANEL ACTION: Reject.

PANEL STATEMENT: See panel action and statement on Proposal 2-110.

NUMBER OF PANEL MEMBERS ELIGIBLE TO VOTE: 12

VOTE ON PANEL ACTION:

AFFIRMATIVE: 10

NEGATIVE: 2

EXPLANATION OF NEGATIVE:

NISSEN: See my Explanation of Negative on Proposal 2-110.

PAULEY: See my Explanation of Negative Vote on Proposal 2-110.

(Log #2816)

2- 112 - (210-12(b) and (c)): Accept in Part

SUBMITTER: Harvey E. Johnson, Estero, FL

RECOMMENDATION: Revise text as follows:

(b) Dwelling Unit Bedrooms. All branch circuits that supply 125-volt, single-phase, 15- and 20-ampere ~~receptacle~~ outlets installed in dwelling unit bedrooms shall be protected by an arc-fault circuit interrupter(s). This requirement shall become effective January 1, 2002.

(c) Dwelling Unit Living Areas. All branch circuits that supply 125-volt, single-phase 15- and 20-ampere outlets installed in dwelling unit living areas shall be protected by an arc-fault circuit interrupter(s).

FPN. A living area is any normally occupiable space in a residential occupancy, other than sleeping rooms or rooms that are intended for combination sleeping/living, bathrooms, toilet compartments, kitchens, closets, halls, storage or utility spaces and similar areas.

SUBSTANTIATION: During the past year I have visited many Electrical Shows and Inspector Meetings around the country. One technology that has created a great deal of interest is the Arc Fault Circuit Interrupter which has been demonstrated at many of these events by several manufacturers. The overwhelming response has been positive, and the most frequently asked question has been "Why does the Code only limit the technology to bedroom outlets?" In fact, most people consider that AFCIs should be used on all dwelling circuits.

At this time I am proposing that the circuits to all bedroom outlets be protected by AFCIs. It is difficult enough to explain to people why only bedrooms are protected without attempting to explain the further limitation to receptacle outlets. This can be resolved by removing the word "receptacle". AFCIs would then provide protection to all of the branch circuits which supply bedroom outlets, including the lighting outlets. Here I note that the AFCI protection is not limited solely to the branch circuit wiring, but AFCIs in the branch circuit also provide enhanced protection to the cords attached to the outlets.

With respect to my proposed application of AFCIs to the protection of branch circuit receptacles associated with living areas, I am responding to the question, raised at Electrical Shows and Inspector Meetings, "Why only bedrooms?" During the last Code cycle, the Code Making Panel was interested in the gradual introduction of the AFCi technology. However, during the past several years many manufacturers have introduced UL listed product, UL has issued a standard, there is increased customer awareness, and many devices have been installed. With this increased product availability and experience, I consider that the protection should be expanded. It is well recognized that bedroom and living areas are frequently associated with household electrical fires, and I therefore consider that both of these areas should be

protected without delay. This still falls well short of whole house protection.

I appreciate that the term "Living Areas" is not defined in the National Electrical Code. Here I am proposing that the NEC include, as a FPN, the definition adopted by the Vermont Code Making Authorities; namely "Any normally occupiable space in a residential occupancy, other than sleeping rooms or rooms that are intended for combination sleeping/living, bathrooms, toilet compartments, kitchens, closets, halls, storage or utility spaces and similar areas". Here I also note that Vermont has advanced the effective application date for Section 210-12(b) of the 1999 NEC from January 1, 2002 to January 1, 2001.

AFCIs at the branch circuit location, provide a significant safety enhancement that can impact the present tragic loss of human life, human injury and property damage. The devices are real, their protection is real, and their application is dependent on Code panel action.

PANEL ACTION: Accept in Part.

The panel accepts the deletion of "receptacle" in (b) of the proposal, and rejects the remainder of the proposal.

PANEL STATEMENT: See panel action and statement on Proposal 2-103.

NUMBER OF PANEL MEMBERS ELIGIBLE TO VOTE: 12

VOTE ON PANEL ACTION:

AFFIRMATIVE: 11

NEGATIVE: 1

EXPLANATION OF NEGATIVE:

BROWN: See my Explanation of Negative Vote on Proposal 2-102.

COMMENT ON AFFIRMATIVE:

NISSEN: See my Comment on Affirmative on Proposal 2-103.

