backdraft

The newsletter of Fire Protection Engineering / Code Consulting

Fire Protection Engineering

viewpoint

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Welcome to the 2007 edition of **Backdraft**, my irregularly issued newsletter for viewers of this website.

I would like to announce that ESH Consultants will be completing our seventh year in business this coming October (2007). Calendar year 2006 has been our most successful year, with a doubling of billable hours over the previous year and I would like to thank all of you that have referred clients to our business.

In past issues of **Backdraft,** I have not spent much time on our projects. Because of the varying degree of projects, and their linkage to other articles in this issue, I will expand coverage of these projects.

As in past, during 2006-7 ESH Consultants has been providing in-house consultant services for the Division of the State Architect (DSA), State of California, working at both the Sacramento and Oakland regional offices. Two new major clients have been added: one a major biotech company located in South San Francisco, and the other being John Deere Landscapes, located in Georgia.

With the biotech company (per agreement their name cannot be mentioned), ESH Consultants has provided in-house consulting services for the Corporate Environmental Health and Safety organization, and for the South San Francisco Site Facilities organization. For John Deere Landscapes, ESH Consultants prepared a master template and submitted Hazardous Materials Business Plans for 15+ retail/wholesale locations in Northern California, and supported similar activities for locations in North and South Carolina.

ESH Consultants has begun adding architect firms to our client list. Support for the architecture clients has involved specifications for the installation of a fire pump to boost pressure to serve hydrants and multiple story school buildings. This was accomplished during construction when the contractor and architect determined the site water pressure was not sufficient.

Another architect project involved code evaluation for converting a telephone company call center into a private high school. Based upon our code analysis and work with the local jurisdiction, the cost of the fire detection and alarm system was reduced by more than 40% from the original contractor design.

A third project involved the fire protection and water supply requirements for a rural training center being built by a regional utility company. The project involved the specification and layout of a complete water supply system, sizing of a fire pump and water tank, as well as the design build requirements for multiple sprinkler systems.

Other interesting projects in 2007 involve alternative materials and methods analysis for a green roof (covered later in this issue) and a fire protection analysis for a biodiesel fuel production plant. For the biodiesel location, a compressed air foam system will be used for the flammable liquids room, as there is limited water supply at this rural site. The use of compressed air foam will reduce the water supply to 25% of that needed for a regular foam system.

Working on more projects for architects is building on the company's long-term goal to move away from fire and life safety plan review, and to work directly on design projects at the front end, where we can give the greatest value to our clients and their stakeholders. By getting involved early in the projects, it is our intention to help our clients obtain early approval of the fire and life safety aspects of the design.

Calendar year 2007 began with the conclusion of projects that were started in 2006. One of these projects was to provide hydraulic analyses of existing sprinkler systems and site fire flow calculations affected by a proposed installation of reduced pressure backflow prevention devices. These devices would be installed on systems where no devices are currently installed, or to replace double detector check valve assemblies, which are not acceptable to the local water department. The analyses were used to verify existing sprinkler systems and hydrants will meet their original design criteria.

Another continuing project involves specifying fire protection requirements for a training center in a rural location that only has a well for a water supply. The project will require a fire pump, well pump, dry and wet pipe sprinklers as well as a water storage tank for the fire pump.

Before you read the newsletter, I would like to set some ground rules for those readers who do not reside in, or work in California. My observations are based on how things function in California, specifically the northern section of the state. As such, some of the observations may not apply in other jurisdictions; however, there is always something to learn.

The newsletter will conclude with an article submitted by one of my industry contacts. This article discusses photo-luminescent exit signs. This fits in with the topic of "Green" buildings as covered in the article on "Green" roof construction.

I hope you enjoy this issue. As always, if you have any questions, comments, or opinions forward them to esh.fire@sbcglobal.net.

Elliot L. Gittleman, FPE, MBA

Water Supplies

ESH Consultants has been providing fire and life safety plan review services for school projects, K-12 and Junior Colleges, as a consultant to the State of California. This has involved more than 200 sprinkler submittals and resubmittals, as well as original project permit drawings. The authority having jurisdiction (AHJ) should understand how and where to apply the water supply requirements for new construction, as the AHJ must approve the available project water supply, prior to the state agency approving projects for construction.

