

## FPE Panels – Hazard or Hype?

*by Douglas Hansen*

*(this article last updated November 2003 – check back soon for a newer edition)*

*This article focuses on the controversy over inspecting and reporting Federal Pacific panels. It has been published in the magazine for the California Real Estate Inspection Association and in other technical journals.*

### FPE Panels – Hazard or Hype?

Federal Electric – later known as Federal Pacific Electric (FPE) – was a popular manufacturer of panels and breakers from the mid-1950's until the early 1980's. Based in New Jersey, their products were very popular throughout the country, and some communities have FPE panels in almost every home. For years, stories have circulated about the hazards and defects unique to this equipment, and the darker rumors include tales of product recalls, fraudulent manufacturing, and house fires resulting from failed breakers. Inspectors and electricians share tales of breakers falling out of panels when the deadfront is removed, or breakers failing to shut off when the handle is operated. Home inspectors need the facts so they can present their clients with accurate information on which to base a decision on accepting or replacing FPE panels.

Problems with FPE panels can be broken down into 3 basic categories: **First**, there is the simple fact that the equipment is old, and manufactured to less stringent codes and standards than modern equipment. Electrical equipment is not something that improves with age or use. **Second**, there are problems unique to the design of the FPE Stablok breakers, problems that are not found in other equipment this age. **Third**, there are issues of manufacturing defects and circuit breaker failures. This last issue causes the greatest concern; what good is a circuit breaker that won't trip when overloaded or shorted? What good is a breaker that doesn't de-energize the circuit when the handle is tripped?

### Older isn't Better

Several of the problems found with FPE panels are found in other brands of equipment of the same age. There is less gutter space in the panel than we find in modern equipment. The result is crowding of the wires in the panels. It is sometimes impossible to see all of the terminals in an FPE panel. The space for bending wires is also less than required in modern panels. The rules that proscribe minimum wire bending space are found in the National Electrical Code (NEC) in section 312.6 in the 2002 edition. Over the years, the required minimum space has increased, with the most significant changes in the 1981 NEC, near the very end of the days when FPE panels were made. FPE manufactured some panels with less clearance than the minimum code rules by installing the lugs at an angle, so the conductor was already parallel to the wall opposite the breaker terminal (figure 1). However, the bends shown in figure 1 defeat the purpose of the angled lugs, and the wire is bent too sharply.



*Figure 1 – Insufficient wire bending space*

The bus bars on several of the FPE models were set on springs, with a depth adjustment that enabled the position of the breakers to be moved forward or backward. For a recessed panel, this feature allowed the breakers to be brought out flush to the deadfront cover even if the panel set too far back into the wall. The code today does not allow this, and states that bus bars must be rigidly mounted (section 408.31). Rigid mounting prevents the entire bus from moving when a single breaker handle is operated. Another problem with spring-mounted bus bars is that the breakers sometimes push against the deadfront cover, creating a danger to the inspector when they remove and put back the deadfront cover.

Since the 1984 edition of the NEC, breakers that operate with their handles in a vertical position must be on when in the up position, and off in the down position. Prior to that time, several manufacturers made equipment such as that seen in figure 2, with a row of breakers that was on when down and off when up. The word “on” when upside down is “no.” Inspectors encountering such equipment might want to warn their clients that these FPE breakers are on when facing the outer edge of the panel, and off when facing the center of the panel. It can be very difficult to remove these covers without accidentally tripping a breaker.