(Log #3687)

2- 113 - (210-12(b)): Accept in Part

SUBMITTER: Steve Campolo, Leviton Manufacturing Co., Inc.

RECOMMENDATION: Revise text to read as follows:

210.12(b) Dwelling Unit Bedrooms. All branch circuits that supply 125-volt, single-phase, 15- and 20-ampere receptacle outlets installed in dwelling unit bedrooms shall be protected by a Branch/Feeder arc-fault circuit interrupter(s). All 125-volt, single-phase, 15- and 20-ampere receptacles in dwelling unit bedrooms shall be protected by an outlet/circuit arc-fault circuit interrupter(s). ~~This requirement shall become effective January 1, 2002.~~

SUBSTANTIATION: Article 100 defines the branch circuit as "The circuit conductors between the final overcurrent device protecting the circuit and the outlet(s)." Applying this definition to Section 210-12(b) of the NEC and the definitions of UL 1699 results in a requirement that provides arc fault protection only for the fixed wiring from the overcurrent device to the receptacle outlet. This indicates that branch circuit extensions may remain unprotected. Expanding the requirement to provide arc fault protection for the receptacles and the wiring extending from the receptacles (e.g., extension cords and power supply cords) greatly increases the level of safety afforded by AFCIs. In fact, it may be argued that exposed extension cords and power supply cords are subject to considerably greater abuse than fixed wiring and are more susceptible to abuse resulting in an arcing condition.

Underwriters Laboratories Inc. issued the first edition of UL 1699, UL Standard for Safety for Arc-Fault Circuit-Interrupters on February 26, 1999. This standard defines different types of arc-fault circuit-interrupters. The definitions include the following:

A Branch/Feeder AFCI "...is intended to provide protection of the branch circuit wiring feeder wiring, or both, against the unwanted effects of arcing. This device also provides limited protection to branch circuit extension wiring." Simply, a Branch/Feeder AFCI is not required to offer low current arcing fault protection for branch extensions.

An Outlet Circuit AFCI "...is intended to provide protection of cord sets and power-supply cords connected to it (when provided with receptacle outlets) against the unwanted effects of arcing."

UL has indicated that a coordinated system of protection should emerge where combinations of the various types of AFCIs are used to increase the likelihood of the greatest possible degree of overall protection. This perspective is reinforced by the definitions of various types of AFCIs contained in UL 1699, which explains several different types of AFCIs.

It is apparent that the UL standard considers arc fault protection is important for both the fixed wiring of the branch circuit and the branch circuit extension wiring (Power Supply and Extension Cords).

Based on the AFCIs that are defined in UL 1699, a complete system of arc fault protection may be provided by installing a Branch/Feeder AFCI in the panelboard and an Outlet Circuit AFCI at the receptacle. The branch is protected as well as branch extensions.

Adopting the proposed revision to 210-12(b) will result in a system that provides complete arc fault protection for both the fixed wiring and the branch circuit extension conductors by requiring installation of a coordinated system of AFCIs.

PANEL ACTION: Accept in Part.

The panel accepts the deletion of the last sentence in the proposal, and rejects the remainder of the proposal.

PANEL STATEMENT: See panel statement on Proposal 2-110.

NUMBER OF PANEL MEMBERS ELIGIBLE TO VOTE: 12

VOTE ON PANEL ACTION:

AFFIRMATIVE: 10

NEGATIVE: 2

EXPLANATION OF NEGATIVE:

NISSEN: The submitter has provided adequate substantiation of the need for both branch/feeder and outlet circuit AFCI protection in dwelling unit bedrooms, and that concept should be accepted.

PAULEY: See my Explanation of Negative Vote on Proposal 2-110 (Log #2262).

(Log #3803)

2- 114 - (210-12(b)): Reject

NOTE: It was the action of the Technical Correlating Committee that this Proposal be referred to Code-Making Panel 17 for action. This will be considered as a public comment.

SUBMITTER: Thomas D. Mock, Consumer Electronics Mfrs Assn.

RECOMMENDATION: Revise paragraph 210.12(b) as follows:

(b) Dwelling Unit Bedrooms All branch circuits that supply 125-volt, single-phase, 15- and 20-ampere receptacle outlets installed in dwelling unit bedrooms shall be protected by an arc-fault circuit interrupter(s). This requirement shall become effective January 1, 2002

(c) Dwelling Unit Living Areas All branch circuits that supply 125-volt, single-phase, 15- and 20-ampere outlets installed in dwelling unit living areas shall be protected by an arc-fault circuit interrupter(s).

