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Fire Protection System Integration

By Thomas C. Brown, P.E.

What is system integration in commercial building construction? It used to be that system integration meant coordinating and interfacing building systems for proper operation. Today, to many, system integration means all building systems operate over a common data path, through common head-end equipment. Modern computer technology has provided the hardware capability to implement the latter definition. As with most new technologies, however, there are pros and cons to its implementation.

Using a common building automation system to monitor and control lighting, HVAC, elevators, security and access control, and fire alarm signaling offers many opportunities for cost savings during initial construction.

Utilizing common conductors, controllers, hardware and a user interface offers obvious cost savings during initial installation. The architecture also allows utilization of system processing power, which is often underutilized in standalone systems. Some would argue that economies exist in ongoing service and maintenance expenses. However, these advantages are traded off against some distinct, often underreported, disadvantages.

Integrating all building systems through common hardware potentially creates a sole source dependency for parts and service. The costs associated with eliminating the competitiveness in service and maintenance can far outweigh the savings potential of common equipment. There are initiatives in the industry such as the ASHRAE BACNET Protocol to mitigate the problems associated with sole source dependency. However, these initiatives have not been universally embraced by the manufacturers of building systems.

System obsolescence is a problem we all confront in dealing with our personal computers. The problem also impacts computer-based building control systems. Systems no longer can be expected to last the lifetime of a building. Realizing a 10- to 15-year life cycle of a computer- based building system is good. Having all building controls through a common system dictates a common obsolescence for all systems simultaneously. This can lead not only to widespread deficiencies in building services reliability, but also high retrofit costs when the system is obsolete. In addition, the use of common equipment for multiple functions can lead to debilitating outages if the system goes down.

One of the most challenging problems for the building control industry is the quality and capability of technical support staff. These modern building systems are computer systems, and the vendors are competing with all other aspects of the information technology industries for qualified technicians. These technicians are expected to know the hardware and software of the control system, as well as all relevant codes, standards and industry practices related to HVAC control, fire alarms, elevator control, security, lighting control, etc. This is an unreasonable expectation considering industry pay scales, training, turnover and service call charge rates.

Fire Protection Integration

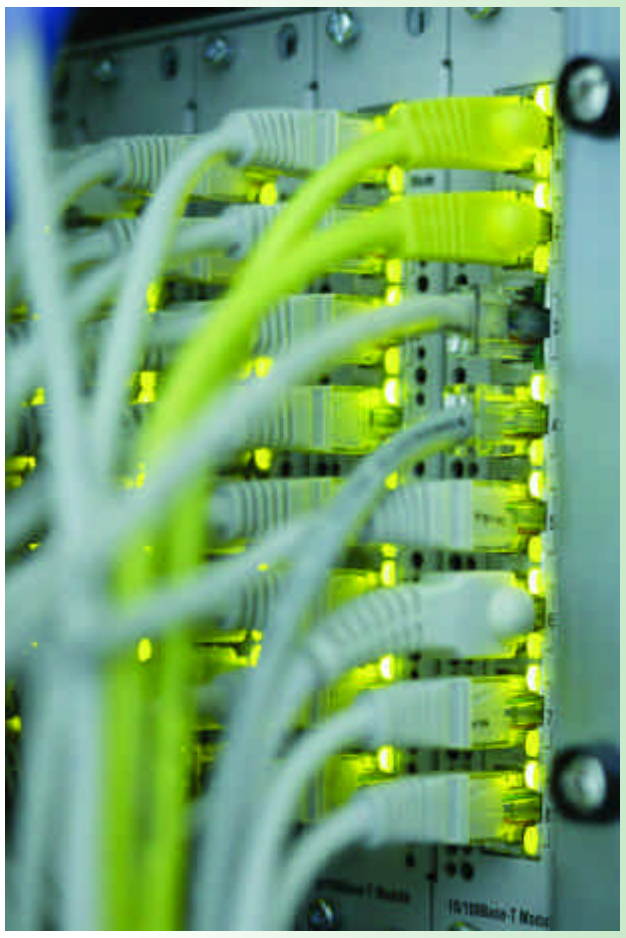
Regardless of whether you use the "old" or the "new" definition of system integration, there are several specific issues related to the coordination of the fire protection aspects. Since fire alarm and smoke control systems form a part of the fire and life safety features of a building's construction, they usually must be 100 percent complete and operational prior to building occupancy. Unfortunately, the systems cannot be debugged after the building has been occupied, as is the case with many environmental air systems. Smoke control systems are usually acceptance tested very late in the construction process and all of the following should be complete prior to final testing:

