APRIL | 2025

FIRE ENGINEERING®
SUPPLEMENT

MORE AIR, MORE TIME

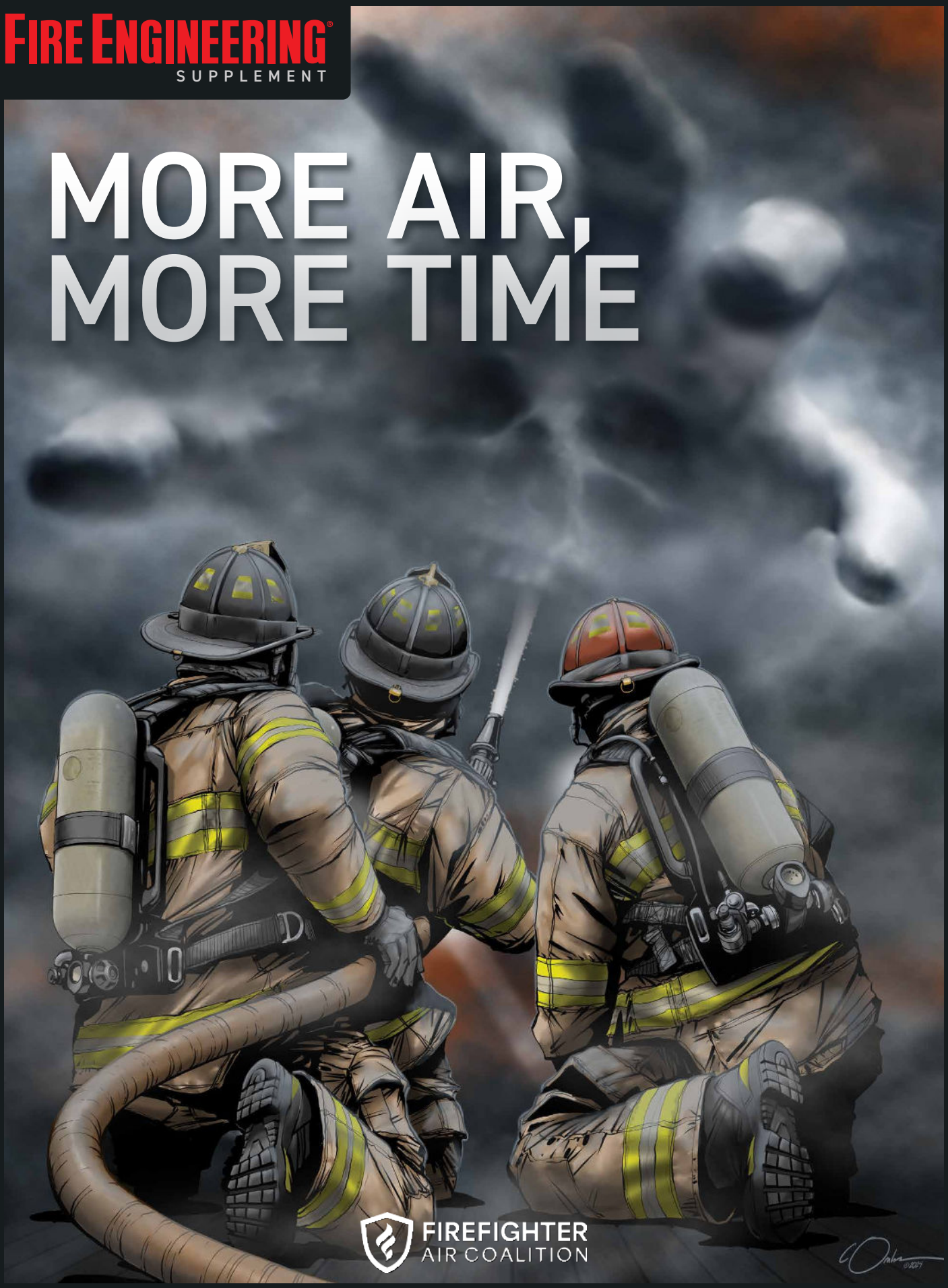


ILLUSTRATION BY PAUL COMBS

Message from Firefighter Air Coalition President Mike Gagliano

There is nothing that energizes me more than seeing firefighters receive excellent training and education. There is something magical about having some of the best men and women in the world empowered to unleash their unique skill sets through the power of knowledge and insight.