FPN A dwelling unit living area is any space, that can be normally occupied, other than bedrooms, bathrooms, toilet compartments, kitchens, closets, halls, storage, garage or utility spaces.

(d) Guest rooms All branch circuits that supply 125-volt, single-phase, 15- and 20-ampere outlets installed in guest rooms in hotels, motels, and similar occupancies shall be protected by an arc-fault circuit interrupter(s) in accordance with the requirements for dwelling units in 210.12(b) and 210.12(c) .

(e) Limited Care Facility Bedrooms All branch circuits that supply 125-volt, single-phase, 15- and 20-ampere outlets installed in limited care facility bedrooms shall be protected by an arc-fault circuit interrupter(s).

SUBSTANTIATION: 1. The submitter would like to respectfully disagree with the need for further field experience before mandating wider application of these devices. Research into the reliability of these devices was undertaken by the Consumer Products Safety Commission and reported in the Consumer Product Safety Review, Volume 4, Summer 1999. The results of this report can be summarized as follows;

"Problems in home wiring, like arcing and sparking, are associated with more than 40,000 home fires each year. These fires claim over 350 lives and injure 1,400 victims annually.

Several years ago, a CPSC study identified arc fault detection as a promising new technology. Since then, CPSC electrical engineers have tested the new AFCIs on the market and found these products to be effective.

You may want to consider adding AFCI protection for both new and existing homes. Older homes with ordinary circuit breakers especially may benefit from the added protection against the arcing faults that can occur in aging wiring systems."

Further delay in the proper implementation of these devices does not appear warranted.

2. The sentence: "This requirement shall become effective January 1, 2002." should to be deleted since that is the nominally effective date for the 2002 NEC® anyway. There is no technical or product supply reason for extending the effective date due to adoption of this proposal.

3. The 1999 National Electrical Code mandates the protection of all branch circuits that supply receptacle outlets installed in dwelling unit bedrooms. This Code wording was influenced, in part, by Comments during the 1999 Code Cycle, such as Comment 2-65 (1).

That Comment addresses the enhanced safety provided by AFCIs in sleeping and living areas; areas that were identified as being most prone to electrical fires as a result of low voltage arcing. The present proposal is aimed at broadening the protection of AFCIs to the branch circuits supplying all bedroom outlets in dwelling units, in guest rooms and in limited care facilities. It is also aimed at broadening the protection of AFCIs to the branch circuits of living areas in dwelling units and in guest rooms.

The substantiation for the present proposal is as follows:

With respect to 210-12 (b), the present restriction to bedroom receptacle outlets only partially satisfies the intended protection of the circuits supplying dwelling unit bedrooms. These rooms are also associated with lighting outlets, and the branch circuits supplying these lighting outlets should also be protected. The proposal, therefore, is to delete the word "receptacle" in order to provide AFCI protection to the circuits supplying all bedroom outlets.

"The U.S. Fire Problem Overview Report, Leading Causes and Other Patterns And Trends" published by NFPA in May 1999, and hereafter referred to as the Overview Report, states,

"Electrical distribution equipment fires ranked second in property damage. Electrical distribution equipment includes: fixed wiring; transformers or associated overcurrent or disconnect equipment; meters or meter boxes; power switch gear or overcurrent protection devices; switches, receptacles or outlets; light fixtures, lamp holders, light fixtures, signs, or ballasts: cords or plugs; and lamps or light bulbs.

During the five year period from 1992 through 1996, electrical distribution equipment in the home caused an annual average of 39,100 structure fires, 360 civilian fire deaths, 1,480 civilian fire injuries and $579.3 million in direct property damage.

Electrical distribution equipment fires involved ranked:

- Fifth in number of home structure fires;
- Fourth in home fire deaths;
- Seventh in home fire injuries; and
- Second in direct property damage.

A study done by the U.S. Consumer Product Safety Commission in the mid 1980's examined detailed information about electrical equipment residential fires in specific cities. They found that improper alterations contributed to 37 percent of the fires; improper initial installations factored in 20 percent of the incidents; deterioration due to aging system components contributed to 17 percent of the fires; improper use was a factor in 15 percent of the incidents; inadequate electrical capacity contributed to another 15 percent; faulty products were implicated in 11 percent, and contributing factors were unknokn in 6 percent of the fires studied."

