It Worked, But It Wasn't Right!

by Dean K. Wilson, P.E.

Question: **Would you please comment on this recent occurrence? I knew something was wrong the moment I walked in the door. The first due engine company responding to a partial roof collapse at a two-story office building in our community, a victim of Hurricane Irene, had asked for a fire inspector. When I arrived, I noted that the fire alarm system annunciator inside the front door displayed a normal standby condition. When I went to the utility room to look at the main fire alarm system control panel, it also indicated a normal standby condition. This seemed curious since most of the roof had collapsed into the second floor of the building. A couple of dozen smoke detectors lay damaged on the floor. When I opened the panel I saw the problem immediately. The installer had placed the end-of-line resistors right across the terminals of the panel.**

First of all, please accept my most sincere sympathy for what you and your fellow fire fighters have had to endure during the past week: first an earthquake, then a hurricane. I can only image how these events must have taxed your resources.

My first reaction to your question made me want to ask: "What about the acceptance test on the system? Why didn't the original inspector discover this grievous error?" But then, I remembered a situation in my own experience, more than 30 years ago, when I discovered the very same problem during a comprehensive original inspection at a facility that insurance company where I worked intended to insure.

Like you, I opened the door to the fire alarm system control unit and discovered that the installing contractor had placed the end-of-line resistors across the terminals of each fire alarm initiating device circuit and each fire alarm notification appliance circuit. In other words, the monitoring for integrity of the fire alarm initiating device and notification appliance circuits ended at the end-of-line resistors in the panel, and never extended throughout the building to the field wiring. In this case, and in yours, it seems as if the installer did not understand the meaning of the words: "end-of-line!"

When I first told the story of what I had found to some of my friends in the fire alarm industry, one of my closest friends, who happened to operate a fire alarm system installation company, explained to me that a common practice among installers during the early stages of an installation included placing the end-of-line resistor directly across the terminals of each initiating device circuit and each signaling line circuit. This practice allowed the installer to apply operating power to the fire alarm system control unit without having the panel indicate a "trouble" condition.

Obviously, the installer would have to remember to remove these temporary end-of-line resistors when he or she proceeded to install fire alarm initiating devices or notification appliances. But, in my case and yours, the installer completely forgot this important step in the installation process.

NFPA 72-2010, *National Fire Alarm and Signaling Code*®, makes it clear in Chapter 14 that an initial acceptance test has two critical parts: visual inspection and initial testing. Both parts of the acceptance process contribute significantly to the baseline for quality assurance. That baseline allows the building owner to verify the long-term operability of the system by comparing the current system conditions to the baseline acceptance test.

The *Code* requires a visual inspection as follows:

> **14.3.1*** Unless otherwise permitted by 14.3.2 visual inspections shall be performed in accordance with the schedules in Table 14.3.1 or more often if required by the authority having jurisdiction.
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> **A.14.3.1** Equipment performance can be affected by building modifications, occupancy changes, changes in environmental conditions, device location, physical obstructions, device orientation, physical damage, improper installation, degree of cleanliness, or other obvious problems that might not be indicated through electrical supervision.
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> The intent of 14.3.1 is to prevent an inspection being made at intervals exceeding those allowed by Table 14.3.1. Annual inspections should be made every 12 months; monthly inspections should be made every 30 days, and so forth. For example, it is not acceptable to conduct an annual inspection in January of year one, and December of year two (23 month frequency) just because Table 14.3.1 requires an inspection once each year.
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> **14.3.2** Devices or equipment that is inaccessible for safety considerations (e.g., continuous process operations, energized electrical equipment, radiation, and excessive height) shall be permitted to be inspected during scheduled shutdowns if approved by the authority having jurisdiction.
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> **14.3.3** Extended intervals shall not exceed 18 months.
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> **14.3.4** The visual inspection shall be made to ensure that there are no changes that affect equipment performance.

It seems obvious to me that, in either of our cases, a proper visual inspection would have disclosed that the installing contractor had not removed the temporary end-of-line resistors. If the inspector had actuated the initiating devices, they would likely operate properly and cause the notification appliances to operate, as well. But, in addition, the inspector should have witnessed the required tests for each fire alarm initiating device circuit and each fire alarm notification appliance circuit, as required in Table 14.4.2.2, Item 12

Table 14.4.2.2 *Continued*

Device	Method
12. Conductors — metallic	
(a) Stray voltage	All installation conductors shall be tested with a volt/ohmmeter to verify that there are no stray (unwanted) voltages between installation conductors or between installation conductors and ground. Unless a different threshold is specified in the published manufacturer's instructions for the installed equipment, the maximum allowable stray voltage shall not exceed 1 volt ac/dc.
(b) Ground faults	All installation conductors, other than those intentionally and permanently grounded, shall be tested for isolation from ground per the installed equipment manufacturer's published instructions.
(c) Short-circuit faults	All installation conductors, other than those intentionally connected together, shall be tested for conductor-to-conductor isolation per the published manufacturer's instructions for the installed equipment. These same circuits also shall be tested conductor-to-ground.
(d) Loop resistance	With each initiating and indicating circuit installation conductor pair short-circuited at the far end, the resistance of each circuit shall be measured and recorded. It shall be verified that the loop resistance does not exceed the limits specified in the published manufacturer's instructions for the installed equipment.
(e) Supervision	Introduction of a fault in any circuit monitored for integrity shall result in a trouble indication at the fire alarm control unit. One connection shall be opened at not less than 10 percent of the initiating devices, notification appliances and controlled devices on every initiating device circuit, notification appliance circuit, and signaling line circuit.

As you can see from the requirements in this Table, if the inspector had witnessed these circuit tests, the tests would have disclosed the lack of proper monitoring for integrity. In addition, if the company performing annual testing and maintenance had performed a proper visual inspection each year, they, too, would have found the forgotten end-of-line resistors.

Inspection, testing, and maintenance—performed in accordance with the requirements of NFPA 72-2010, *National Fire Alarm and Signaling Code*®—helps prevent problems such as the one you encountered in the aftermath of Hurricane Irene. Sometimes, even when a fire alarm system appears to work properly, it still may have installation flaws that will prove seriously fatal at some point in the life of the system.

If you're at all like me, you probably wonder how many other fire alarm control units in your jurisdiction have this same problem. I would suggest you make a point to check on them.

IMSA member Dean K. Wilson, P.E., FSFPE, C.F.P.S., now retired on disability, formerly worked as a Senior Engineer in the Erie (PA) office of the fire protection engineering and code consulting firm, Hughes Associates, Inc. (www.haifire.com.). The opinions expressed in this article are strictly his own. You may reach him by e-mail at deanwilson@roadrunner.com or by telephone at 814-397-5558.