Figure 2 – Breakers that are on when down

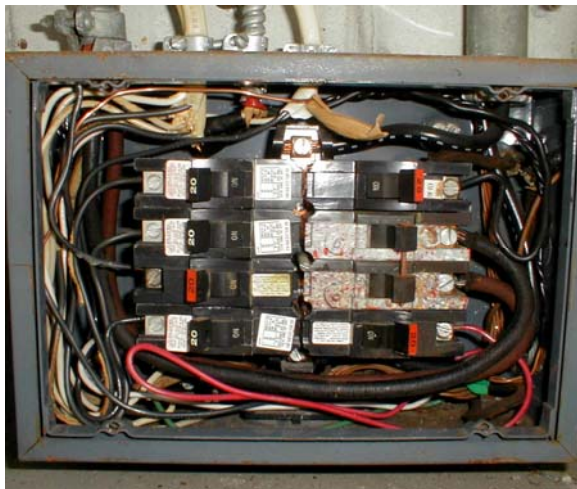
Prior to 1984, many manufacturers offered “split bus” panels for residential use, such as the panel in figure 3. These panels have no main breaker. They do meet the rule requiring no more than 6 disconnects, and one of these disconnects feeds a separate bus that typically contains the 15 and 20 amp 120 volt circuits. The advantages of a split bus panel were purely economic. If the largest breaker was the one feeding the secondary bus, and it was rated at 50 amps, it cost less than a single main 100 amp breaker. In addition to the “six disconnects” rule for service equipment, another rule also applies to panels that are categorized as “lighting and appliance” panels. These are panels where more than 10% of the breakers are rated 30 amps or less and serve circuits with neutrals. These lighting and appliance panels must be capable of having their power disconnected by not more than 2 hand movements. Until 1984, the code exempted these panels from the “two-disconnects” rule when they served as residential service equipment. Today, the code allows them to remain when they are “existing” service equipment, though it would not allow a new installation of such a panel.



Figure 3 – Split Bus Panel

The panel in Figure 3 has 5 breakers at the top. The 3 on the left control a water heater, clothes dryer, and electric space heater. The top right breaker controls the range/oven circuit, and the one just below it controls the lower bus section, with all the lighting and appliance circuits. The wires from this breaker to the lower bus section are the sign that this is a split bus panel.

There are at least 5 design issues that are no longer allowed by code; the gutter space, the wire bending space, spring-mounted bus, breakers that are on when down, and the split bus service equipment. These issues mean that a panel that has been sitting on the hardware store shelf for 20 years would not meet today's code, despite the UL listing of the panel at the time it was manufactured. Another even greater concern is that older breakers – of any brand – do not become more reliable with age. The internal mechanical components can become corroded or distorted, and the springs, hinges, and levers inside the breaker might not operate as designed after sufficient passage of time. Most breaker manufacturers guarantee their products for only a year, and for valuation purposes breakers are considered fully depreciated after 15 years.



*Figure 4 – Overcrowded FPE panel with wires obscuring terminals, neutral bar, and bonding jumper. If the wires press against the deadfront, it may pop out and trip the breaker handles as soon as the panel screws are removed.*

## The Unique FPE Design

Inspectors might find that their first problem with FPE is the difficulty in removing the deadfront cover without tripping the breakers. Several models of FPE panels have breakers that are on when the handle is positioned toward the outside of the panels. The handles stick out slightly over the deadfront, past the twist-out opening for the breaker. To remove the cover, it is necessary to first lift it slightly away from the panel, then slide it under the handles of one row while lifting the cover off the other row. If an inspector pulls the cover straight off, it is likely that some of the breakers will accidentally trip. The panels in figures 2, 3, and 4 have this problem.



*Figure 5 – Scorched Bus Bar*

Most plug-in circuit breakers have a set of jaws that fit over a bus bar, bringing the metal of the jaw into a parallel position to the bus bar. The FPE Stablok design is the opposite; the breakers have a set of prongs that are inserted into a slot in the bus bars (figures 5 – 8). The result is a connection between two pieces of metal that are at right angles to each other, only touching at their edges. One of the common FPE problems is to find the breakers loose in the bus bars. Good electrical connections require contact pressure. If the FPE stab only touches one edge of the opening in the bus, the lack of contact pressure and the small contact area will combine to produce arcing and overheating. If you remove the breakers from the panel, it is not uncommon to find scorch marks on FPE bus bars, as in figure 5.