At the Firefighter Air Coalition (FAC), we believe that firefighter air is a critical part of successful emergency response. It is the single component that gives you permission to enter the toxic IDLH environments you face every day. We can sum up excellence in this area in four words: More Air, More Time.

More time to attack the fire. More time for search and rescue. More time to get in, stay in, and give our citizens the highest possible chance of surviving the worst day of their lives. More time to live. More time to do our challenging work safely. More time to live a healthy life, spend time with our loved ones, and enjoy a longer and impactful career.

Both of the above are equally important to us. We are committed to providing you with the best information from the best people—thus, the content of this fantastic *Fire Engineering* supplement.

We spare no effort in creating and sharing the important need for air management training and its implementation during emergencies. It is well established and known that today's fire smoke is toxic and carcinogenic, with the risks of disorientation, smoke exposure, and asphyxiation during the fire attack. Additionally, the realities of the dire impacts on our health and well-being, including elevated instances of illness and disease, are killing our brothers and sisters in alarming numbers. The concept of More Air, More Time will have an enormous impact on everyone who joins our call.

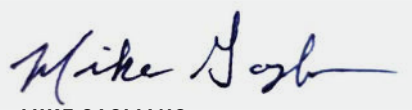
To enable our successful efforts, the FAC strongly promotes innovation and technology to enable better firefighter air practices. We hope you'll look at Johnson Controls/Rescue Air, Lifeline Firehose, Arctic Compressor, Bauer Compressors Inc., and Shambaugh & Son—all of which support air technologies we need to work and survive. And, we'll keep sharing the latest research on how to do the job the right way, for the right reason.

I hope you enjoy reading, learning, and sharing the content inside this supplement as much as we enjoyed pulling these phenomenal authors together for you. Please take a minute to join us on Facebook and LinkedIn. Stay connected to all the great things we will bring you in the coming year.

On behalf of our team, the many supporters, and sponsors, we are proud to be at your side in this great journey of the fire service.

Always remember: More Air, More Time.

Respectfully,



MIKE GAGLIANO
PRESIDENT, FIREFIGHTER AIR COALITION
CAPTAIN (RET.), SEATTLE (WA) FIRE DEPARTMENT

YOUR FIRE SERVICE STORY MATTERS!

Sharing your work history can help prevent cancer in the fire service, whether you've been diagnosed with cancer or not.

When you sign up for the National Firefighter Registry (NFR) for Cancer and tell us about yourself and your time in the fire service, you provide critical information that can help improve our understanding of firefighters' risk of cancer and identify occupational factors contributing to that risk. Over time, this information can help pave the way for new health and safety measures to keep future firefighters safe.

Join the more than 20,000 firefighters who have signed up so far! Create your account on NFR.CDC.GOV, sign the consent form, and complete your user profile in just **5 to 10 minutes**. Then tell us your story by filling out the questionnaire. This can be completed over time.

Join the NFR today!

Which Mask Do You Want to Wear?

1. Photo by Tony Greco.

BY MICHAEL N. CIAMPO

GROWING UP and being exposed to firefighting was easy for me. My dad was the director of fire apparatus for the Fire Department of New York (FDNY) and a third-generation volunteer firefighter. Going to work with him was a highlight for a kid who liked fire apparatus. Also, in the 1970s, the book *Report from Engine Company 82* was written, and the kid who had no desire to read books suddenly found himself reading it numerous times. During a hot summer night, I had the opportunity that made the most impact on me in my quest to become a firefighter: Riding in Brooklyn with Rescue 2 during the War Years and going to eight fires gave me insight on choosing a career path.

While I was studying fire science at John Jay College of Criminal Justice, the District of Columbia Fire Department recruiting team visited campus. The test was being given soon, and I was hired in 1985 to work in our nation's capital. After graduating the academy, I was responding to calls in federal and vacant buildings, performing helicopter landing duties for the President and foreign dignitaries, and even toured the White House.