Prior to final design approval by the state, the local fire authority must approve the fire hydrant locations and determine that the available site water supply system can meet or exceed the fire flow requirements of the California Fire Code (CFC), 2001 edition, Appendix III-A, and Appendix III-AA (when regulated by the State Fire Marshal). The local fire department reviews the size of the building and construction type to determine fire flow requirements. The information is used to determine the minimum required number of hydrants, the spacing between hydrants, and the spacing from hydrants to any point on the street or road. The required fire flow at 20 PSI is then compared with the existing water supply system data, preferably a flow test less than 12 months old.

For the California Division of the State Architect (DSA) building plan approval, sprinkler design density and flow requirements are not shown on the approved project drawings or provided in the specifications. The specification usually directs the contractor to meet the design requirements of NFPA 13 for the hazard classification associated with the building use. To be blunt, there is no engineering for the sprinkler system or design requirements until after the project has been approved and most likely already in construction. I believe this could be a potential problem for the local authority having jurisdiction.

As the plan review drawings do not include any specific details on the sprinkler system or fire flow, and the water flow test information is considered the responsibility of the sprinkler contractor, to be submitted with the sprinkler deferred submittal. If you are the local approval agency, how can you properly assess a project, and issue approval for the required fire flow if water supply information is not included with the project drawings. You can determine the code required fire flow; however, you will not know if the existing water supply can meet this demand.

Another water supply issue is based upon where the water supply test was conducted versus the actual location of the fire flow demand. In most of the submittals, there are no calculations to bring the water supply data from the point of testing to the actual location of the fire demand. It is very possible on a multiple building campus, that the hydrant at the public road will not be the most remote hydrant with the highest demand.

Usually the local water purveyor provides flow test data from the public main, which is not located on the property, or near the project site. Do not assume the water supply information is accurate or correct for the specific project. The designer of the site utilities needs to provide a current (less than 12 month old) water supply test, and a friction loss calculation from the point of the water supply test to the point of demand. With this information, it is possible to determine if there is sufficient pressure and flow at that location. The designer provided information for the water supply test must also include a diagram showing the location of the test versus the proposed site water supply system.

Other items to consider: How old is the flow test information? Has there been major development in the area since the date of the test? Where was it taken? Where is the fire flow required?

The following are examples from actual projects or installation.

⇒ A sprinkler contractor provided water supply test information for a sprinkler design. By using an on-line mapping service, it was determined that the water supply test was conducted a mile away, on a water main that was not gridded or cross connected to form multiple loops. A mile of 10-inch pipe, flowing about 750 gallons per minute would have a loss of less than 10 PSI. This may not be a problem for the sprinkler designer but would be a problem for the required fire flow. Using a flow of 2,500 gallons per minute, the loss is about 80 PSI. With a required minimum pressure of 20 PSI, the system would need to have a residual pressure, at the test hydrant, of more than 100 PSI. I doubt this was considered when it was approved by the local fire department.

⇒ A utility district is installing reduced pressure backflow prevention devices on fire mains for existing sites. At one site, there is a dead-end, 12 inch, public water main. The location is at the top of a mountain ridge. The water department provided test information for hydrants immediately adjacent to and in front of the property (at the public main). The test showed sufficient water pressure and flow in the street. The site is a multi-building school campus with a site fire main and multiple fire hydrants. When performing the analysis for the new backflow device, the water supply did not have sufficient flow and pressure. Was the problem the new device? No. Calculations to the on-site fire hydrants, without the new device, indicated the water supply was never sufficient at the on-site hydrants. It appears that no one had allowed for friction losses for the site fire mains.

⇒ A water supply calculation was prepared for a utility district, for fire mains serving fire hydrants in an apartment complex. The calculations indicated what appeared to be a severe drop in available pressure at the required flow. The utility district contested the calculations believing too much loss was being used for the backflow prevention device. They were concerned that the local fire department would not approve their system changes. The staff at the utility district did not understand that the pressure available on the public main was not the pressure available at the fire flow hydrant. They did not take into account the pressure losses (more than 20 PSI) attributed to friction losses in the site fire main.