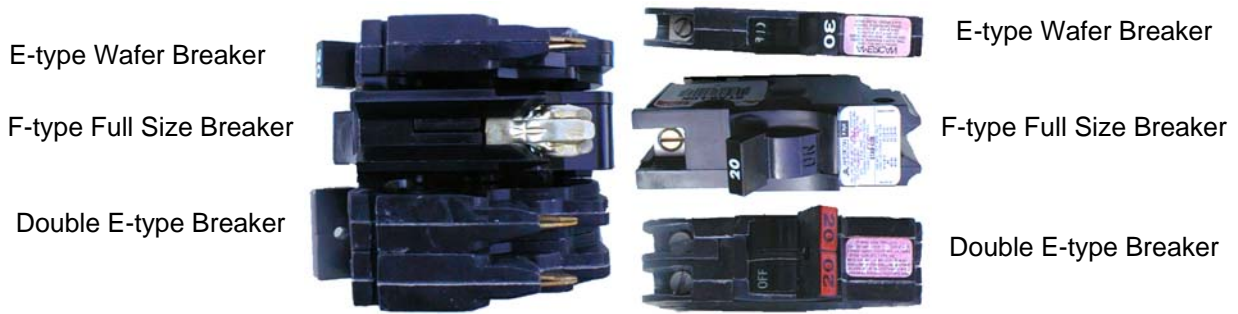


Figure 6 – “E” and “F” Breakers

Most panels accept two different sizes of breakers – full size and half size, or “wafer” breakers. By using the half-size breakers, the number of circuits in the panel can be doubled. Because more circuit breakers and more connected load will increase the heat on the bus bars, manufacturers must install some physical means of limiting the number of breakers that can be installed in the panel. Panels with an inherent limitation on the number of breakers are referred to by UL as “Class CTL” panels, and the breakers that go into them will also be categorized as Class CTL. Most panels can be completely filled with wafer breakers without exceeding the limits set by the UL standard, which assumes 10 amps of load per breaker pole per leg. By this formula, a 100 amp panel usually has a total of 20 bus stabs. An example of something that is a half size breaker, and not class CTL, would be certain models of Square D “piggyback” breakers.

FPE found a unique way of designing their wafer breakers and creating a limitation on the number of them that could fit in a CTL panel. Full size breakers have a stab that is perpendicular to the direction the breaker handle operates, and wafer breakers have a stab parallel to the direction of the breaker handle. The full size breakers stabs are referred to as “F” type, and the wafer breakers as “E” stabs (figures 6&7). FPE has two different styles of bus opening. An “E” type opening will allow either two “E” type breakers or one “F” type. An “F” type opening will only allow one breaker, of either type. The number of breakers that can fit in the panel

can therefore be limited by installing “F” type openings, instead of “E” openings.

