



Fire Alarm Systems . . . Getting It Right The First Time

By Merton Bunker, P.E., CFEI
Merton Bunker and Associates

Did you have to re-submit shop drawings to the Authority Having Jurisdiction (AHJ) on your last project? Did you need to schedule a retest with the AHJ on your last project? Did you lose money on your last project? If you answered “yes” to any of these questions, you may have a fire alarm acceptance problem.

Obtaining AHJ approvals and passing a fire alarm inspection or acceptance test the first time is not an easy task for many fire alarm designers and installers. Poor design practices, failure to understand code requirements and a general lack of planning can prevent acceptance of design/shop drawings by the AHJ. Poor programming, detector placement, misapplication of products, and other poor installation practices can, and usually do, prevent installers from passing inspections and acceptance tests the first time out.

It is very important to design and install fire alarm systems properly from the beginning. It is also imperative that the installer be ready for the tests when the AHJ comes to witness them. Good planning and execution will save time and money. More importantly, it will result in a better life safety system.

So, you might ask “What’s in it for me?” Getting it right the first time results in higher profits, better relations with authorities having jurisdiction, fewer punch list items, fewer legal problems, and increased pride in workmanship.

This article explores some of the most common failures by designers and installers, and ways to mitigate problems with your next project. In all cases, we take a three-pronged approach taking on designs and reviews, installation, and acceptance testing. This approach is sometimes referred to as “commissioning”.

Successful Projects Start with Good Planning

Many fire alarm system designers have experienced rejection of plans and submittals. It is usually because of inadequate planning and research of local codes and amendments. Additionally, a lack of understanding of codes will also result in a bad design that is likely to be rejected, too. Many designers, including the author of this article have experienced plans rejection by the AHJ. But it doesn’t always have to be that way. The old adage “There is no substitute for hard work” still holds true.

Before designing any system, we must start with a basis of design. The basis of design is the road map we use to determine:

- (1) Applicable codes and standards
- (2) Local amendments
- (3) Occupancy Type/Use Group
- (4) Fire protection system requirements (type and coverage of systems)
- (5) High-rise requirements
- (6) Special hazard requirements
- (7) Additional user/stakeholder requirements

The basis of design must be developed before starting any system design because it defines all fire protection system requirements. Developing the basis of design forces the designer to focus on what is actually required. From the Basis of design, the designer can then, and only then, develop the project specifications and drawings.

Keep in mind that specifications frequently contain additional requirements (beyond code) that must be followed, such as use of certain materials or methods. However, specifications are not developed in a vacuum. Other parties, such as the AHJ, must be consulted when developing a basis of design.

The AHJ is just one of the stakeholders and he or she must be consulted in order to avoid wasting time by heading in the wrong direction. Working with the AHJ, rather than against the AHJ will definitely help matters. This doesn’t mean the designer has to give on every issue. Respect all parties, understand the codes, ask questions, and work toward a compromise when there is disagreement. There can be many authorities having jurisdiction. These may include, but not be limited to the fire marshal, electrical inspector, building code official, insurance interests, and building owner.

The system owner must also be consulted and the designer must explain all options so he or she can make an educated decision on matters concerning the system. Most building owners want to simply meet code. It is the designer’s job to educate the owner so they understand this may not be in their best interest. However, some owners are proactive and will listen to reason. They may even have special requirements of their own.

Good communication is critical to obtaining approvals. Most authorities having jurisdiction and other stakeholders will be more than happy to spend a few minutes on the phone or in person discussing your project approach. They can offer insight on local requirements that you may not know about. It is recommended that minutes be recorded during each meeting, and copies must be provided to all attendees. Doing this extra bit of homework will help grease the ways for reviews and acceptance of plans and submittals.

Plans and submittals must conform to project specifications and applicable codes and standards. NFPA 72, *National Fire Alarm Code* contains requirements for design documents and for those developing design documents. However, NFPA 72 is not a design manual for untrained persons. Consult a trained fire protection design professional as needed. They can save time and can offer advice. Most good fire alarm designers can save the cost of their fees on any given project.

Section 4.3.2 of NFPA 72 requires the system designer to be qualified and experienced in the design of fire alarm systems. Section A.4.3.2.2(2) provides minimum recommended levels of

Continued on page 33

IMSA Journal

Fire Alarm Systems . . . Getting It Right The First Time *Continued from page 32*

qualification, including IMSA Fire Alarm Certification. Some jurisdictions have local requirements, and may permit or prohibit some parties from design work unless properly licensed (e.g., Professional Engineer). Having a qualified designer on your team will almost always result in better quality products that are accepted more quickly. Many state licensing boards prosecute those who design without proper licenses. The reader is cautioned to understand and comply with all local laws regarding this issue.