With respect to 210-12 (c), the proposal is to extend AFCI fire protection to the circuits supplying dwelling unit living areas. This change, in conjunction with 210-12(b), would provide AFCI protection to the circuits supplying outlets in all dwelling unit rooms with the exception of bathrooms, toilet compartments, kitchens, closets, halls, storage, garage or utility spaces.

The above referenced Overview Report also states that;

"One-third of the home civilian fire deaths resulted from fires that started in the living room, family room or den."

With respect to 210-12(d), the intent is to extend the enhanced safety benefits of AFCIs in dwelling units to comparable occupancy locations (bedrooms and living areas) in the guest rooms (210-60) of hotels, motels and similar occupancies.

With respect to 210-12(e), the intent is to extend the enhanced safety benefits of AFCIs to the bedrooms of Limited Care Facilities as defined in 517-3. These facilities cater to persons who may be incapable of self-preservation or may suffer from some physical or mental limitation which would hinder the rapid exiting of buildings in an emegency. Fire safety needs to be increased by the addition of AFCIs.

This overall Code proposal is justified on the basis of enhanced safety. According to the NFPA Overview Report, the data on structure fires in residential properties (based 0n 1992-1996 annual averages) shows totals of 448,700 fires, 3,765 civilian deaths, 20,520 civilian injuries and $4,475.3 million in direct property damage. Many of these fires and much of this loss of life could have been prevented by AFCIs. But for AFCIs to be effective, it is necessary to provide arc fault detection and protection to as many dwelling-unit supply-circuits as possible.

The state of Vermont has recognized the value of AFCIs. THE VERMONT ELECTRICAL SAFETY RULES - 1999 (Effective Date: August 1, 1999) include the following;

NFPA 70, National Electrical Code, (1999 edition) To meet the needs of Vermont, NFPA 70 is amended as follows:

-delete and replace as follows - article 210-12(b)

210-12(b) Dwelling Unit living Area and Bedrooms. All branch circuits that supply 125 volts, single phase, 15 and 20 ampere receptacle outlets installed in the dwelling unit living area and bedrooms shall be protected by an arc-fault circuit interrupter(s). (To achieve an orderly transition for compliance this Section shall take effect January 1, 2001).

In view of the positive changes that have occurred since the last cycle, and the continuing heavy toll in human lives, in human injury, and in property losses occasioned by electrical distribution fires, the Code Panel is urged to adopt these proposals. The objective is to optimize protection for dwelling unit bedrooms, for dwelling unit living area circuits, for the comparable guest rooms of hotels and motels, and for the bedrooms of limited care facilities.

PANEL ACTION: Reject.

PANEL STATEMENT: See panel statement on Proposal 2-103.

The limited care facility issue is outside the Scope of Code-Making Panel 2 and the panel recommends that the Technical Correlating Committee forward this item to Code-Making Panel 17 for action.

NUMBER OF PANEL MEMBERS ELIGIBLE TO VOTE: 12

VOTE ON PANEL ACTION:

AFFIRMATIVE: 12

COMMENT ON AFFIRMATIVE:

NISSEN: See my Comment on Affirmative on Proposal 2-103.

(Log #4143)

2- 115 - (210-12(b) and (c)): Accept in Part

SUBMITTER: Philip M. Piqueira, General Electric Co.

RECOMMENDATION: Modify 210-12(b); Add 210-12(c); Add FPN:

(b) Dwelling Unit Bedrooms. All branch circuits that supply 125-volt, single-phase, 15- and 20-ampere ~~receptacle~~ outlets installed in dwelling unit bedrooms shall be protected by an arc-fault circuit interrupter(s). This requirement shall become effective January 1, 2002.

(c) Dwelling Unit Living Areas. All branch circuits that supply 125-volt, single phase, 15- and 20-ampere outlets installed in dwelling unit living areas shall be protected by an arc-fault interrupter(s).

FPN: A dwelling unit living area is any space, that can be normally occupied, other than bedrooms, bathrooms, toilet compartments, kitchens, closets, halls storage, garage or utility spaces.

SUBSTANTIATION: This proposal is intended to enhance the protection provided by arc-fault circuit interrupters as mandated by Section 210-12 of the 1999 National Electrical Code.