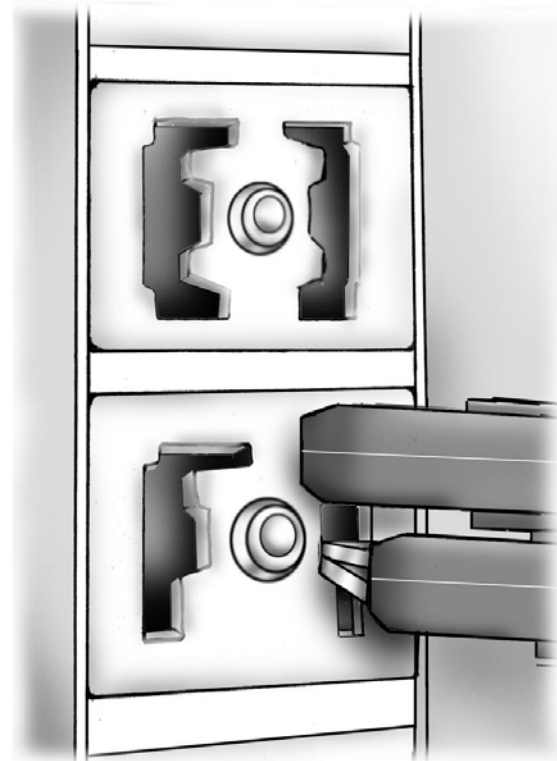


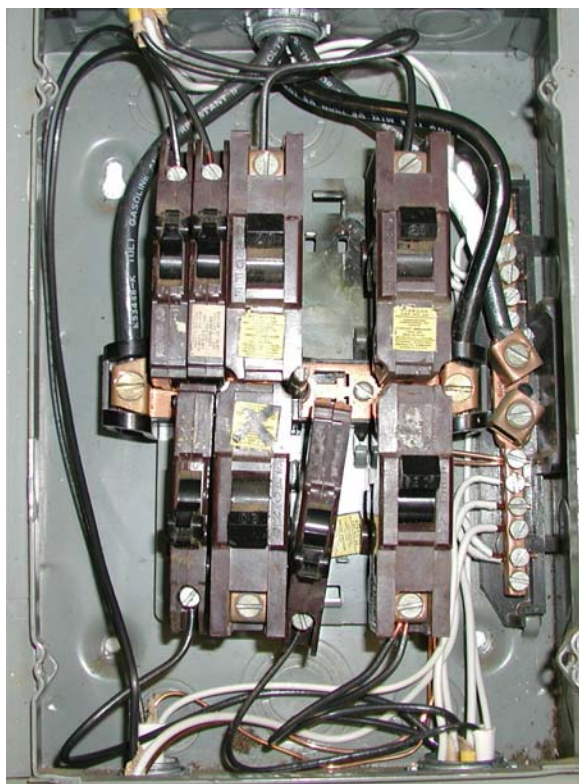
Figure 7 – “E” & “F” bus slots

The problem with this arrangement is that the “E” breaker stabs can be bent over and jammed into an “F” socket, and the result is another poor connection, as well as an overcrowded panel. Figure 7 illustrates this condition.



*Figure 8 – Damaged “E” type breaker*

Not only do “E” breakers make poor connection to “F” sockets, forcing them into the socket can damage them. The breaker may split when shoved into the slot, with the bus stab receding inside the breaker (figure 7). Since it is now making a very loose contact to the bus, the breaker might fall right out when the deadfront cover is removed (figure 9). Inspectors can be forewarned of this condition before taking off the cover. Simply look at the label for the panel to see where the “E” slots are located and whether any “E” breakers have been inserted into “F” slots. When finding that situation, there is no need to remove the cover to know that the breaker is in the wrong position.



*Figure 9 – Loose breaker*

If a home inspector points out the hazards of FPE breakers, there is a possibility they will be contradicted by an electrician who says he didn't see any problem in the panel. However, if they haven't taken the breakers out of the panel, they haven't really inspected it. While it is beyond the scope of a home inspection for an inspector to remove the breakers, an electrician could not make the same claim. They cannot possibly know if the bus is scorched or the breakers overheated unless they pull the breakers out and look. Breakers burn out from the back toward the front, not the other way around.

### **Product Defects**

The Federal Pacific Electric company was headquartered in New Jersey, and was acquired by Reliance Electric Company in 1979. A 1982 financial statement from Reliance indicated that they had learned that previous UL listings on FPE products had been obtained by “deceptive means” and that “as a result, most of the circuit protective products manufactured by Federal Pacific, at some point thereafter, lost their UL listing.” Reliance claimed that the deceptive practices ceased after their acquisition, and asked the Consumer Product Safety Commission (CPSC) to investigate. The CPSC performed their own tests on FPE breakers, and Reliance also hired their own independent testing company. Additionally, Reliance initially stated that their own in-house testing alerted them to potential problems with 2-pole circuit breakers. Shortly after these actions, the manufacture of FPE Stablok breakers under that name ceased, and for a time the breakers were manufactured under the Challenger name. Meanwhile, lawsuits were initiated between the purchasers and sellers of the prior company in its various business manifestations.

A company acquires a UL listing for its product, along with the right to use the UL insignia, by two basic steps. First, the manufacturer submits the product to UL for testing to a known standard of safety (for circuit breakers, the standard is UL 489). UL then tests the product against the foreseeable hazards outlined in the standard of safety.

The second step is for the manufacturer to allow unannounced field inspections from UL representatives to assure that the product is still being manufactured to the same specifications as those submitted for testing. Rather than repeating rumors about what may have occurred that constituted obtaining the listing by “deceptive means,” the test results themselves are the next item to examine.

The CPSC documents show the results from testing 122 2-pole breakers in 1982. The breakers were obtained directly from FPE as well as some that were purchased retail or taken from existing installations. The failure rate was higher after mechanical operations of the breakers, which seems contradictory to the recommendation that many inspectors make that breakers should be routinely operated to prevent them from “freezing” in place. Under UL 489 test conditions, the rate of failure to trip greatly exceeded the tolerances allowed by the standard. The full document showing the CPSC results is posted at the web site maintained by Dan Friedman (see below). At the same time the CPSC tests were performed, Reliance conducted their own testing, and disagreed with the results from the CPSC. They claimed a lower failure rate than the CPSC test results.

