

Addressable Notification Research Results

New Research Validates Benefits of Addressable Notification Appliances

Studies conducted by researchers from two of the country's most prestigious fire protection engineering universities have recently concluded that addressable notification technology offers reliable and cost effective advancements in fire alarm and signaling systems.

The studies were commissioned by Johnson Controls and were designed to compare the cost of the company's Simplex TrueAlert ES line of addressable notification appliances to the cost of conventional, non-addressable appliances, and to explore the reliability of what's become one of the most valuable features of its addressable notification products: The ability to self-test also referred to as automated testing in NFPA 72 14.2.8¹.

This paper details the content and results of the studies conducted by researchers at Worcester Polytechnic Institute and the University of Maryland.

Operational Value & System Performance Study Is Addressable Notification Cost Effective?

The purpose of this study was to examine cost differentials of the Simplex TrueAlert ES line of addressable notification appliances compared to conventional, non-addressable appliances for a specific building. The study was conducted at the request of Johnson Controls and the company's Product Manager for Notification, Bruce W. Marien.

"One of the things that we hoped the research would show was that although some aspects of addressable notification equipment have a higher first cost, the cost to install ultimately ends up lower for a variety of reasons," said Marien. "And I believe that was demonstrated by the study."

A faculty member at Worcester Polytechnic Institute (WPI), in Worcester, Massachusetts, was selected to conduct the study. Home to the first master's program and one of only three fire protection engineering graduate programs in the United States, WPI's Fire Protection Engineering Department drives significant cutting edge research, develops real-world solutions through its state-of-the-art fire laboratories, and educates influential,

in-demand engineering experts. The study was conducted independently by Professor Milosh Puchovsky, PE, FSFPE, Professor of Practice and Co-Director, Center for Global Public Safety in the Department of Fire Protection Engineering.

"Johnson Controls came to us because they wanted a neutral, unaffiliated third party to take a look at the differences in equipment and installation costs between addressable and conventional notification devices," said Puchovsky. "And at first, I was admittedly surprised by what I found."

¹ NFPA 72 14.2.8 Automated Testing. (2013 Edition)

14.2.8.1 Automated testing arrangements that provide equivalent means of testing devices to those specified in Table 14.4.3.2 at a frequency at least equivalent to those specified in Table 14.4.3.2 shall be permitted to be used to comply with the requirements of this chapter.

14.2.8.2 Failure of a device on an automated test shall result in an audible and visual trouble signal.

Operational Value & System Performance Study

Scope of the Study

The study compared the costs of equipment and installation in a nine-story medical research and training facility, with each floor encompassing 47,840 sq ft. Floors one and two were parking; floors three through nine contained offices, procedure rooms, laboratories, lecture/training halls, support and storage rooms.

Two notification system designs were developed. The fire alarm system design utilizing “smart” addressable notification appliances was completed by a design team at Johnson Controls. A comparable design utilizing conventional, non-addressable appliances was provided by third-party engineering design firm Jensen Hughes.

Both designs followed the 2013 edition of NFPA 72, offered the capability of voice announcements and had the same layout including the number of devices and appliances. The same fire alarm control equipment was specified for both systems except where internal panel equipment was needed to support the associated non-addressable notification appliances and features. Simplex branded fire detection and alarm equipment was specified for both systems. Price quotes for the necessary equipment were provided by Johnson Controls.

The two designs were then presented to an electrical contractor, who estimated the project as if it was actually going out to bid. Then, both the designs and the estimates were presented to Professor Puchovsky at WPI who analyzed the data and submitted a report.

Study Results

*Summary: Addressable appliances resulted in a **4.57% reduction in cost** when compared to a system using conventional appliances.*

The study delivers quantifiable results that during system installation, fire alarm systems utilizing addressable notification appliances offer certain cost advantages.

“Initially I thought this would have been a bit more expensive to use the newer technology but when the price quotes came back, I was actually surprised that this was not the case,” said Puchovsky. “As I looked closer at the designs, the numbers made more sense because addressable notification technology can be installed in a more efficient manner, and requires less overall power to operate.”

The lower cost is achieved through a combination of more efficient wiring, the need for fewer system components and smarter use of power. The cost differentials are summarized in the following table and detailed below.

Addressable System Wiring: 75,648 ft.		Conventional System Wiring: 81,350 ft.		Delta
Fire Alarm Equipment	\$270,579.00	Fire Alarm Equipment	\$280,080.00	\$9,501.00
Electrical Materials	\$ 34,706.98	Electrical Materials	\$ 36,463.69	\$1,756.71
Installation Labor	\$241,683.84	Installation Labor	\$256,616.24	\$14,932.40
Total Cost	\$546,969.82	Total Cost	\$573,159.93	\$26,190.11

Operational Value & System Performance Study

Wiring Materials and Costs

Summary: The addressable notification system utilized 75,648 ft of wiring while the conventional system utilized 81,350 ft of wiring. This results in 5,702 ft less wiring materials for the addressable system.