Wearing My Mask

One day tour, I quickly learned the value of wearing your mask. (In some areas of the country, "mask" means your entire self-contained breathing apparatus; in others, it's "BA.") We received a call for a bus on fire on the National Mall. We could see the smoke as we pulled out of quarters. I stepped off the rig and grabbed a mask while the engine company stretched the hoseline to a "slinky" bus engulfed in flames. Once water was applied, the windows were ventilated. As entry was about to be made, they handed me the nozzle because I was wearing a mask. Quickly donning the face piece and entering the bus, I opened the hoseline and extinguished the remaining fire. Once my air was depleted, I handed off the nozzle and exited the bus. I often question why I let a simple lesson of breathing fresh air while operating become more lax as time moved on.

A Culture of Not Wearing My Mask

After spending five years in D.C., the FDNY called and moving north was now on the agenda. I was assigned to the South Bronx, where blocks of leveled buildings and vacant structures and cars being stripped were normal sights. Wearing a mask at my first response to a car being stripped and on fire wasn't the culture here, and soon I left it on the rig. The vacant fires were like D.C., but many of them were now in larger tenements and multiple dwellings. The buildings were being renovated with federal aid, and older buildings were installing thermal-pane windows. Fires with today's modern fire loads were now being sealed inside, and the carcinogens were begging to be released for you to consume if you weren't on air. The new normal was oily, soot-stained skin and black snot dripping from your nose.

The smoke began to burn my eyes and throat. Mask usage improved but not like it should have. The daily grind of responding to the habitual burning food on the stove incidents, with the cheap metal pots off-gassing and clinging to your bunker gear for days, while wearing no mask occurred too frequently. The abandoned vehicle fires stopped, but encountering a car burning, you could taste that distinct plastic flavor in your throat because you weren't on air.

Another big exposure in this city was responding to an underground electrical fire. The smoke tasted horrible from the burning polyvinyl chloride wire casing, which released hydrogen chloride and more. All are inhalation hazards to your lungs, especially if you're not wearing a mask.

Another culprit was overhauling—breathing in carbon monoxide, asbestos, lime dust, and a host of carcinogens. We must stop acting like cowboys ready to rob a stagecoach with our hoods pulled up over our mouth and nose. Sure, it can filter out some of the particulates but not all of them. Mask up! You'll be thankful later!

In life, you're going to experience things that you never could imagine—from being inside the White House to standing on top of the George Washington Bridge and operating at the 1993 bombing and the 2001 collapse of the World Trade Center. Living history just doesn't enter your mind when you sign up for this job. Working for more than 20 years after 9/11, I was exposed to the daily smoke, gases, chemicals, and biohazards we often take for granted. Smoke and irritants will take their toll on you over the years and lead you on a journey you don't want to travel.

A Career-Altering Diagnosis

Realizing something is wrong with you is a hurdle many of us might push aside and not pay much attention to. Looking in the mirror and giving in may be very difficult, especially when you're living the job you love. But you must take a hard look at yourself, especially if the symptoms are telling you something is wrong.

Losing my voice after a short exposure to smoke and not being able to breathe properly while walking up the stairs were very concerning. I visited a cardiologist and had tests that revealed things were fine. He recommended an exam by an ear, nose, and throat doctor. Having a few squirts of numbing spray blasted up my nose and the putrid taste running down my throat was the easy part of the test. A few minutes later, having a long rubber tube inserted into my nose and down my throat wasn't as pleasant. This was prescribed bimonthly to monitor a problem that was found. Being diagnosed with a hyperreactive larynx and chronic laryngitis and told that smoke and irritants are the worst thing for you will take your career away in a heartbeat. Plus, the vocal cord damage wasn't going to cease with continued exposure. Getting injections into the vocal cords could help, but the gravelly voice will always be part of my life moving forward.

My days in the firehouse were now over. Light duty began as the monthly medical monitoring continued. Sitting in these sessions was now the norm. I was calm because I got used to it. But when the doctor pulls the tube out of you and immediately says, "Whoa," you sit there paralyzed. Does the "Whoa" mean I'm suddenly cured or is it something worse? Unfortunately, in my case, it was something worse.

I saw another specialist who would repeat the procedure and recommend a visit to a surgeon for more testing and procedures. A few weeks passed until they could fit me in, and the eight-hour visit began with the customary nose and throat scope, followed by blood tests

and sonograms before a doctor discussion. Two small lumps were found up in my neck and the best way to quickly see what they were was to do a needle biopsy.