⇒ An architect used sprinklers in lieu of one-hour construction. The specifications and design did not provide information on the existing site water supply. Once in construction it was determined that the water supply pressure was deficient. As the plans had been approved with the elimination of some of the one-hour construction, and the buildings were in construction, the only other alternative was the installation of a fire pump and tank. A major change to the site fire protection system, which should have been identified in the original plan review.

If, as the AHJ, you are reviewing plans for fire flow, make certain that the project drawings and specifications provide accurate water supply information. The data should indicate the location of the test, should be less than a few months old, and in close proximity to the site. Next, a calculation submitted by the designer to show the calculated flow expected at the on-site hydrants and at the base of the sprinkler riser. The fire code requires hydrants within specified distances of the buildings. The fire flow must be proven at the location of the pro-

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Hydraulic Calculations

In 1999, I attended an NFPA 13 sprinkler training class in San Francisco. The class was sponsored by NFPA and taught by members of the NFPA 13 committee. At the class, we were looking at a large warehouse with a gridded system, to determine the most remote area. I asked the lead instructor, if it was allowed to provide multiple calculations for this open warehouse. My premise being, branch lines closest to the riser have a higher the available pressure, thus it could be possible to save the customer money by reducing the branch lines sizes near the riser. The purpose of the multiple calculations would to prove the smaller branch lines closest to the riser would be acceptable.

The response was amazing. Without the instructor knowing my background, he spit out a comment similar to, "You must be an engineer. Only an engineer would want to provide multiple calculations, and it is not allowed in the code." I asked him to show me the code section that prevented multiple calculations of this type. This made him madder as he could not reference a section and stated he had no time to look for it, and if I did not like it, I should leave the class. To this day, I have never found such a code statement. Shortly thereafter, I found out that the instructor was on the NFPA 13 committee, was a sprinkler contractor and sells his services as a sprinkler consultant.

So, what is my point? It is possible to need multiple calculations for a sprinkler submittal review because of varying occupancy hazards and types of sprinklers. When reviewing sprinkler submittals for hydraulically designed systems, many sprinkler contractors will only provide one calculation, for a remote area that they have decided is proper. It is your job, to make certain they have picked the correct remote area or areas. You may say that is a simple task: just find the section of the grid that is furthest from the riser.

However, it is not that easy. Many of the grids that are reviewed are not symmetrical. Some have the riser connected at the center of one end, or at the center of one side. Those are easy, but what about a riser that is on the end or side but not at the center, or has two or more separate irregular feeds from the riser to the grid. Should one calculation be submitted when there are sprinklers above and below the ceiling, with different areas of coverage and different sprinkler characteristics (such as standard versus quick response, or extended coverage)?

Do you accept one calculation for a hydraulically calculated system that is not a grid, but a combination of loops and side fed branch lines; with different types of sprinklers; with sprinklers above and below the ceiling; with different design densities and areas of coverage? Does a calculation based upon piping furthest away from the riser truly indicate the most hydraulic demand on the system? The answer is not all of the time.

I have rejected single calculation designs because the sprinkler system had multiple densities, loops or grids, and portions that were end feed, and had vastly different areas of coverage per head from one side of the system to the other. The system looked as if someone had thrown spaghetti on the drawings and then added pipe sizes and sprinkler heads.

New sprinkler calculations were provided for multiple portions of the system and proved that a portion of the system closest to the riser was not sufficient. It had a higher design density and area of coverage than the original calculation, which was for an "obvious" remote area further away from the riser. In one instance, the sprinkler system on the first floor had a more remote hydraulic area than the system on the second floor. Why? Different hazards and different design areas.

I have rejected calculations for gridded systems because the system was not symmetrical. The contractor used software to "prove" the calculation, but the calculation is only as good as the information provided to the program. If you do not provide information to allow the program to try shifting the design more that one or two heads along the branch line, then it is simply a matter of GIGO, garbage in and garbage out.

In many cases the resubmittal with the additional calculations showed the original remote areas was not the most hydraulically remote. Moving the remote area closer to one of the mains resulted in a greater demand because of differences in pipe lengths, fittings, and number of operating sprinkler heads.