The difference in required wiring is largely attributed to two factors: Addressable appliances require less power than conventional devices and their circuits can be “T-tapped.” Because the power supply demands are decreased for addressable appliances, there are fewer voltage drops throughout the connecting circuits. This gives the designer the flexibility to either increase the length of individual notification appliance circuits and place more addressable appliances on each circuit, or decrease the wire size of each circuit and place the same number of addressable appliances as a conventional circuit.

“T-tapping” allows for more efficient and flexible wiring installation. In preparing the cost estimates, the electrical contractor reviewed both designs, performed wiring takeoffs and estimated electrical material quantities and costs for both systems. Because T-tapping was allowed for the addressable system, the designers took advantage of utilizing shorter circuit lengths that resulted in the need for less wiring materials.



Electrical Materials and Costs

Summary: Overall electrical material costs of the conventional notification system were \$36,463.69, while the corresponding costs for the addressable notification system were \$34,706.98. This resulted in a material cost savings of \$1,756.71 for the addressable system.

In addition to wiring, other electrical materials such as conduit, junction boxes, connectors, fasteners, etc. are needed to complete the installation. The third party electrical contractor estimated the quantity and costs for these materials.

The following table summarizes the costs for all electrical materials including wiring for the addressable and conventional systems. The plans for each floor are divided into two parts – a West (W) and East (E) section.

Floor / Dwg	Materials Conventional System	Materials Addressable Systems	Materials Delta
P2W	\$1,295.12	\$1,459.14	-\$164.02
P2E	\$3,046.33	\$3,119.21	-\$72.88
P1W	\$1,627.35	\$1,792.98	-\$165.63
P1E	\$1,044.93	\$648.01	\$396.92
1W	\$2,463.92	\$1,877.96	\$585.96
1E	\$1,791.19	\$1,605.67	\$185.52
2W	\$3,098.53	\$2,963.50	\$135.03
2E	\$2,030.77	\$1,900.92	\$129.85
3W	\$3,214.15	\$3,194.35	\$19.80
3E	\$1,910.42	\$1,728.21	\$182.21
4W	\$2,933.50	\$2,899.02	\$34.48
4E	\$2,017.68	\$1,889.66	\$128.02
5W	\$3,048.36	\$2,914.70	\$133.66
5E	\$2,046.18	\$1,890.16	\$156.02
6W	\$1,806.55	\$1,667.13	\$139.42
6E	\$1,192.38	\$1,181.25	\$11.13
7W	\$1,629.44	\$1,670.53	-\$41.09
7E	\$266.89	\$304.58	-\$37.69
Totals	\$36,463.69	\$34,706.98	\$1,756.71

Operational Value & System Performance Study

Installation Labor

Summary: Overall labor hours for the conventional notification system totaled 4,539.47 hours, while the corresponding labor hours for the addressable notification system totaled 4,275.32 hours. This resulted in 264.15 less labor hours required for the installation of the addressable system.

As part of its estimate, the electrical contractor estimated the labor hours necessary to install the associated electrical materials and fire alarm equipment, which is shown on the following table.

Floor / Dwg	Hours Conventional System	Hours Addressable Systems	Hours Delta
P2W	192.92	203.08	-10.16
P2E	366.64	372.91	-6.27
P1W	203.88	214.79	-10.91
P1E	132.50	78.32	54.18
1W	298.49	230.99	67.50
1E	193.63	177.76	15.87
2W	351.58	335.23	16.35
2E	252.03	234.58	17.45
3W	413.01	406.67	6.34
3E	244.13	214.97	29.16
4W	370.49	362.10	8.39
4E	251.14	233.08	18.06
5W	386.44	364.59	21.85
5E	254.78	234.84	19.94
6W	252.36	222.46	29.90
6E	161.99	156.45	5.54
7W	180.97	195.26	-14.29
7E	32.49	37.24	-4.75
Totals	4539.47	4275.32	264.15

The decrease in labor hours for the addressable system as compared to the conventional system can be attributed to two key factors. T-tapping and decreased power demand requirements. T-tapping allows for more efficient routing and connecting of circuits. The decreased power demand results in lower voltage drop so circuits can either be longer decreasing the overall number of circuits that need to be installed and connected, or the circuits can be comprised of smaller conduit that is easier to bend and generally work with.