Shop drawings must contain a minimum amount of information in order to be used in the field. Section 4.5.1.1 requires complete drawings, calculations, matrix of operation, and specifications to be submitted for approval. Although the content of shop drawings is not specified in the body of the Code, Section A.4.5.1.1 recommends the following items be included on all design documents:

- (1) Name of owner and occupant
- (2) Location, including street address
- (3) Device legend
- (4) Date
- (5) Input/output programming matrix
- (6) Floor identification
- (7) Point of compass
- (8) Graphic scale
- (9) All walls and doors
- (10) All partitions extending to within 15 percent of the ceiling height
- (11) Room descriptions
- (12) Fire alarm device/component locations
- (13) Locations of fire alarm primary power connection(s)
- (14) Locations of monitor/control interfaces to other systems
- (15) Riser diagram including locations & number of risers
- (16) Type and number of circuits in each riser
- (17) Routing for Class A compliance, where applicable
- (18) Ceiling height and ceiling construction details
- (19) General arrangement of the system, in building cross section
- (20) Identification of the control equipment depicted
- (21) All field wiring terminals and terminal identifications
- (22) All circuits connected to field wiring terminals, and circuit identifications
- (23) All indicators and manual controls, including the full text of all labels

- (24) All field connections to supervising station signaling equipment, releasing equipment, and fire safety control interfaces
- (25) Typical wiring diagrams for all initiating devices, notification appliances, and power supervisory devices.

Good shop drawings will facilitate better installations because they provide more complete information.

The primary reasons for failure at this phase of the project are:

- (1) Incorrect code references
- (2) Didn't include applicable amendments
- (3) Didn't include stakeholders
- (4) Designer didn't understand the code
- (5) Drawings didn't contain correct information

Take the time to develop a good basis of design, specifications, and design drawings. Think of this as an opportunity, not a problem. Designers who do these things may exert a bit more effort, but they are often rewarded with more projects.

Installing the System

Qualified installers are essential for the successful completion of a project. Section 4.3.3 of NFPA 72 requires the system installer to be qualified or supervised by persons who are qualified in the installation, inspection, and testing of fire alarm systems. Section A.4.3.3(2) provides recommended examples of qualified installers, which includes IMSA Fire Alarm Certification. Qualified installers know and understand installation requirements contained in the Code, which will help ensure compliance at the time of inspection.

Some projects fail because the installation doesn't comply with the applicable codes, standards, and specifications. But others fail because of a poor design. Some projects suffer both fates. However, a good design will help eliminate many problems...if it is followed. A good installation will always closely follow approved plans and submittals.

Continued on page 34

Fire Alarm Systems . . . Getting It Right The First Time *Continued from page 33*

Many fire alarm systems are installed by electrical contractors because a significant part of the system is wiring. Therefore, shop drawings must be complete, so that any qualified installer could install the system without much supervision. This requires detailed drawings showing typical mounting details, wiring schedules, and other important information. The drawings also need to be on the job site, and must be kept up to date (red-lines) by the installer.

The primary reasons for failure during the installation phase are:

- (1) The installer isn't following approved plans and specifications
- (2) The plans are vague and don't contain sufficient details
- (3) The approved drawings are not on the project site
- (4) The installer isn't keeping red-line drawings up to date
- (5) A lack of communication between the installer and other disciplines

Designers are not infallible and make mistakes. Additionally, unforeseen building conditions may make changes necessary. Any questions on the design should be brought to the designer's attention through a Request For Information (RFI). A RFI will not only serve to clarify the issue at hand, but records the issue in writing for the project file. Fire alarm projects take teamwork. If the installer suspects a problem, it should be immediately flagged back to the designer.

Other problems may include a failure to install equipment in the prescribed (listed) application. All fire alarm system equipment must be listed, and the instructions included with the product must be followed. For example, some manual fire alarm boxes require the use of a back box. Some permit mounting by screws alone. Be sure the instructions that come with the device are followed.

Smoke detectors that are improperly placed near air diffusers or in dead air spaces will not operate properly. Sections 5.6.3.1, 5.7.3.2.1 and 5.7.5.3.2 contain specific requirements for the location of heat and smoke detectors. Most authorities having jurisdiction will fail the system installation when these devices are improperly installed. Improperly installed smoke detectors are rejected by the AHJ for a good reason: they will cause nuisance alarms or won't work during a fire.