- Installing the mechanical equipment for the smoke control system
- Completing the fire suppression systems
- Completing the fire alarm system
- Completing architectural boundaries for the smoke control system, which can include interior partitions, shaft walls, smoke barriers or exterior walls
- Completing the building's building automation system if it is interfaced with the mechanical systems as part of the smoke control system design

As each trade finishes the work on its portion of this integrated system, interconnection problems are inevitable. Unfortunately, often there is no time in the schedule to absorb these last-minute details.

Common Problems

It is common design practice to integrate building environmental air systems into smoke control systems. As a result, portions of smoke control systems are often under the control of both the energy management system and the fire alarm control panel. This leads to problems in integrating,debugging and testing the system and in identifying the responsible contractor when the system does not function as expected.
The number of interconnections and interdependencies between the fire alarm system and the building automation system should be minimized. If the building automation system is going to provide the control for the smoke control system, the interface should be kept to a contact closure from the alarm system to the building management system. Having dampers or other devices that are associated with a single fan or shaft controlled by two systems can lead to significant problems.



For example, a large new entertainment facility was designed with environmental air handling units integrated into the smoke control system. The fans and dampers at the air handling units were controlled by the building automation system. Smoke dampers throughout the associated ductwork were directly controlled by the fire alarm system. Conditions occurred during system commissioning where the smoke dampers closed in the ductwork without a signal being sent to shut down the associated fans, which resulted in extensive damage to the system ductwork.

When the smoke control system is split between the fire alarm and building automation systems, subcontractor responsibility is also split. Subcontractors often assume that a required function is being performed by another subcontractor, but when final acceptance testing is done, neither subcontractor has provided the required work.

Additional problems can result in splitting the responsibility for operation of the smoke control system, which may include incompatibility of methods or materials. Modern fire alarm systems use data communications between microprocessors to coordinate system responses through several subpanels. If the fire alarm system is providing relay outputs for damper or fan control from an external power source, the wiring methods and installation of the control wiring can interfere with the proper data communication of the fire alarm system. It is very important to follow manufacturers' recommendations and requirements of the National Electric Code regarding the separation of conductors from digital communication circuits and other light and power circuits.

If the system's installation causes interference with data processing, it will not be realized until the fire alarm system is brought online, usually in the last several weeks of the project. The solution may involve rerouting conductors to isolate the problem, which will involve substantial time and money.

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In most cases, smoke control systems are required to operate from the building's emergency power system as a backup to primary power. The electrical load required for the motors in the smoke control system has a substantial impact on the sizing of the building's emergency generator.

Though not as demanding from an electrical load viewpoint, integrating all fan control circuits and status indicators to the emergency power system must be anticipated. If the system is designed to operate on emergency power, emergency power sources must be designed to operate all portions of the system.

For example, while testing the fire alarm and smoke control system at a high-rise building, a test was done to verify system operation under emergency power. When the primary power was disconnected, not only was the fire command station dark, but all fan control and status indication circuits were lost.

To obtain UL approval as a listed fire alarm control unit, a microprocessor-based fire alarm system must maintain its control logic in a non-volatile memory. However, many microprocessor-based building management systems have volatile memories. In a recent installation review, it was determined that, under emergency power, fans and dampers controlled through the fire alarm system operated properly. But fans and dampers under the control of the building management system did not operate properly. Investigation revealed this was because the building management system lost its volatile memory when primary power was lost. Even when normal power was restored, the service technician was required to reload the software into the building management system before resuming proper operation. Although memory volatility is not an issue with most new building automation systems, the relative reliability and integrity of the building automation system compared to the fire alarm is still an issue.