When considering an electrical journeyman labor rate of \$56.53 per hour, this produces a total labor cost of \$256,616.24 for the conventional systems and \$241,683.84 for the addressable system resulting in a labor cost savings of \$14,932.40 for the addressable system.

"I was happy to see the results of the research," said Marien. "I had been working as a technical instructor for SimplexGrinnell when the first generation of addressable notification was launched. I was impressed by it then, and continue to see the very distinct advantages offered by this technology. I believe strongly that addressable notification is a positive leading technology for making buildings safer and smarter, which is why I have accepted a position as the Product Manager for notification."



The University of Maryland Study: Can the Self-Test Feature Be Trusted?

Addressable notification devices use technology to assess whether a device in a system is in working order without requiring an individual to stand next to the respective units. Sensors within each appliance monitor if the visual aspect of the device makes a flash and whether the audible aspect makes noise.

"What addressable notification does with the self-test function is actually allows you to push a button on the fire panel, the system will test the appliances for no more than 5 seconds and it reports back at the fire panel, by individual device, the status of them. Typically this means it emits a single chirp and it flashes three to five times," said Connell. "But we're often asked, 'How do you really know that the self-test results are, in fact, true?'"

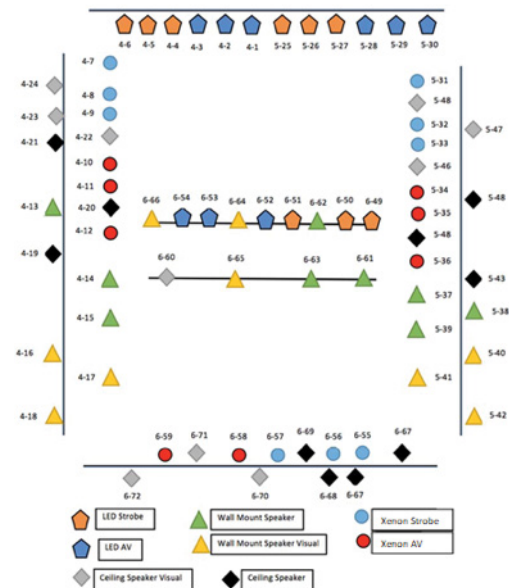
At the request of Johnson Controls, a research group at the University of Maryland was asked to evaluate the effectiveness of the self-test regimen in the company's Simplex TrueAlert Addressable Notification Appliances.

"The idea was to do an analysis of the appliances in our lab to see if they could report their status back to the control panel as claimed by Johnson Controls," said Dr. James Milke, PE, FSFPE, Professor and Chair of the Department of Fire Protection and Engineering. "Until our study, no independent body had taken a look at that or documented what they did."

Research Design

The system design used in the study was provided by Johnson Controls and consisted of 72 notification appliances, connected to a 4100ES control panel with 50 feet of wiring between each appliance. The array of notification appliances functioned as specified in the automated test section of NFPA 72 and included LED strobes, LED AVs, Xenon Strobes, wall mounted speakers, wall mounted speaker visuals, ceiling speakers, and ceiling speaker visuals. The control panel illustrated in the following figure was utilized to initiate each test and produce an output report. The output report included a status report to indicate whether each notification appliance worked properly or noted "trouble" if there was an error during the test.

Two sets of tests were conducted in the research program, comparing one-story, four-story and eight-story buildings with both addressable and non-addressable design.



The University of Maryland Study

"Part of our role was not just to put it through the general testing routine, the easy routine, but to try and play devil's advocate," said Dr. Milke. "We wanted to see if there were ways we could get it to fail without being too contrived."

One set was conducted each day at 11:00 p.m. The daily tests included the 54 strobe, speaker or combination speaker-strobe devices. In addition, several unique tests were conducted to challenge the accurate reporting of the self-test results by incorporating a selected condition. The selected condition was incorporated to determine if the self-test regime would report a false positive, i.e. indicating that the system was "normal" despite having a non-operational appliance.

Special tests included tests to assess the potential for:

- A sensor within a nonoperational strobe unit to observe an operating strobe in an adjacent appliance to yield a false positive
- A sensor within a nonoperational strobe unit to observe an external light to yield a false positive
- A report from a nonoperational speaker unit to report a false positive
- An excessive voltage drop (from an additional length of wire) to lead to inappropriate reports from the self-tests
- To miss a second disabled unit, a strobe-horn device.

In all, 79 daily and special test configurations were conducted to observe the self-test capability of the Simplex TrueAlert ES Addressable Notification Appliances. The alternate test configurations were intended to significantly challenge the self-test capability, in some cases by imposing an extreme condition. The intent of such extreme tests was to explore the boundary for correct performance.