Another calculation option to review carefully is the room method versus the area method. Contractors use the room method because they can design for small areas of coverage, which greatly reduces the pipe sizes of the sprinkler system. Less demand, smaller pipes, lower bid price. There is nothing wrong with this method, but it must be applied correctly. The water supply for the sprinkler system shall be based upon the room that creates the largest demand (NFPA 13 – 1999 7-2.3.3.1). In addition, the walls of the room must have a proper fire resistance rating to equal or exceed the required water supply duration for the hazard classification. This means the walls and doors or other openings must have a proper fire rating. If the openings are not protected, then additional sprinklers outside of the room or in communicating rooms must be added to the calculation.

The key is determining which room has the greatest hydraulic demand. A single room calculation, when different design densities and areas of coverage per sprinkler are used in different locations in the building, or where there are unprotected openings, may not accurately identify the greatest hydraulic demand. In some instances, the room chosen by the contractor was not the most hydraulically demanding portion of the sprinkler system.

Point of Connection

There is another issue to be aware of when reviewing sprinkler submittals. Some of the contractors will provide calculations with the demand to the point of connection. The calculations need to be taken back to the point of the flow test, not to the point of connection. To most sprinkler contractors the point of connection is no more than 5 feet past the exterior wall, from the base of the riser, or they take the calculation to the point where the lead-in connects to the site fire main. Once again, the calculation must be made to the location of the flow test.

If your location is a potential insurance HPR site, and the site main has two or more points of connection to the public water supply (loop), then the calculation for the sprinkler system should assume one feed to the loop is closed. With a two feed loop, the calculation should be made with the closest feed closed thus requiring the flow through the largest length of pipe.

When reviewing sprinkler plans for complicated designs, do not base your review on the obvious or on the submission of the contractor. Look at the design, see if the remote area makes sense, see if the water supply is properly calculated, and if necessary request additional calculations to prove the design. Better to be cautious than wrong when there is a fire.

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Green Roofs

Within the engineering and architectural community, we are seeing the design of more energy end environmentally efficient buildings. In some situations, the architect wants to use green technology for the roof of the structure, hence the term "Green Roof".

During the past year, ESH Consultants was involved with the submission of an alternative materials and methods submittal for a green roof to be installed on a non-combustible building (Type II-N), which was being built at a community college. The roof consists of a metal deck supported on metal roof rafters. The deck is covered with 4" rigid insulation, and a ¼" SECUROCK® roof board that is covered with a membrane roof. The project architect stated that the manufacturer represents this configuration as a rated assembly that has passed the rating for a Class B roof.

For the green roof, additional layers of materials would be added on top of the already approved Class B roof covering. The modified design will include a polyethylene/polypropylene liner that is used to retain water and aid in drainage. A thin layer called a bio-blanket is then inserted into the liner. This layer is a water saturated hemp fiber. The bio-blanket is then covered by the growing substrate, which consists of 85% gravel and 15% organic matter. Drought tolerant succulent vegetation (Sedums) is then planted in this substrate.

To assure exposure to a fire in the building would not dry out the vegetation, thus increasing the potential for flying brands or dropping burning material, the building fire alarm system is connected to the built in soaker hose irrigation system. Whenever the building fire alarm system is activated, a signal will be sent to the rooftop irrigation system to activate water flow in the soaker hoses.

The question to ask about this design is very simple: Does this meet the requirements for a Class B roof deck? It appears that some jurisdictions believe this is acceptable. Both Chicago and New York City have modified their building codes to allow green roof construction. Buildings with variations of this design have been constructed in the Pacific Northwest and San Francisco. Yet, there has been no testing by either U.L. or FM Global on a green roof design.

ESH Consultants believes the green roof industry should fund a study to determine if these roof coverings can qualify for a Class A or Class B roof, or if these additions will void the ratings of previously classified roofing systems. For the above-mentioned project, ESH Consultants did not consider the additional materials placed on the Class B roofing system to be a portion of that roofing system. In addition, we required that moisture sensors be installed in the bio-blanket that would automatically activate the soaker system if the moisture content were too low. The other requirement was connection of the building fire alarm system to the soaker system, to assure wetting of the roof if a fire was detected in the building.