Lying on my side with doctors pressing and prodding with the sonogram probe and then inserting a long needle into my neck made me break out into a cold sweat after they did it six times. Then, the doctors explained that they wanted another scan. This had me worried that these weren't just small cysts under the skin.

Treatment

After the scan, they told me the dreaded news that these things were cancerous. For those who've been told this news, we know the feeling inside and it's almost indescribable to people who haven't experienced it. Another scan was scheduled for the following week to prescribe a treatment plan. Not to alarm anyone, I remained silent and was waiting for the next round of tests before disclosing my medical situation. Unfortunately, more needles and injections with radioactive materials revealed more cancer in my throat, tonsils, and mouth.

Surgery was scheduled. In the operating room, nurses, the anesthesiologist, doctors, and a robot were waiting. Waking up seven hours later in a complete fog, I heard my ramblings had my nurses and family amused. Although I was in and out of it, when the nurse jabbed a needle into my side, like I was trained to administer the antidote kit on a dummy, it hurt.

I was transferred into an intensive care unit and realized there was a piece of tubing dangling out of my neck and draining into a container pinned onto my gown. Nobody mentioned that prior to the surgery. I knew I'd have an incision a few inches long but not from my ear to my Adam's apple. Trying to sip some water was now a feat, since part of my tongue, tonsils, soft palate, 47 lymph nodes, and two tumors had been removed. Due to the type of surgery performed, I couldn't use a straw, so now sipping fluids was a chore, and a painful one at that. Waking up the next day, I didn't find the clear liquid diet appealing, but the thought of swallowing food seemed much worse. It took some time until I could swallow room-temperature liquids, broth, gelatin, and yogurt.

Hospital life has the uncanny ability of waking you up when you least expect it, much like the tones going off in the firehouse, whether it's for vital signs or the daily early-morning blood draw. Prior to being discharged, I had to have the drain removed as the doctor snipped some of the stitches away. As he began removing the drain, I thought he was pulling up a crab trap from the bottom of the bay. How long could this tube be? Once it was removed, he put a piece of gauze over the site and gave me some wound care instructions, but I couldn't focus on that because of the cold sweat I broke out in.

For the next few weeks, my life consisted of sitting in the recliner or propped up on the sofa. The pain medicine prescribed was very difficult to swallow. After two nights of waking up, sweating profusely, and having bad nightmares, I discontinued it. Luckily, I could take liquid acetaminophen to deaden the pain.

Despite this tough experience, another brutal battlefield lay ahead. With my throat not healed, radiation and chemotherapy were set to begin. The "trial" day is first and quite a unique experience. It involves being fitted for a radiation mask. How hard could it be to wear a mask? We're firefighters?

In the "fitting room," I had to lie down on a table with hot towels pressed over my face and shoulders, as the plastic mesh was molded over me. From there, I had an MRI where I was stapled down to the table because the mask has clips on its edges to lock you into place. Then a fat foam tongue depressor was inserted into my mouth. Sliding into the tube with inches to spare while strapped down was another uncomfortable experience.

After this, we went into the radiation vault, where they lined me up with the infrared beams. They said something about getting a tattoo, but I thought it was just going to be a permanent marker, as a nurse said, "You're going to feel a needle pinch in your chest." Some people get multiple tattoos. I have just one, but seeing it every day is a harsh reminder of my sessions.

A week later, I began 33 days of radiation. I was locked onto the table, tongue depressor inserted, as everyone walked out of the vault. The machine, like a giant octopus, began its regiment of killing cells, muscle, and tissue beneath the skin.

One day a week, I had a six-hour chemotherapy treatment following the radiation session. There the routine included a blood draw; two hours of fluids via an IV; urinating a certain amount of "cc's"; administer the "flush" chemicals; needles for nausea, vomiting, and steroids; chemotherapy drugs; followed by two more hours of liquids via an IV.

During these visits, the highs were having friends and family accompany me and the nurses being so kind. The lows were the rapid weight loss, not being able to swallow due to the swelling from the radiation, second-degree burns on the neck from radiation, and losing my hair and my appetite.