Study Results

*Summary: The self-test capability **detected non-operational units in every test.** (100%). In addition, false negatives (identifying a non-operational device even though it had performed properly) were minimal (0.9%). The test also confirmed the appliances function as specified in the automated test section of NFPA 72.*

"We were able to demonstrate that even in less-than-ideal conditions the system worked as described in the manufacturer's literature," said Dr. Milke. "From everything we saw, I felt that it was a trustworthy system, for sure. It provides reliable reports back of status and that has huge implications for maintenance and confirming operability, which would be a huge cost saving to the industry."

Johnson Controls Senior Manager of Life Safety Systems Tom Connell said he was pleased and relieved that the product claims were validated by the University of Maryland study. "It worked exactly the way that we said it would. I guess the only thing that surprised me is that they deliberately tried to trick a sensor into thinking that the self-test was going on, to get a false report, and the sensors weren't able to be spoofed. That was a pleasant surprise because we hadn't done that."

The proven accuracy will bring peace of mind to both building owners and occupants, according to Dr. Milke who led the study. "With a non-addressable system, you're relying only on a periodic test—monthly or semi-annually—so you know it's working on those days, but what about all the days in between?" he said. "You're hoping that the last test is indicative of what goes forward. But this provides an opportunity on a very regular basis to know it's working each and every day. You don't have to wait for the contractor to come in to do that test. And that should be a huge benefit for peace of mind."



The Future for Addressable Notification

Inside the classrooms at Worcester Polytechnic Institute and the University of Maryland, where the two studies were conducted, professors Puchovsky and Milke say addressable notification systems are already part of the discussion of next-generation, automated systems. And the results of their tests will add insight to the conversation.

"The question about automation has always been all about reliability," said Dr. Milke. "There's been a lot of suspicion about whether it can do the job. But here's a situation where it appears to do right as advertised. And it does a very nice job in providing a reliable output. I think that's a win for everybody involved."

Outside the classroom, Puchovsky said the study results are likely to gain the attention of building owners, engineers and contractors who are traditionally focused on first cost. "Most folks I talk to out in the field are crazy busy. Life is good, the economy is moving along, and they want to build fast and start turning revenue. But after conducting this cost analysis, I'd tell them, 'Hey, this is actually an option. And if you take just a few minutes out of your busy, busy life to hear about this, it may make your life a lot easier down the road and more profitable.'"

Beyond its end-to-end cost effectiveness and proven fire safety capabilities, Johnson Controls Senior Manager Tom Connell sees a much broader future use for addressable notification.

"For example, it's my belief the speaker variant of our addressable technology is the future of the entire industry," he said. "I believe in the next five years nobody will be using piezos or chimes or anything like that anymore, because all of those things can be duplicated using a speaker. And you also get the added benefit of being able to use voice, which allows us to use the fire alarm system as the core infrastructure for other notifications like paging K-12 classrooms and life safety communications such as directed evacuations."

Whether planning for future scalability or addressing the need to enhance fire safety today, the analysis conducted by researchers Worcester Polytechnic Institute and the University of Maryland leaves no doubt about the benefits of the Simplex TrueAlert ES line of addressable notification appliances.

For engineers, the product allows for easier system design and wiring layout which reduces installation costs. For contractors, addressable notification makes installation easier and safer. And for building owners, TrueAlert ES minimizes disruption of building occupants, enhances fire safety and is scalable to meet future needs.

All stakeholders; engineers and architects, contractors, and customers can experience positive results by specifying and using TrueAlertES addressable notification technology. A proven technology with superior performance. More information can be found at www.simplex-fire.com.

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University of Maryland

The Department of Fire Protection Engineering was established within the Clark School of Engineering in 1956. It focuses on recent advances in material testing practices, fire detection, performance-based design and modeling techniques to predict fire growth, smoke movement or the response of building systems in design and fire investigation applications. The laboratory facilities provide hands-on experience with "standardized" ASTM test procedures and permit the investigation of fire dynamics principles. It offers a fully ABET accredited undergraduate program and one of three graduate degree programs in the U.S.

fpe.umd.edu

Worcester Polytechnic Institute

WPI's Fire Protection Engineering Department is focused on making the world safer by tackling challenging questions about fire behavior and our response to it. Students work alongside them in state-of-the-art facilities to gain and create knowledge that informs and shapes regulatory policy, building design, manufacturing processes, first responder operations, and product performance standards. It is home to the first master's program and one of only three fire protection engineering graduate programs in the United States.

www.wpi.edu/academics/departments/fire-protection-engineering

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