Considering that there was such a high failure rate in the CPSC tests, why were they not recalled? The answer, as with most such considerations, is tied up with the economics of the situation. The CPSC stated that they had insufficient data to accept or refute the claims from Reliance, and that it would cost several million dollars to conduct the necessary studies to determine if a recall was warranted. Their budget for 1983 was only 34 million, and they simply did not have the funds to pursue the issue. FPE was one of the most popular products of its time, and it is not the only old product that would merit such attention if we lived in a perfect world.

FPE also is not without its defenders. A 2-page letter in the May/June 1999 issue of IAIE News, the magazine of the International Association of Electrical Inspectors, defended FPE breakers. The article claimed that all listings of FPE equipment were valid, and that home inspectors calling the equipment “hazardous” were making unsupported recommendations.

One of the major sources of information on FPE failures, with documentation in the form of stories from the field and photographs of fires associated with FPE, is the web site maintained by Dan Friedman, at [www.inspect-ny/fpe/fpepanel.htm](http://www.inspect-ny/fpe/fpepanel.htm). When we look at documentation on this subject, it is important to consider the source. Mr. Friedman has no economic interest in the FPE controversy, though he does have a long history of consumer advocacy. The letter defending FPE was published anonymously, with the author only being identified as “the former quality manager of FPE.”

### **Replacement Breakers**

If the breakers themselves are the problem, should homeowners consider replacing the breakers and keeping the panel? At various times over the last 2 decades, different manufacturers have made after-market products designed to fit FPE panels. In some cases, these breakers have been made in Canada, Mexico, or China. Salvaged old FPE breakers are also available from specialty dealers. The breakers sold under the “American” brand (figure 10) are no longer UL listed, though they are listed by ETL, another nationally recognized testing laboratory. In all cases, replacement breakers are very expensive, with a single-pole 15 amp breaker costing as much as \$50. If one wanted to replace all the breakers in a panel, they could spend a great deal more than it would cost to replace the panel with modern listed equipment.



*Figure 10 – Replacement Stablok breaker*

Another consideration is the desire to install GFCI or AFCI breakers. GFCI breakers can sometimes be found in the specialty supply houses, and they are very expensive. Since GFCI protection can also be provided by receptacle outlets and other feed-through devices, the lack of available GFCI breakers is not a major issue. As of this writing, no listed AFCI breakers are available for FPE panels.

In Canada, a similar product, under the name “Federal Pioneer” is still available. They are a subsidiary of the parent company of Square D. Their web site did not include information on whether there is a third-party listing for the breakers, and they are limited to the Canadian market. Their site is

<http://www.schneider-electric.ca/www/txt/products/stablok/html/cb.htm>.

The Canadian company does make an AFCI breaker, though without an American third-party listing it would not be practical to install them in an old FPE panel. Federal Pioneer did issue a recall of circuit breakers manufactured between August 1, 1996 and June 11, 1997. In the words of the manufacturer “In some circumstances these breakers may not trip.”

### **The Home Inspector’s Dilemma**

Given this set of facts, what can inspectors say to their clients? In general, product defects and recalls are beyond the scope of a home inspection. Even if the CPSC were to request a recall of the product, such information would exceed the minimum standard of care for a home inspector. However, home inspectors who say nothing about it could find themselves with angry clients who wish that something had been said. If a purchaser calls an electrical contractor, and the contractor refuses to work on the system because it has an FPE panel, the clients could well blame the home inspector. I personally was not a believer until I witnessed a multiple failure of FPE breakers in a dead short. The branch circuit breaker, the feeder to the subpanel, and the main breaker all failed to open while a dead short carrying thousands of amps ran through the breakers. Those of us conducting the experiment heard a violent shaking that nearly tore the panel out of the wall, and the service wires whipped in the air from the magnetic fields created by the high currents going through the breakers. That experience was convincing. I continue to hear stories from the field, and Dan Friedman is always adding new ones to the web site.

I suggest that inspectors at least tell their clients that there is widespread information on defects with this product, and refer them to the CPSC data and other information on Dan Friedman’s web site.

*Thanks to Jay Balin for his editorial assistance, and to Mark Cramer for his usual keen perspective and for figure 5. Thanks to John McComas and Alan Block for bringing this safety issue to our attention. Portions of this article are taken from Electrical Inspection of Existing Dwellings, by Douglas Hansen, Redwood Kardon, and Michael Casey.*