210-12(b). The present restriction of this article to bedroom receptacle outlets, while partially satisfying the intention of protecting circuits supplying bedrooms from low voltage arcing, creates a significant void in the protection of the entire bedroom. The deletion of receptacle from the present article would then enable all of the circuits, including those supplying lighting outlets to be protected.

210-12(c). The addition of dwelling unit living areas to this section of the National Electrical Code is a logical extension of the work which was begun during the 1999 code cycle. It is certainly naive to assume that only bedrooms are susceptible to the dangers of low voltage arcing and, consequently, this proposal would provide AFCI protection to all of the circuits supplying outlets in dwelling unit rooms.

During the 1999 code cycle, code panel #2, in responding to one of the AFCI proposals, stated that "The panel has limited the requirements to dwelling unit bedrooms to permit these new devices to be introduced into the public domain on a gradual basis...an effective date of January 1, 2002 was established to allow industry to accommodate the new requirement and to allow a transition period". It is important to note that his statement does question the need for arc-fault circuit interrupters but, instead, deals with limiting the use of these devices and extending the timing of implementation in order to allow industry to accommodate the introduction of this new technology more effectively.

However, since the introduction of this technology into the 1999 NEC, manufacturers have gained experience with hundreds of millions of hours of operating time with AFCIs. As a result of this experience, consumers have not only benefited from enhanced protection from arc faults, but have also not experienced nuisance tripping, a concern of some of the code panel members.

Further, the CPSC (Consumer Product Safety Commission) has stated the following on its web page, Preventing Home Fires: Arc Fault Circuit Interrupters (http://cpsc.gov/cpscpub/pubs/afci.html): "...Several years ago, a CPSC study identified arc fault detection as a promising new technology. Since then, CPSC electrical engineers have tested the new AFCIs on the market and found these products to be effective."

The most recent report by the CPSC on residential fire losses has estimated that there were 41,600 fires ($682 million in property damage) and 370 civilian deaths in 1996. Many of these fires and fatalities could have been prevented if arc fault circuit interrupters had protected those residences. Code Panel #2 can certainly play a valuable role in protecting the public if they act responsibly and adopt this proposal to expand AFCI protection.

Note: Supporting material is available for review at NFPA Headquarters.

PANEL ACTION: Accept in Part.

The panel accepts the deletion of the word "receptacle" in (b) of the proposal, and rejects the remainder of the proposal.

PANEL STATEMENT: See panel statement on Proposal 2-103.

NUMBER OF PANEL MEMBERS ELIGIBLE TO VOTE: 12

VOTE ON PANEL ACTION:

AFFIRMATIVE: 11

NEGATIVE: 1

EXPLANATION OF NEGATIVE:

BROWN: See my Explanation of Negative Vote on Proposal 2-102.

COMMENT ON AFFIRMATIVE:

NISSEN: See my Comment on Affirmative on Proposal 2-103.

(Log #4150)

2- 116 - (210-12(b)): Accept in Part

SUBMITTER: William Keezer, Bose Corp./Rep. Nat'l Systems Contractors Assn. (NSCA)

RECOMMENDATION: Revise paragraph 210-12(b) as follows:

(b) Dwelling Unit Living Areas and Bedrooms. All branch circuits that supply 125-volt, single-phase, 15- and 20-ampere receptacle outlets installed in the dwelling unit living areas and bedrooms shall be protected by an arc-fault circuit interrupter(s). ~~This requirement shall become effective January 1, 2002.~~

SUBSTANTIATION: Problems:

1. The 1999 NEC Handbook states that: "Restricting the requirement to bedroom circuits reflects the desire to gain field experience in a limited application before mandating installation of devices in other unit circuits. Bedrooms contain readily ignitable cloth and cotton materials, and occupants may be sleeping when ignition occurs and not likely able to take protective action rapidly." There are three issues to be addressed here:

1.1 The submitter respectfully disagrees with the contention that bedroom occupants are uniquely vulnerable to the consequences of fire initiation. The NFPA Journal frequently cites fires originating in other occupancy areas where the occupant was asleep when the fire started. These occupancy areas are usually a family room, den, TV room, or other room where the occupant falls asleep in a comfortable chair or sofa while reading, drinking, smoking, or watching TV.