In order to address this issue, Underwriters Laboratories now lists Building Automation Systems as "Smoke Control System Control Units." The UL Standard used to evaluate these systems for smoke control use is UL 864, "The Standard for Fire Alarm System Control Units." The listing process verifies these control units can function with the same degree of reliability and integrity as fire alarm system control units. Unfortunately, this additional criterion often is not specified by system designers. As a result, many building automation systems are relied upon to perform critical life safety functions that do not offer the industry standard for system reliability.

The design intent for sequential operation of smoke control systems is often not clearly represented on design documents. Sequential operation of damper, fan interlocks, as well as smoke control system response to multiple fire alarm inputs, must be clearly defined. In cases where these interlocks are clearly defined, they are often incorrectly installed. This should be closely scrutinized during acceptance testing of the system. Again, it is recommended that all interlocks be through one control system rather than mixing and matching confirmation signals with control signals between the fire alarm system and the building automation system.

NFPA 92A, Recommended Practice for Smoke Control Systems, states that only the first alarm received should automatically initiate smoke control, subsequent automatic inputs should be ignored. Only manual control of the system should alter the smoke control sequencing. Most installations start additional smoke control sequencing from subsequent alarms, therefore they violate established guidelines.

The issue of ultimate control of the smoke control system is often debated. The fire chief may want the manual override controls to be the ultimate controlling influence on the system. The HVAC equipment manufacturer wants to ensure their equipment is properly protected and wants the safety controls to be the ultimate controlling feature. The control contractor may feel his system monitors the most information on existing conditions, and therefore may want final control. The system designer may desire that a duct smoke detector have ultimate control over the fan to avoid recirculating smoke.

The prioritization may vary from one design to the next, but it must be clearly defined to avoid coordination problems. NFPA 92A indicates that automatic operation of the smoke control system should have priority over all automatic controls, with the exception of static pressure limit sensors and duct smoke detectors on the supply air systems. NFPA 92A additionally states that manual activation or deactivation from the firemen's command station should override all other functions of the air-handling equipment. The ultimate system control should be clearly defined by the design engineer, who should gain the agreement of the authority having jurisdiction. The zoning of smoke control systems must be closely coordinated with both the fire suppression system design and the fire alarm system design. Any lack of coordination between these three systems can cause problems. While working on final acceptance testing for a large hotel complex, a coordination review of sprinkler, fire alarm and smoke control systems revealed the public assembly areas of the hotel had five independent smoke control sequences. Due to the zoning of the fire alarm system and the hydraulic design of the sprinkler system installation, only two discrete input signals could be given to activate the smoke control system. Therefore, three of the smoke control system sequences could not be automatically initiated from the alarm and suppression systems.

Seemingly minor field changes or drawing liberties taken by either the alarm installer, sprinkler installer or mechanical system installer can lead to serious problems with the operation of the smoke control system.

Avoiding the Problems

The previous section identified common problems, but the real question is how these problems can be avoided. Developing an overall fire and life safety plan for the building and establishing objectives for the systems and subsystems are the first steps. These objectives should be reviewed very early in the design process with the authority having jurisdiction to gain agreement.

A fire protection engineer should assist the design team in coordinating complex designs and also should review shop drawings of the suppression, detection and control systems. The fire protection engineer also should be part of the final inspection team. Often the design engineers involved in the layout of the associated systems do not effectively coordinate to attain proper integration of these systems.

In reviewing the drawings for a large shopping mall for system coordination, it was identified that the electrical designer had laid out fire alarm zones using letter designations and proceeding clockwise. The plumbing designer had laid out sprinkler zones using number designations and proceeding counterclockwise. The mechanical designer designated smoke zones by fan numbers. The total number of zones was not consistent between any two of the three, yet these drawings were issued for construction by the mechanical/electrical/plumbing firm on the project. It was no wonder that problems developed at the final integration of these systems.

A common practice is to utilize a design/build concept for installation of the sprinkler system. However, this can lead to severe problems in buildings with a smoke control system. The sprinkler system designer may not realize the design impact on the other fire and life safety systems. A thorough, concurrent review of all

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CSI MasterFormat™ 04 to Address CLA Issues

By: Chuck Wilson, Executive Director, NSCA

The Construction Specifications Institute (CSI) is in the final stages of rolling out an expanded version of the MasterFormat™ specifications guideline. This document is the de facto standard for organizing specifications and writing project manuals for commercial construction projects. Our industry will be well served by this expansion.