Other common problems include the installation of smoke detectors outdoors or areas where temperatures dip below 32 °F (0 °C), are over 100 °F (38 °C), where the humidity is over 93%, or where there are particulates present. These requirements are also found in Section 5.7.1.8 of NFPA 72. Failure to place detectors in the proper environment will result in failure by the AHJ and will cause nuisance alarms. Again, the installer is encouraged to contact the designer when he or she suspects an improper application.

Misapplication of products is a common occurrence. For example, a visible notification appliance (strobe) listed only for wall mounting is mounted on the ceiling. The appliance will not properly alert occupants unless installed according to its listing. Installing devices and appliances listed for dry locations on the exterior of a building is another common misapplication of a product. This often results in ground faults and premature failure of the equipment.

Fire alarm system wiring requirements can be a bit of a mystery to many installers. One key is to closely follow the requirements contained in Article 760 of NFPA 70, *National Electrical Code* (NEC). The NEC is primarily concerned with shock and fire hazards and it will permit the installer to use methods and materials that the manufacturer may not allow. For example, some manufacturers require shielded cable for signaling line circuits, while others may not allow shielded cable. The NEC permits either type of cable for fire alarm systems.

T-Tapping circuits is generally not permitted by NFPA 72. The only exception is Class B signaling line circuits. T-Tapping any other circuits will result in circuits that are not monitored for integrity. Some project specifications do not permit T-Tapping, so be sure to read them thoroughly.

Many ground faults and open circuits are caused by poor wiring practices. All conduits must be properly de-burred so the conduit doesn't cause damage to conductor insulation, which usually results in a ground fault. Also take care to ensure the bare part of conductors do not touch the metallic enclosure or back box. When using compression type fittings, be sure they are properly connected in accordance with manufacturer's instructions. Another common cause of ground faults is the use of ordinary wiring in underground (wet) locations. Only conductors and cables listed or approved for wet locations should be run underground.

The NEC also requires conductors to be properly supported. Cables installed within seven (7) feet of the floor must be protected from damage by using raceways, fishing inside walls, or by using building features. Cables installed above suspended ceilings must be supported independently from the ceiling grid supports. Device boxes must also be supported independently from the ceiling tiles.

Branch circuits for fire alarm systems must be dedicated to the system. No other outlets, such as a receptacle or luminaire (lighting fixture), may be connected to this branch circuit. The location of the disconnecting means must be identified at the fire alarm control unit, and the disconnecting means must be identified as FIRE ALARM CIRCUIT CONTROL at the panelboard. Finally, the disconnecting means must be red in color, and protected against unauthorized use by locking the panelboard, room, or disconnecting means.

All suppression systems installed in the protected premises must be connected to the fire alarm system, so that their actuation causes an alarm. Sections 6.8.5.5 through 6.8.5.7 of NFPA 72 require alarm signals upon actuation of the fire alarm system. Subsequent sections also require supervisory signals to be annunciated on suppression systems. The site-specific software must be properly programmed, so that the correct signals are received.

Waterflow switches and valve supervisory (tamper) switches can be problematic. Depending on the contract and jurisdiction, the sprinkler contractor may install these devices. In all cases be sure you know who is responsible, and be sure they are properly adjusted prior to testing the system. Waterflow switches may require adjustment to the delay (retard) to ensure they don't cause an alarm when surges occur on the sprinkler system.

Wall mounted combination audible/visible notification appliances are frequently installed at the incorrect mounting height. This is often because the back box for the appliance is mounted at the proper height for a single visible notification appliance without an audible component. The plate for a combination appliance is sometimes mounted so the visible appliance is much higher or lower than the back box. Be sure to read the instructions before roughing-in the box for these appliances.

The above installation problems are but a small sampling of the types of violations found in the field. Of course, there are many other types of installation issues that could be discussed. However, a lack of space will limit our discussion of this topic.

Acceptance Tests – Are You Really Ready?

Were you or your technician making last minute changes to site-specific software when the AHJ arrived to witness your last test? This is a clear sign that the installer isn't ready to test the system, and implies that a pretest was either not conducted or went wrong.

Many acceptance tests go afoul because the installer is not ready. Authorities having jurisdiction generally will not accept a system that fails to meet all required tests or is not properly installed. Unfortunately, many authorities having jurisdiction have very busy schedules and long waiting periods for re-scheduling acceptance tests. Fortunately, there are ways to prevent these problems, such as pre-inspections and tests by the contractor.

Section 4.5.1.2 requires the installer/contractor to provide the AHJ with a written statement that the system is installed in accordance with approved plans and specifications, and that it has been pre-tested. Pre-testing is essential to the smooth completion of a project because problems are ferreted out while there is time to correct them. All pre-tests must be conducted as if they were an actual test for the AHJ.