Completing the final session was a blessing, and having the nurses ring the bell with me because we operated like a team was an honor. Walking out of there, I didn't know the pain would be so excruciating. The neck burns were throbbing all day, even though they were covered in ointment. The internal swelling was so bad I couldn't swallow. I did not want a feeding tube, so the only way to get things down for the next 19 days was drinking fluids or having an IV line.

The Future

The saga of the worst year of my life, even harsher than the events of 9/11, was now over. Unfortunately, I didn't have a last tour in the firehouse with visitors and fellow firefighters dropping in. Instead, mine was at the hospital, leaving treatments and going home in a fire department car, beat up like I just fought a top-floor job that got into the cockloft. Life now consists of the unknown, as body scans are scheduled until eternity.

I wondered, what kind of teaching abilities will I have? Will my voice be strong enough today or will I struggle to speak? Will I be able to teach consecutive lectures or days?

Daily life has truly changed. Swallowing food is difficult because my saliva glands were destroyed by radiation. My throat swells with weather changes. If you're lucky you get some of your taste buds back, but even if you do, things don't taste like you remember them. Trying to rebuild your body's strength and shape after chemotherapy destroys it is a journey too.

Believe me, wear your mask. It's much more comfortable than the radiation mask and chemotherapy. Your body and mind will thank you as well as your family and friends who must watch you travel down an unforgiving road. ■

MICHAEL N. CIAMPO spent 39 years as a career firefighter, retiring as a lieutenant in the Fire Department of New York, previously with the DC Fire Department. He has a bachelor's degree in fire science from John Jay College of Criminal Justice. He is a technical editor for *Fire Engineering* and writes the monthly back page column On Fire. He is featured in Training Minutes videos on fireengineering.com. He wrote *Tower Ladders Tactics, Tips & Tales* (mikeciampo.com) and *On Fire: The First 10 Years* (Fire Engineering Books).

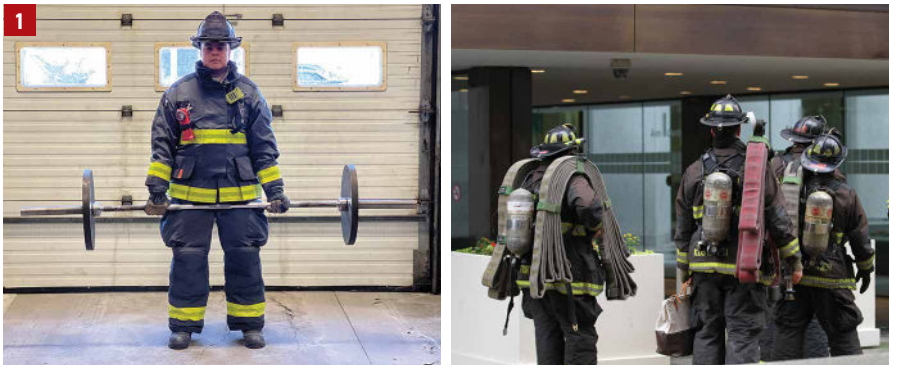
Operational Burdens: The Impact of Firefighter Stairwell Ascends at High-Rise Fires

BY JAMES DAVIS

"THE ELEVATORS ARE OUT! We have to take the stairs." This likely scenario represents a significant operational and logistical challenge when firefighters have no other option but to endure a lengthy, physically demanding stair climb to reach the upper floors of a high-rise building. The entire operation will need to be moved vertically using the stairwell to initiate critical firefighting interventions against the burden of time and the physical limitations of firefighters carrying heavy equipment. Time is a significant factor, as every phase of a high-rise operation—from fire suppression to search and rescue and logistical support—is all measured in time. Valuable time is negated when firefighters must travel a significant vertical distance when stairs are used alone.

Elevators are essential to a high-rise operation for one reason: *speed!* To gain a timely tactical advantage, elevators are the primary means to transport firefighters and their heavy equipment as close to the fire as possible as quickly as possible. However, in some cases, the elevators may be unavailable as the primary means of conveyance or fail at some point during the fire, thus leaving a lengthy stairwell climb as a last resort. The worst-case scenario in any high-rise fire is that firefighters must ascend via the stairwell to reach their destination. The late Paul Grimwood, PhD., summed it up quite well: "Any fire of significant height, stairs alone are inadequate." Ascending the stairwell adds another layer of complexity of operational impediments, exposing the entire high-rise operation to significant time delays and additional threat platforms.