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Readers Forum:

Architects and Engineers Give Green Light to Photo-luminescent Exit Signs by Michael O'Connell, July

Most of the USAs 100 million electrically powered exit signs use between 2 and 40 watts of power and contain batteries and circuit boards that are now recognized as hazardous "universal wastes." An increasing number of new and refurbishment building projects are glowing in the dark with Photoluminescent exit signs that are powered from nearby area lighting and are constructed of non-hazardous recyclable materials.

Progressive building owners, architects and engineers focusing on energy efficient and sustainable products are paying more attention to the types of exit signs on their lighting fixture schedules. From a green perspective, they know the most popular fixture may not be the best choice.

Today, well over 90% of the exit signs being installed into new facilities employ LED [Light Emitting Diode] lamps that use 2 – 5 watts of power and have an expected service life of 20 – 25 years. Compare this to the popular exit signs of the 1970s and 1980s that used 20 to 40 watt incandescent and compact fluorescent bulbs with service lives of months, and its easy to see how the current love affair with LED exit signs evolved.

Although a giant step forward with respect to energy conservation and bulb life, LED exit signs have adverse safety, efficiency and sustainability issues when compared to another evolving technology, the non-electrical Photo-luminescent exit sign.

Not to be confused with industrial looking radio-luminescent Tritium exit signs that glow from the radioactive decay of hydrogen to helium, Photo-luminescent [PL] exit signs use a non-toxic, non-radioactive compound of strontium oxide aluminate to store ambient light energy, and then when the light is removed, to release the stored energy as an intense green-yellow glow. Its the same "glow-in-the-dark" technology used in toys and other curios, but with a radiance that is much brighter and longer lasting.

Glow Safely

PL exit signs and systems have been marketed since the early 1990s, primarily for low level exit systems. However, with the advent of more effective glow-in-the-dark compounds, PL exit signs are now UL listed and accepted by the NFPA for both high and low level exit sign applications. UL and NFPA recognize that, as long as nearby lighting is on a few minutes before an emergency, PL exit signs are almost failsafe.

New York City went a step further last year and passed Local Law 26 requiring installation of PL exit signs and marker systems into many new and existing high rise office buildings. This extraordinary measure is a result of studies of the World Trade Center bombings which confirmed that building occupants exited faster and safer in those areas that were outfitted with PL technology. LED and other electrically based technologies rely on emergency generators, battery back-ups and light bulbs – all of which can and unfortunately do fail during emergencies.

As the following comparison table outlines, the enhanced safety protection of PL exit signs costs less than competing LED and Tritium products, and is a more sustainable building technology.

Sign Type Feature	**Photo-luminescent [PL]**	**Light Emitting Diode [LED]**	**Tritium**
Sign Cost Range [single sided signs]	$50 - $100	$30 - $290	$175 - $225
Average Installed Cost	$110	$155	$195
Average 10 Year Total Cost of Ownership	$216	$400	$367
Sign Life	25 years +	20-25 years	20 years
Safety Issues	Failsafe if nearby lights were on before emergency.	Not effective if batteries and bulbs not working, or if emergency generator fails.	Powered by radioactive tritium decay. Banned by US Military and many schools, companies.
Cost Issues	Low installation and operating costs = most cost effective technology available.	Most expensive exit sign type to install and operate.	Expensive purchase and disposal costs.
Sustainability Issues	Non-toxic materials. Non-radioactive Recyclable. Non-electrical.	Circuit boards and batteries are hazardous wastes. Greenhouse gases released from producing electricity used to power signs .	Significant radioactivity issues with fabrication and operation. Not-recyclable.
Bottom Line	Energy Star listed. “Best Available Technology” [US Dept of Energy FEMP] Safer, less expensive and sustainable. Architecturally Attractive	Energy Star listed. Big improvement over older electric signs but adverse safety, cost and disposal issues. Architecturally Attractive.	Easy to install but expensive to buy and dispose of. Radioactivity marginalizes use in “sustainable” projects. Industrial look.

Glow Wisely

PL technology is an excellent choice for many exit sign applications but there are important guidelines specified by NFPA:

- The face of a PL exit sign is illuminated by a suitable charging light source.
- The charging light source is controlled by authorized personnel and energized when the building is occupied.

- Signs are located in accordance with their viewing distance, typically 50 feet or 75 feet.