1.2 Sleep is not a necessary prerequisite for failure to notice the start of a fire, nor is observing the start of a fire a guarantee of survival. It is far better if the fire never starts due to appropriate branch circuit protection.

1.3 Fire deaths and injuries happen in rooms other than the place of fire origin more than 50 percent of the time. A bedroom occupant is not protected from the initiation of a fire by an arc fault permitted to occur in a nonbedroom location within the house.

2. The sentence: "This requirement shall become effective January 1, 2002." should be deleted since that is the nominally effective date for the 2002 NEC anyway. There is no technical or product supply reason for extending the effectivity date due to adoption of this proposal.

Substantiation:

1. The State of Vermont has independently considered the issues of application inadequacy, product availability, product reliability and the improved life safety consequences of a revision such as the one proposed. The Vermont Electrical Safety Rules text replacement for 210-12(b) is fundamentally identical to this proposal and was adopted August 1999. The text of this document reads: "210-12(b) Dwelling Unit Living Area and Bedrooms. All branch circuits that supply 125 volts, single phase, 15 and 20 ampere receptacle outlets installed in the dwelling unit living area and bedrooms shall be protected by an arc-fault circuit interrupter(s). (To achieve an orderly transition for compliance this Section shall take effect January 1, 2001)." Note that the effective date for compliance with this more comprehensive requirement is one year earlier than that required in the 1999 NEC.

2. The substantiation for Proposal 2-128 (210-11-(New)) found on page #111 of the 1998 NEC Committee Report on Proposals (Annual Meeting - Cincinnati Ohio) contends that a significant percentage of electrical fires occur in permanently installed wiring or wiring devices. Such a fire could originate in a bedroom wall, but might have been caused by a circuit passing through that wall to service a kitchen, bathroom, garage, or other space within the occupancy. The circuit could even be servicing an outdoor outlet on a bedroom's exterior wall. The concept that protecting a bedroom branch circuit protects the bedroom occupant is a fallacy under such conditions.

3. In May of 1999, the NFPA published a report titled: The U.S. Fire Problem Overview Report - Leading Causes and Other Patterns and Trends (Marty Ahrens, Fire Analysis and Research Division, NFPA). Page 50 of that report supports the submitter's concern about restricting sufficient protection to bedrooms. The report states that "Half of all fire victims were fatally injured when outside the room of origin" (Actually, 57.6 percent).

4. In the same NFPA report, it is stated on page 55 that electrical distribution equipment fires ranked: fifth in number of home structure fires; fourth in home fire deaths, seventh in home fire injuries; and second in direct property damage. Electrical distribution equipment includes (but is not limited to) fixed wiring, transformers or associated overcurrent or disconnect equipment, overcurrent protection devices, switches, receptacles or outlets, cords and plugs. A U.S. Consumer Product Safety Commission study done in the mid-80's determined that improper initial installations was a factor in about 20 percent of all electrical equipment residential fires. This data supports the concern addressed in 2. above. The CPSC found that electrical distribution equipment faults were not unique to any one location of a dwelling.

Clarification:

The submitter would have preferred to state: "All branch circuits" without qualification. Limiting the circuits to receptacle outlets does address protection from arc faults in appliances and extension cords, even if not all branch circuit wiring is protected. With this proposal, what is NOT protected is the following: 1) branch circuits for lighting, 2) permanently installed appliances such as dishwashers and garbage disposals, and 3) branch circuits for 240 volt circuits such as air conditioners, heat and hot water. It is felt that this proposal is not an unreasonable increase in the protection provided by the original 210-12(b), but is not as comprehensive as it ultimately should be. It is proposed as a possible interim step toward total adoption of AFCIs for residential branch circuits in a future Code cycle.

PANEL ACTION: Accept in Part.

The panel accepts the deletion of the last sentence of the proposal, and rejects the remainder of the proposal.

PANEL STATEMENT: See panel statement on Proposal 2-103.

NUMBER OF PANEL MEMBERS ELIGIBLE TO VOTE: 12

VOTE ON PANEL ACTION:

AFFIRMATIVE: 12

COMMENT ON AFFIRMATIVE:

NISSEN: See my Comment on Affirmative on Proposal 2-103.