Communications, life-safety, and building automation and control (CLA) will each have it's own new division for specifying work. The process of developing the work results and section titles has been a task of the MasterFormat™ Expansion Task Team, a group I have been fortunate to serve with for the past two years. The latest version of this document, including the new divisions, is now available to review at www.nsca.org.

The impact of this expanded document will take several forms and have various timelines. I expect that you will begin to see the early adopters of this program get started almost immediately. The scheduled implementation and training will begin right after the first of the year, when the new document hits the desks of design professionals. Our industry has the opportunity during this implementation phase to begin our own training programs intended to educate the building owners, consultants, architects and engineers on the best practices for specifying our technologies.

Something new to most technology providers will be the phrases "work results" and "facility lifecycle". As a new feature of MasterFormat, we will begin to see it more widely used for developing specifications on design-build projects and re-purposing of existing structures.

The work results concept is more difficult to understand. The concept is to assist in the transition of performance-based vs. prescriptive specifications. Specifying work results rather than products will become common with the anticipated rate of obsolescence we expect to see in coming years. Look for specification writing tools like MasterSpec to follow suit.

What is especially exciting for our systems industry is the recognition that will be developed for the systems integration. For the first time, we have a placeholder for specifying our specific skill sets. This will facilitate early consideration and proper budgeting on the client's end and more recognition for our industry. In reality, we couldn't have asked for more. There is one catch. We need to deliver more than quality products.

Our job is to raise the bar of performance and to set standards by which we are measured. In other words, we need to embrace the concept of being properly trained and credentialed to do this work. As part of this outreach effort with the design community comes the promise that we can do better than "the systems shall be installed in a neat workman-like manner". We all know and love that phrase, but it has to go. And, "installed in accordance with manufacturer's specifications" isn't what they want either. Both phrases lack specificity and are subject to interpretation by those who do the installation.

What we are working toward is an industry-wide initiative to establish best practices for systems installation based on a common body of knowledge. This has to be an industry priority or our promise to deliver in a performance-based world has been broken. NSCA now offers certification, training and apprenticeship programs all designed to compliment the advancement in technical skills and development of best practices for systems installers and technicians. It is a major step toward verifying the minimum level of competency of those who do the work. I urge you to consider this for your employees.

Assessment tests for placement in the program are also available. NSCA will be working with manufacturers like NOTIFIER to support this program and offer joint training programs.

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Advanced Fire Alarm System Pays Huge Dividends In Texas IRS Facility

Most everyone has heard the expression, "Nothing is certain in life except death and taxes." To the second part of that axiom we should add a corollary: "It is essential to protect taxes and the people who collect them."

That's exactly what the fire alarm system installed at the Internal Revenue Service Building in Farmers Branch, Texas was intended to do, and for years it did the job admirably. Still, in keeping with the corollary, "Protecting taxes and the people who collect them," it was decided that even "admirably" was not quite enough. After all, the facility, built in 1984 and staffed with 1,100 employees in the building's 322,000 square feet, had far too critical a mission - and far too many human assets - for management to miss an opportunity to improve safety. Consequently, it was decided that the system would receive a comprehensive upgrade.

The General Services Administration (GSA), which ultimately would purchase the new system, turned to Carl Ball, President of Fire Systems Design, a NESCO affiliate located in Dallas/Fort Worth area. Ball in turn recommended the AM2020 as the foundation of the upgrade. The system, produced by NOTIFIER, the world's largest manufacturer of engineered fire alarm systems, is considered one of the best in the industry.

It wasn't a stretch for Ball to recommend the system; in fact, because Fire Systems Design believes NOTIFIER is the best-engineered and most user-friendly product of its kind on the market.

With the NOTIFIER AM2020 firmly in place, Ball then recommended NOTIFIER's XPIQ Quad Intelligent Audio Transponder, an advanced voice evacuation system. Accompanying the XPIQ was fire fighter phones, FCPS remote power supplies for visual alarms (strobes), NOTIFER addressable devices, detectors, and pull stations.