Knowledgeable architects and engineers understand these and other guidelines and know how to design building lighting systems to work synergistically with PL exit signs. Typically, PL exit signs need to be within 8 – 10 feet of a charging light fixture. Consequently PL exit signs are excellent choices for the high and low level exit signage in the lobbies, corridors, hallways, stairwells and parking garages of many buildings.

Glow Efficiently

On a sign in the box basis, architecturally attractive PL exit signs appear to cost more than lower end LED exit signs but after factoring-in the costs of installing and testing the signs, PL exit signs are considerably less expensive than nearly all LED exit signs – at least 40% less. Since PL exit signs work off of area lighting, there are ***no*** electrical connections to engineer, install and test, so the cost of installation is usually the cost of the sign and the cost of a tradesman [usually not an electrician] to spend 5 – 10 minutes affixing the sign to the building wall or ceiling.

The operating costs of a PL exit sign are also significantly less than an LED exit sign because there are no power costs, no batteries or bulbs to replace and no monthly and annual testing procedures. PL exit sign maintenance typically consists of verifying that charging lights are operational and periodic wipe-downs with a damp cloth.

With escalating construction and operational costs, these savings are increasingly attractive to building owners and operators. One large condominium community in San Diego is realizing savings of $18,500 per year by using PL exit signs instead of LED exit signs in 70% of their exit sign locations.

Glow Green

As sustainable design in the building industry becomes more prevalent, PL exit signs are the clear choice over radioactive tritium signs and electrically powered LED signs. Non-radioactive, non-toxic, non-hazardous, non-electrical and recyclable, PL exit signs are a green dream product.
The radioactive nature of Tritium exit signs increasingly precludes their use in many locations, including grade schools, college campuses, and corporate facilities. The United States Department of Defense Unified Facilities Criteria specifically prohibits Tritium exit signs in military facilities.

Regulated by the Nuclear Regulatory Agency, owners of tritium exit signs must notify the NRC if a sign is damaged or goes missing. Expressly prohibited from landfills, tritium exit sign owners must also notify the NRC when a sign is decommissioned and sent to a nuclear waste facility. Proper disposal typically costs about $75 per sign.

To avoid the high costs and negative environmental impact of tritium exit signs, early in a projects schedule building owners should advise their architects and engineers that radioactive signs are not acceptable products. Although it only takes a little extra engineering to do it right, it is surprising how many architects and consulting engineers specify "self-luminous" tritium exit signs to minimize their workload.

Watt miser LED exit signs should not be considered a sustainable building product for 3 reasons.

1. Contribution to greenhouse gas inventory. Although 3 – 5 watts per sign is low compared to other electrically powered exit signs, it adds up when there are well over 100 million exit signs in the USA using about 35 megawatts of electricity [Energy Star info]. If all these signs were converted to LED technology tomorrow, it would still take nearly 5 megawatts of electricity to power them. Assuming this electricity is produced from fossil fuels, over 11,000 metric tons of carbon equivalent in greenhouse gases would continue to be released into the environment annually [Nuclear Energy Institute info].
2. Hazardous Chemicals are used during fabrication processes. The housings of many exit signs are PVC, which is associated with chlorinated dioxins and other extremely hazardous and long-lived pollutants. The fabrication of the circuit boards used in LED exit signs also involves environmentally unfriendly chemicals, including methyl ethyl ketone, hydrochloric acid and sulfuric acid.
3. Circuit Boards and Batteries are hazardous wastes. Federal Regulations [EPA 40CFR Part273] now consider the back-up batteries inside many LED exit signs to be a "Universal Waste" because they contain various heavy metals. In some states [i.e. California], the circuit boards inside LED exit signs are also a Universal Waste as they contain lead, chromium, cadmium and sometimes mercury. Universal Wastes are not permitted inside municipal landfills and must be directed to a recycler.

Glow Forward

So next time you are reviewing your projects schedule of lighting fixtures, check out the exit sign specifications. If the specification lists self-luminous tritium signs or internally illuminated LED signs, consider changing to photo-luminescent exit signs. That way youll be getting an almost fail-safe product that is the most cost effective and sustainable exit sign technology on the market today.

Several companies make high quality photo-luminescent exit signs. Make sure that you specify an exit sign that is UL924 listed and install it per NFPA 101 and local codes.