(Log #1194)

2- 117 - (210-12(b) Exception No. 1 (New)): Reject

SUBMITTER: Charles G. Hendry, Hempstead, NY

RECOMMENDATION: Add new (b) Exception No. 1:

Exception No. 1: In addition to the required receptacle outlets, receptacles supplied by a dedicated circuit, (A/C units, electric heaters etc.) shall be exempt from AFCI protection.

SUBSTANTIATION: 1) This exception will take additional big loads off the bedroom AFCI breakers.

2) In our fire district area 2 1/2 square miles (120,000 people) we had 26 bedroom fires in the last 3 years, 3 electrical (2 extension cords, 1 receptacle), "none" in direct wired units in residential use.

PANEL ACTION: Reject.

PANEL STATEMENT: There is no substantiation to indicate that AFCIs should not protect all 15- and 20-amp, 125 volt bedroom outlet circuits.

NUMBER OF PANEL MEMBERS ELIGIBLE TO VOTE: 12

VOTE ON PANEL ACTION:

AFFIRMATIVE: 12

(Log #1193)

2- 118 - (210-12(b)(1) (New)): Reject

SUBMITTER: Charles G. Hendry, Hempstead, NY

RECOMMENDATION: Add new (b) (1) to read as follows:

(1) 15 AMP Branch Circuits shall be limited to 12 receptacle outlets and

20 AMP Branch Circuits limited to 14 receptacle outlets.

SUBSTANTIATION: 1) This will still allow up to three (3) bedrooms (average 4 receptacles a room) on the circuit but would limit all bedrooms and loads being installed on one (1) AFCI.
2) At a current cost of electricians price of $75-90 per AFCI all bedrooms will end up on one (1) AFCI (some electricians are cheap).
PANEL ACTION: Reject.
PANEL STATEMENT: The number of outlets connected to an AFCI does not affect its ability to provide protection.
NUMBER OF PANEL MEMBERS ELIGIBLE TO VOTE: 12
VOTE ON PANEL ACTION:
AFFIRMATIVE: 12

(Log #2453)

2- 119 - (210-12(c) (New)): Reject
SUBMITTER: William H. King, Jr., U.S. Consumer Product Safety Comm.
RECOMMENDATION: Add new paragraph to Section 210-12 as follows:
(c) Lighting and Appliance Branch Circuits. Each existing 125-volt, single-phase, 15- and 20-ampere lighting and appliance branch circuit shall be individually protected by an arc-fault circuit interrupter when the service equipment is replaced.
FPN: See Section 230-XX (Editorial note: Section 230-XX is a proposed new section, submitted separately to the CMP for Article 230, to compliment this proposed new paragraph (c) to Section 210-12. For information purposes, the proposed new Section 230-XX reads as follows: 230-XX. Replacement of Service Equipment in Dwelling Units. When service equipment in dwelling units is replaced, each existing 125-volt, single-phase, 15- and 20-ampere lighting and appliance branch circuit shall be individually protected by an arc-fault circuit interrupter.)
SUBSTANTIATION: According to a study conducted by the U.S. Consumer Product Safety Commission (CPSC), "Residential Electrical Distribution System Fires", Smith & McCoskrie, 1987, fires originating in branch circuit wiring predominately occurred in dwellings over 20 years old, with the highest rates of fires occurring in dwellings over 40 years old. Older dwellings are frequently upgraded with replacement service equipment to accommodate an increase in the service rating to supply additional appliance and equipment loads. However, often times, the existing lighting and appliance branch circuits in dwelling units are not replaced when the service is upgraded, due to the increased cost, and/or the inability to evaluate the remaining life expectancy of the branch circuit conductors. The branch circuit conductors are frequently located in concealed spaces surrounded with thermal insulation, and could be in a deteriorated condition at the time the service is upgraded. This proposal is intended to remedy this situation with the addition of arc-fault circuit interruption (AFCI) protection against fire hazard conditions for the existing branch circuit conductors.
PANEL ACTION: Reject.
PANEL STATEMENT: The proposal calls for a significant expansion of this device beyond the bedroom circuits. The panel does not intend to expand the code to require AFCIs in existing dwellings at this time.
NUMBER OF PANEL MEMBERS ELIGIBLE TO VOTE: 12
VOTE ON PANEL ACTION:
AFFIRMATIVE: 12
COMMENT ON AFFIRMATIVE:
NISSEN: See my Comment on Affirmative on Proposal 2-103.