Chapter 10 of NFPA 72 contains all requirements for inspection and testing of fire alarm systems. Chapter 10 is not optional, where NFPA 72 adopted in the jurisdiction or referenced by local building codes. Table 10.3.1 requires all new systems to be 100% inspected prior to testing. Table 10.4.4 also requires a 100% test of all system components at the time of acceptance. The methods of testing each component on the system must follow Table 10.4.2.

So, before you call the AHJ to schedule the acceptance test, be sure you are ready. Conduct a 100% inspection and pre-test before scheduling the acceptance test. Pre-testing will expose errors that must be corrected, such as programming problems, missing devices, and inoperative devices and appliances.

You should also be sure all tools, materials, and documentation are ready. The required tools for testing a fire alarm system include, but are not limited to the following:

- (1) Ladders
- (2) Two-way radios
- (3) Digital Volt/Ohm Meter
- (4) Heat source
- (5) Aerosol smoke
- (6) Assorted screwdrivers
- (7) Sound Pressure Level (SPL) Meter
- (8) Manual pull station keys

- (9) Flashlight
- (10) Pen and pencil
- (11) Assorted highlighters

The following documentation is essential to conducting fire alarm tests:

- (1) Shop drawings (with red-line changes)
- (2) Specifications
- (3) Equipment specification sheets
- (4) Blank copy of the Record of Completion (NFPA 72, Figure 4.
- (5) Operations and Maintenance (O&M) manual for the system

At the completion of the project, the final O&M manual must contain, as a minimum, the following items:

- (1) Record (as-built) drawings for the system
- (2) List of spare parts (if provided)
- (3) Troubleshooting guide
- (4) Matrix of Operation
- (5) Calculations
- (6) Written Sequence of Operation
- (7) List of emergency contacts
- (8) Cut sheet for all installed equipment
- (9) Copy of the site-specific software (CD format preferred)
- (10) Record of Completion

The system controls should be energized, and a power on indication should be observed. There should be no trouble, supervisory, or alarm signals present on the controls prior to testing the system.

Continued on page 37

SVS-1 is Here!

A powerful little black box with a very affordable price. Use SVS-1 for stop line video detection on up to 30 zones per camera from up to six cameras. Access SVS-1 remotely to check on traffic queues or movement. Interface it to your existing TS1, TS2, Type 2070 controller.



SVS-1 Video Detector

Phone: 410-315-9727
Fax: 410-384-9284
sales@smarteksys.com



SmarTek Systems, Inc.

Sensing and Systems Integration Solutions

The UL and You . . . *Continued from page 36*

addition of sub-assemblies. Optionally a site visit by a UL engineer would be required.

If the panel is modularly listed, each replaceable sub-assembly and enclosure will have its own individual UL Label, referring to "Listed Fire Alarm Equipment Enclosure", "Listed Fire Alarm sub-assembly" etc. These assemblies, cabinets, etc. may be installed in the field.

Modifications involving rebuilding of listed equipment are an entirely different subject, since allowing the original OEM's name or UL label to remain on rebuilt equipment without authorization of the OEM or UL involves violation of the copyright laws and is illegal.

This brings us back to the opening question regarding voiding of the UL Listing. In actuality, the UL Listing process involves only one thing: it allows the OEM to affix the UL label to his product. This means only that the product was manufactured in accordance with the UL Standard in place at the time of manufacture. Once the product is sold to a customer and leaves the OEMs shipping platform, the product becomes the property of the customer and no longer comes under UL authority.

One exception to this would be a situation where the panel installation is to be certified by a UL certified third party who ensures that all equipment remains as manufactured, with no modifications allowed, and the installation is per the National Fire Alarm Code and other applicable codes.

Otherwise, any subsequent modifications to the equipment, such as addition of components, relays, etc., fall under the auspices of the Authority Having Jurisdiction (AHJ) who is usually a Fire Prevention Officer, Fire Marshal, Fire Chief or similar person, depending on the jurisdictional structure in the area where the installation is to take place. Some towns or cities may have ordinances or bylaws requiring modifications to the equipment. One typical modification commonly required in the past was the installation of a proprietary key operated switch that the responding Fire Dept official could operate to silence audible signals when it was safe to do so, so as not to impede fire fighting operations. Thus the officer in command could use his special key to silence any brand of control panel. Therefore, in the event of any subsequent legal challenges, the AHJ can refer to the ordinance or by-law as his authorization to allow that particular modification.