When the elevators are out of service, how would you respond if asked to carry a 135-pound barbell up 27 flights of stairs by yourself (photo 1)? Most likely, you'd say, "That's impossible." Yet, in many cases, firefighters are effectively doing just that—hauling the equivalent of a 135-pound barbell up the stairs when equipment weight alone is factored in. The degree of operational impact at a high-rise fire will be predicated on the number of floors to climb, the weight of the equipment, and the firefighter's physical fitness. This article will examine the operational burdens in a stairwell-only high-rise operation.



1. These firefighters are carrying the equivalent of a 135-pound barbell in equipment alone. The weight carried here is unrealistic when stairs are used exclusively to reach the fire floor. Seldom is weight factored in and considered during a high-rise response where elevators are not an option. How much do your firefighters weigh when fully loaded? *[Photos by author (left) and Gordon Nord Jr. (right).]*

Vertical Response Time and Reflex

When the elevator is unavailable, consider the physical and physiological demands of a strenuous stair climb to reach a fire on the 27th floor. How long will it take personnel to get there, and will they have enough physical capacity to go to work fighting the fire? In this case, the whole operation is reduced to a slow, painstaking process with severe implications and adverse effects on reflex time when stairs alone are used (photo 2). A high-rise operation is measured according to the speed at which intervention tactics and critical tasks are applied against specific time parameters. Here are some key points about reflex time to understand.

The vertical response time is the critical time factor representing, in simple terms, the "total time" it takes for the first-arriving units to arrive on the fire floor to initiate timely water intervention. This includes the time from receipt of the alarm, response, arrival, method of vertical travel (stairs vs. elevators), and water on the fire. Anecdotally, we have an 18-minute operational threshold to apply water on the fire. Case studies and valuable lessons learned from major high-rise fires worldwide reveal a consistent pattern of predictable adverse events likely to occur, which are solely imposed on significant operational delays or firefighting ineffectiveness when

2. When stairs alone are used to reach the upper floors of a high-rise fire, expect substantial time delays and lengthy periods of nonintervention that will have an overall effect on reflex time. Expect fire and smoke conditions to worsen during a lengthy stair climb, creating a greater threat to civilians and firefighters. Unequivocally, smoke spread is the largest threat to building occupants during a high-rise fire. *[Photos by Chicago Fire Media (left) and author (right).]*

measured against time. These findings support and validate the many concerns when operating outside this crucial benchmark.

In addition, a high-rise operation will also undergo several other reflex times:

- **Primary reflex.** This reflex is the portion of the vertical response time that measures the time from entry into the building, vertical ascend, setup, and initiation of water on the fire performed by the first-due assignment at a high-rise fire. This reflex time can be excessively long. It is not uncommon for water application to take 10, 15, or 20 minutes sometimes, even when elevators are used for conveyance. Without elevators, stairs will have the most adverse impact on reflex time.
- **Secondary reflex.** The second reflex, or subsequent vertical ascends from others, represents the time it will take before more help and resources arrive to sustain uninterrupted operations, including logistical support, task-level expansion, and timely relief and rotation of crews. For example, if it took 20 minutes for the first-due company to ascend the stairwell, your next wave of additional help will also take 20 minutes to arrive. A high-rise operation must be supported, which justifies the need for a personnel-rich response to plan for contingencies, such as elevator loss.

High-rise fires require many (full) air cylinders. Fresh air cylinders must be readily available without delay during a high-rise fire. During the primary reflex, air cylinders are brought up only in limited supply. If the second reflex is delayed, such as a lengthy stairwell-only ascend, the entire high-rise operation is set back due to the inability and lack of support to replenish breathing air for already committed firefighters.

This scenario supports the benefits of firefighter air replenishment systems (FARS) in high-rise buildings. Having breathable air readily available eliminates the need to carry air cylinders. It dismisses the reliance on additional reflexes to satisfy logistical air cylinder requirements, lending to a safer and more effective operation.