(Log #2849)

2- 120 - (210-12(c) (New)): Reject
SUBMITTER: Donald M. King, Wilmington, DE
RECOMMENDATION: Add a new paragraph (c) to 210-12 to read as follows:
(c) Guest Rooms. All branch circuits supplying 125V single-phase 15- and 20- ampere receptacle outlets in guest rooms of hotels, motels, and similar occupancies shall be protected by an arc-fault circuit interrupter(s).
SUBSTANTIATION: Receptacle outlets and flexible cords that are installed behind furniture in guest rooms of hotels and motels are subject to the same risk of physical damage as those that are installed behind furniture in bedrooms of single family dwellings. Section 210-12(b) requires arc fault protection for branch circuits supplying receptacle outlets in bedrooms of single family dwellings. This added text would extend the same level of protection offered by this new technology to persons and property of similar occupancies.
PANEL ACTION: Reject.
PANEL STATEMENT: See panel statement on Proposal 2-103.
NUMBER OF PANEL MEMBERS ELIGIBLE TO VOTE: 12
VOTE ON PANEL ACTION:
AFFIRMATIVE: 12
COMMENT ON AFFIRMATIVE:
NISSEN: See my Comment on Affirmative on Proposal 2-103.

(Log #1050)

2- 121 - (210-19): Accept
SUBMITTER: James M. Daly, BICC General
RECOMMENDATION: Revise 210-9 as follows:
210-19(c), Exception No. 2 - change "No. 10" to "10 AWG".
210-19(d) - change "No. 14" to "14 AWG".
210-19(d), Exception No. 2 - change "No. 14" to "14 AWG".
SUBSTANTIATION: To provide consistency throughout the Code. The term "No." is not used in any of the Tables in Chapter 3.
AWG and kcmil are trade size designators specifically authorized for use with the SI system of units in North America. Also, industry practice is to use AWG or kcmil only.
This is one of a series of proposals to make this change throughout the Code.
PANEL ACTION: Accept.
NUMBER OF PANEL MEMBERS ELIGIBLE TO VOTE: 12
VOTE ON PANEL ACTION:
AFFIRMATIVE: 12

(Log #392)

2- 122 - (210-19(a)): Reject
SUBMITTER: Glenn W. Zieseniss, Crown Point, IN
RECOMMENDATION: Add the following to the last sentence of the paragraph:
"and where adjustment or correction factors are applied, the ampacity of the conductor shall not be less than 100 percent of the noncontinuous load plus 100 percent of the continuous load."
SUBSTANTIATION: The existing text seems to imply that is a "stand alone" statement and other NEC sections, such as the first paragraph of 240-3 and 240-3(d), do not apply if the ampacity of the conductor was greater than or equal to 125 percent of the continuous load plus 100 percent of the noncontinuous load before applying any adjustment or correction factors. There is no text to indicate the minimum conductor ampacity required after any adjustment or correction factors are applied. It is possible for the calculated conductor ampacity to be less than 100 percent of the continuous and noncontinuous loads after adjustment and correction factors are applied.
PANEL ACTION: Reject.
PANEL STATEMENT: The last sentence of 210-19(a) establishes a minimum conductor size for the branch circuit that supplies any continuous loads. The first sentence of 210-19(a) provides the text that establishes the minimum conductor ampacity by stating that it shall not be less than the load to be served. Ampacities of conductors are determined from 310-15 and 210-19(a) FPN No.1 guides the user to that section.
NUMBER OF PANEL MEMBERS ELIGIBLE TO VOTE: 12
VOTE ON PANEL ACTION:
AFFIRMATIVE: 12

(Log #680)

2- 123 - (210-19(a)): Accept in Part
SUBMITTER: Dan Leaf, Palmdale, CA
RECOMMENDATION: Revise to read as follows:
(a) General. Branch-circuit conductors shall have an ampacity not less than the maximum computed load to be served. Where a branch circuit supplies continuous load(s) or any combination of continuous and noncontinuous loads, the minimum branch-circuit conductor size, before the application of any adjustment or correction factors, shall have an allowable ampacity ~~equal to or greater~~ not less than the noncontinuous load(s), plus 125 percent of the continuous load(s) or the ampacity specified for motor circuit conductors in Sections 430-22; 430-24; 430-25; and 440-34, whichever is greater.
Exception No. 1: The correction factors for temperatures below 26°C (78°F) shall be permitted in determining the initial conductor ampacity.