One extremely important point, however, is that the AHJ will be extremely reluctant to allow modifications to listed equipment, due to liability considerations. The AHJ might allow modifications only for an exceedingly good reason, and follow NFPA Fire Alarm Codes, etc. as closely as possible.

Therefore, the answer to the posed question is moot, since the UL Listing applies only to the manufactured product and UL Certified installations. Once the equipment leaves the OEM's premises, a listing cannot be "voided" as such, but any modifications deviating from codes and standards will indeed void the intent of the listing process. An example of this would be additional components that may increase heating or impede ventilation in the cabinet, so component and panel temperatures would be in excess of that allowed in the standard.

Thus, modifications of listed equipment in the field are allowable if approved by the AHJ. Keep in mind, however, that the ultimate AHJ could be the grand jury.



Fire Alarm Systems . . . Getting It Right The First Time

Continued from page 35

Any other trades necessary to conduct the test (e.g., elevator technician) should be on-site and ready to support the test. Keep in mind that some jurisdictions may prohibit fire alarm technicians from operating fire suppression systems. Therefore, a sprinkler technician may be required to conduct flow tests.

Some jurisdictions and Federal agencies now require the contractor or owner to use the services of a qualified and impartial third party to provide indication of compliance of a new installation. There are many qualified third party contractors, and some jurisdictions maintain a list of approved verifiers. In all cases the verifiers must be in no way connected to the installer or owner.

At the completion of all tests, be sure the owner is provided with copies of all required documentation and software. This documentation includes the following:

- (1) Operations & Maintenance (OM) Manual
- (2) Record (as-built) drawings
- (3) Site-Specific software
- (4) Project specifications
- (5) Record of Completion (from NFPA 72, Figure 4.5.2.1)
- (6) Record of Inspection & Test (from NFPA 72, Figure 10.6.3)

When the system requires servicing and testing, this information will be needed. It is recommended that a receipt be obtained upon delivery of the documentation, in order to

Continued on page 49

Protect important intersections from power outages.

Install UL Listed transfer switches with your traffic pedestals.



- Surface or flush mount units available
- Flush design recesses into cabinet to prevent tampering
- 20, 30 and 50 amp configurations available
- Optional pilot light indicates when utility is restored

1-888-GEN-TRAN
www.gen-tran.com
IMSA Sustaining Member



**The Next MUTCD:
What To Expect In
Temporary Traffic
Control** *Continued from page 48*

Guidance:

4. When additional highway agency resources are available, applicable procedures and devices set forth in other Chapters of Part 6 should be used.
5. The initial emergency response vehicle should be Safe-Positioned.
6. Additional vehicles, including tow, media, maintenance, utility, and other emergency responders should be positioned downstream of the incident vehicle to minimize exposure and disruption to both traffic and emergency responders at the incident scene.
7. Emergency responders should carry a minimum of six channelizing devices such as traffic cones (6F-7) and one sign to implement this Typical Application.
8. The first emergency responder should minimize the distance between the incident vehicle and the end of the buffer space.

Continued on page 50

**Fire Alarm Systems . . .
Getting It Right The First Time**

Continued from page 37

to protect all parties and remind the owner of the importance of the system documentation.

Summary

Perhaps you read this article expecting to better understand acceptance testing and approvals. That was certainly the intent. However, plans reviews and acceptance tests are each part of a much larger effort called "commissioning". Commissioning a fire alarm system is far more than just showing up to spray smoke for the AHJ. It really begins at the planning phase, and extends through the warranty period.

Hopefully, implementation of the items discussed in this article will help your next system design/installation progress more smoothly. All this preparation may seem like a lot of work at first glance. The upside of doing things right the first time are obvious.

Merton Bunker is a member of the NFPA Technical Correlating Committee on Signaling Systems for the Protection of Life and Property and the NFPA Technical Committee on Testing and Maintenance of Fire Alarm Systems. He is also the president of Merton Bunker & Associates in Stafford, VA. He can be reached at mwb@mertonbunker.com.



**Discover Relume's
New LED Technology
at the IMSA Annual Conference.**

BOOTH 426

New Crosswalk LED Downlight now enhance Safety and Security at Pedestrian Crosswalks.



New Traffic Control Box LED Light Panels add brightness and clarity to your environment.



New LED Street Lighting Technology reduces energy costs by 50%.



New Illuminated Street Name Signs with "plug and play" LED panels to retrofit any existing sign in under 20 minutes.

LUMECON *Luminance + Economy*
National Distributor of Relume Technology



Visit our web site or call for more information
www.lumecon.com/imsa.html Toll Free: (877) 564-3133