The XPIQ is an integrated, multi-channel distributed audio amplification subsystem, remotely controlled by a fire alarm control panel through a signaling line circuit. By using a software program and internal switching capabilities, the XPIQ eliminates the need for relays and complex wiring during installation, and it is compatible with NOTIFIER's complete line of voice evacuation intelligent fire alarm panels (in this case, the existing NOTIFIER AM2020). As a result, the XPIQ handles all the switching easily with less wiring.

To Betty Doss, Senior Support Service Specialist and the IRS Building's on-site facility manager, the minimal wiring is a huge plus.

"Because each floor has an individual transponder, there are very few cables," she said. "Thus, there were fewer wires to be pulled through the entire building, which obviously means less potential damage to the building's infrastructure. As a facility manager, this made me very confident in the installation." The XPIQ was also chosen because it is the best system to use in this retrofit application.

XPIQ's multi-channel audio system is capable of playing up to four different audio messages simultaneously. Other features include four amplifier slots; up to four continuously supervised 25-watt amplifiers; two independent user-configurable tone generators either for riser back-up or as a main tone source; four Class B or two Class A firefighter telephone zones capable of distinguishing open, short and off-hook states; ground fault detection; and a serial port for configuration download from a laptop. The amplifiers are configurable such that one of the four can act as a redundant backup for the other three. This new system adds a new dimension of survivability insuring the evacuation messages will be heard.

Being addressable means that the system is taking preventative measures by informing the user of sensitivity levels on an individual detector basis. More importantly, it also means that the exact location of trouble can be identified.

"The fact that the system can point out the exact device that is in 'trouble' so that it is easily found is a tremendous benefit," said Facility Director Fred Oeltjendiers. "Traditional systems can point out the zone where the trouble is located, but not the exact location. The time savings, which may be only a matter of seconds, can make all the difference in a life-threatening emergency."

In addition, every occupant of the building can hear and see an alarm, thanks to the voice messages and strobe lights. The old system was limited in that it was not audible throughout the building. Now, for example, if there is an emergency on Floor five of the 15 floor building, people on floors 1-4 and 6-15 will also be informed of the event.

The growth potential of the system should not be underestimated, either.

"The IRS needed a system that would be flexible enough to grow with the building, to meet code changes and upgrades," said Ball. "The system has built-in spare capacity. Since NOTIFIER always provides a migration path to newer products, the AM2020 can easily be upgraded to the latest NFS-3030 product."

Besides the fire protection, the new system also offers capabilities for other emergency warnings, such as weather warnings. A tornado warning, for example, will send people to a designated area - no small benefit in a state like Texas where tornadoes are not an uncommon occurrence. Plus, the system can offer two separate channels of voice; consequently, it can relay two different messages.

Oeltjendiers had high praise for Fire Systems Design's performance during the implementation.

"Fire Systems Design did a fantastic job," he said. "They were very sensitive to the security demands, and completed all work after hours. Each test went according to spec, and the system has performed extremely well."

The system also allows for easy access, meaning that it can be tested with minimal effort and without causing a false alarm.

Technology and performance aside for a moment, it is the building occupants' feeling of security that truly tells the story of the system's performance.

"If there is trouble, everyone can now hear and see the alarm in the entire building," Doss said. "This goes a long way towards making our tenants feel more secure."

So now there are three things in life that we can be sure of: death, taxes, and the fact that the occupants of the IRS Building have the biggest and best fire alarm system in Farmers Branch, Texas.

UniNet® Lite Receives Best New Electronic Product Award at FISP 2003

NOTIFIER's UniNet Lite facilities monitoring system received the Best New Electronic Product Award this past August at the 14th annual FISP exposition, the largest Fire Safety and Protection industry event in Latin America. Held at the Immigrant Expositions Center in San Paulo, Brazil, the FISP is host to 40,000 attendees and over 150 exhibitors. NOTIFIER has participated in the show every year for the last three years.

The Best Electronic Product Award was voted on by FISP attendees, and the UniNet Lite product received 40% of the vote. UniNet Lite is a hardware/software package with a sophisticated design and user-friendly interface that gives users the ability to graphically capture and display events and conditions throughout their facility. Clearly this product captured the attention of the visitors to FISP 2003!