Stairwell: Impact and Implications

Climbing stairs to the 27th floor is a considerable vertical distance to cover to fight a fire. The time required to ascend the stairs makes the entire operation vulnerable to time-developed events because of the exorbitant amount of time needed to get the initial firefighting resources into position when elevators are not an option. Concerns for certain events that may occur include the following:

- **Window failure.** Windows can fail at any point during a fire. Window failure can occur during the initial ascend and you may not be aware of it. This condition develops into many problems, such as being overpowered by a wind-driven fire or autoexposure as the fire plume consumes the floors above. In this case, expect a well-developed fire, burning at a greater rate and intensity when window failure liberates the compartment with oxygen.
- **Compromised doors.** Doors left open, whether propped open or caused by defective self-closing devices, allow a compartment fire to extend into the hallway. Doors leading to the stairwell become smoke-saturated. Eventually, smoke will continue to saturate the building, exposing building occupants to greater risk. Every door open represents a potential flow path. This influences smoke movement. Thus, stack effect and reverse stack effect will be amplified when doors remain open. Smoke conditions encountered in the stairwell requiring already exhausted firefighters to mask up early invites further challenges, such as firefighter disorientation and out-of-air scenarios.
- **Elevator failure.** Elevators are likely to fail at some point during a high-rise fire for many reasons. No specific data is available that can predict the exact time in minutes when failure is likely to occur. Statistics continually show that, on average, elevators in the affected areas of a high-rise fire will likely malfunction and shut down 15 to 20 minutes into the operation, allowing only minimal usage time.[1] When this occurs, other resources are cut off from reaching you when the elevator fails.

Proper staffing, logistical support, and timely firefighter relief are necessary for a sustained, uninterrupted high-rise operation. The entire operation will suffer severe delays when it is now restricted to stairwell movement.

These vulnerabilities are exacerbated by time. The fire you were called to 20 minutes ago will not be the same fire you will encounter. The valuable time lost during a lengthy stair climb gives the fire additional time to develop and spread, resulting in adverse conditions when firefighters finally arrive at the fire floor. Fire spread and smoke propagation are significant concerns in large, open-floor commercial high-rises. In many instances, the rate of fire spread and the time to reach the fire are beyond our suppression capabilities, lending the importance of the 18-minute threshold for water application.

While residential high-rise buildings afford compartmentalization, which may buy us some time in a stairwell-only response, their effectiveness in thwarting fire spread and smoke containment remains dependent on the integrity of the unit on fire. This is a troubling concern in older, nonsprinklered residential high-rise buildings, where aging infrastructure, neglect, and insufficient maintenance of passive fire protection systems can adversely impact a high-rise operation.

In many instances, firefighters must also contend with the converging counterflow of self-evacuating building occupants coming down the stairs as firefighters climb up, further causing significant time delays. An existing building with a narrow return stair width or scissors stairs makes it difficult for firefighters to maneuver, creating an impasse and preventing further movement. It is not uncommon to find building occupants in stairwells despite shelter-in-place directions given beforehand.

Physical and Physiological Effects on Firefighters

Nothing is more taxing on the human body than climbing stairs to reach the fire floor, coupled with the heavy equipment that must be brought up. I am referring to stair climbs that cover a vertical distance of 10, 20, or 30 stories to reach the fire. Stair climbing involves lifting, propelling, and driving the body up against gravity, engaging more muscle mass than walking. This ascending motion requires increased stamina, lower body strength, and increased aerobic capacity, which exposes firefighters to a greater risk of cardiovascular and heat-related events.

Cardiovascular Effects

Research studies highlight the intense physical demands of firefighters climbing stairs with heavy equipment. One study found that carrying 86.5 pounds of equipment imposes significant and prolonged strain on the cardiovascular system. Heart rates can quickly rise to 95% of maximum capacity in as little as five minutes, gradually reaching dangerous peak exertion levels of 180-200 beats per minute (bpm), particularly in less-conditioned firefighters.[2] The greater the vertical distance of the stair climb, the greater the likelihood that firefighters will need to stop and, in some cases, summon medical attention for overexertion, chest pain, or shortness of breath.

Prolonged stair climbs further elevate heart rates as the body struggles to meet escalating oxygen demands, where energy requirements can exceed 80% of a firefighter's maximum oxygen uptake (VO^2).[2] Historically, cardiac events, including sudden cardiac arrest, have been the leading cause of firefighter line-of-duty deaths. Contributing factors that induce cardiac compromise include carrying heavy equipment with protective gear, heat stress, overexertion, and working at near-maximal heart rates for extended periods of time.[3] Prolonged fatigue, a result of increased heart rates, impairs cognitive abilities, diminishes dexterity, and causes auditory impairment, further limiting firefighter performance and decision-making abilities.