NOTIFIER's Luis Guilherme (right) Receives Award from Jose Roberto Sevieri, Director of Group CIPA and FISP Organizer

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associated shop drawings should be done to ensure no required system feature or functions are falling through the cracks.

Project coordination meetings specifically to integrate the life safety systems should be required in the contract documents. All subcontractors associated with any portion of the integrated system should be represented. Members of the design team in attendance should include the mechanical, electrical, plumbing and fire protection engineers.

The first meeting should be held very early in the job, prior to any shop drawing preparation. The number and timing of subsequent life safety coordination meetings will be dictated by the scope and complexity of the project. Suggested critical points would be: after initial shop drawing submittal, after shop drawing approval of all portions of the system, at 50 percent completion, at 95 percent completion and prior to acceptance testing.

If a common control building automation system is used, design engineers should be prepared to provide more detailed information to the installing technicians. Additionally, the owner should fully understand the advantages and disadvantages of the proposed approach.

Most important is the final system acceptance testing. System acceptance should include operating each alarm-initiating device and verifying the control function it is designed to perform. The system components and all associated building operating subsystem components should be functionally tested under emergency power conditions. Multiple alarm conditions should be tested for proper sequential operation.

Sufficient time must be left in the schedule to accomplish all these performance tests. During testing of the fire alarm and smoke control systems, it is important that representatives of all involved trades be present. This typically includes the general contractor, electrical contractor, mechanical contractor, automatic sprinkler contractor, testing and balancing contractor and fire alarm supplier. Absence of any contractor will substantially prolong system testing.

Too often, the installation of these systems is completed close to the building's scheduled opening, and occasionally proper testing is sacrificed to meet that date. For example, several months after the opening of a high-rise office building, a test was conducted on the fire alarm system. It was revealed that every sprinkler waterflow switch in the building had been improperly wired and could not initiate an alarm signal.

Sprinkler flow in this building was the primary method of initiating smoke control. Unfortunately, unless a system is thoroughly tested, its deficiencies will not be realized until it is too late.

Conclusion

New computer-based technologies allow for the integration of numerous building monitoring and control functions into a single system. The pros and cons of this approach should be evaluated on a project specific basis.

Testing the integration of fire alarm and smoke control systems often uncovers unexpected problems. Correcting these problems can require more time than is allowed in the construction schedule.

Clearly defined objectives, good design documents and thorough review of the shop drawings will help minimize last-minute problems. Thorough acceptance testing is required to verify acceptable system performance.

Thomas C. Brown, PE, is a vice president of Fire Protection Management, Inc. He has over 15 years' experience in the design, coordination and testing of complex fire protection systems. He holds a B.S. in Fire Protection Engineering from the University of Maryland.

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System Sensor's China Affiliate, Xi'an Sensor Electronics, Ltd., Receives CFPA Top 30 Award

Xi'an System Sensor Electronics, Ltd. a part of Honeywell's Fire Group, located in Xi'an China, has been selected by the China Fire Protection Association, (CFPA) as a recipient of its prestigious Top 30 Award. Presented at the 2003 CFPA Forum on September 9th, the CFPA ranked Xi'an System Sensor as the #4 company. Based in part on annual sales and growth over previous years, this award is given to those companies that have made outstanding contributions to the fire protection industry.

According to He Jun, Vice President of marketing and sales for Xi'an System Sensor, "This is the second time we've been recognized for our accomplishments with this highly regarded award. Receiving this honor is especially exciting because we were selected by our peers."

Xi'an System Sensor has been affiliated with NOTIFIER since 1994. The company is dedicated to providing its customers with reliable, sophisticated smoke detection and notification technology for real-life applications.

The theme at this year's CFPA Forum was "Forging Ahead With the Times, Developing and Blazing New Trails - Technological Creation and Enterprise Development." More than 30 news media from throughout China attended the bi-annual event.

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Contributors:
Gray & Rice Public Relations
Thomas C. Brown, Vice President of Fire Protection Management, Inc.
Chuck Wilson, Executive Director, NSCA
System Sensor

Graphic Design: Andrea Montano

To contact us, please email leslie_craddock@pittway.com, or visit us on the web at www.notifier.com

NOTIFIER®

12 Clintonville Road • Northford, CT 06472-1610 USA

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