An automatic external defibrillator (AED) should be included and made available in your high-rise operational plan for firefighters undertaking a lengthy stair climb. The AED needs to come with them. Firefighters in cardiac arrest need CPR where found, moved only when immediately dangerous to life or health conditions dictate and not carried down flights of stairs to render care. In a stair-alone operation, there will be significant delays in getting medical teams up to reach the down firefighter.

Thermal Effects

Although personal protective equipment (PPE) provides adequate protection from thermal effects when operating at a fire, our gear also exposes us to other adverse physiological effects on the body, such as heat stress and heat exhaustion. The thermal layers of PPE tend to trap heat, allowing only minimal heat dissipation. The strenuous activity involved in a lengthy stair climb increases core body temperature, placing the cardiovascular system at further risk.

Ascending stairs, encapsulated in PPE, generates significant internal heat with limited ability to dissipate it through perspiration. Prolonged stair climbs can cause core body temperature to rise rapidly, exposing firefighters to the dangers of heat-related injuries. Heat exhaustion begins at a core temperature of 100.2°F, while an increase to 100.9°F poses a serious safety concern and significantly increases the risk of a cardiac event.[4] Firefighters should not exceed a core temperature of 102°F. Life-threatening conditions, such as heat stroke, can occur when body core temperatures exceed these thresholds. The point of heat exhaustion can occur in as little as 15 minutes when wearing PPE.

How Long Does It Take Firefighters to Climb Stairs?

Over the years, many comprehensive studies have been published examining the climbing rates of firefighters when stairs are used exclusively. The data extracted from these studies can be used to quantify the time it takes for firefighters to climb stairs. This data is helpful in determining how time will

affect our vertical response time in these situations.

Many of these studies suggest that, on average, a firefighter can climb one minute per floor wearing PPE and self-contained breathing apparatus (SCBA).[5] The one minute per floor is consistent for the first 10 stories of a stairwell ascending. However, fatigue becomes a critical factor by about the 12th floor. What can be drawn from these studies is the assumption that equipment-laden firefighters will start experiencing difficulty in climbing by about the 10th floor. This difficulty of ascending the stairwell will be exacerbated based on two factors: the vertical distance traveled by stairs and the total net weight of equipment carried.

When firefighters must ascend the stairs beyond the 10th floor, studies reveal time variations in climbing rates depend on the amount of equipment carried. To summarize, a reasonable assumption can be made that firefighters not burdened with extra equipment will take 1.4 minutes per floor compared to firefighters carrying additional equipment who took 2.0 minutes per floor for climbs that exceed the 10th floor.[6, 7] The weight of the equipment firefighters are expected to carry is the most substantial individual predictor of stair climbing performance. Seldom is weight considered in high-rise fire deployment models. For example, carrying an extra load equivalent to 30% of a firefighter's body weight decreased ascend rates by nearly 25%.[6] However, a more realistic assumption is that firefighters will carry 50% to 75% of their body weight in heavy firefighting equipment. This would suggest that the ascend rate would decrease further, adding more time to a stairwell operation.

The climbing rates used in these studies suggest or provide a predictive model based on relative assumptions of a very broad-based sample of firefighters used in these experiments. Climbing speeds will vary among firefighters. Factors such as age, gender, level of fitness, body mass index, and equipment carried are the major determinants that will affect levels of performance when stairs are used.[6, 7] For stair climbs beyond 10 stories, a short rest period (60 seconds) should be included for every five to six stories climbed. A brief rest allows the heart rate to decrease slightly and allows other firefighters to catch up and check their well-being.

In our 27th-floor climb scenario, even if a few firefighters manage to make the climb, how effective will they be in initiating an effective, collaborative fire attack? Most likely, the firefighting contingent will be a splintered group from different fire units lacking adequate supervision, affecting their ability to coordinate an effective fire attack. This scenario describes a realistic example of a systemic failure, potentially affecting every portion of the high-rise operation.

Equipment Deployment: Methods and Rationale

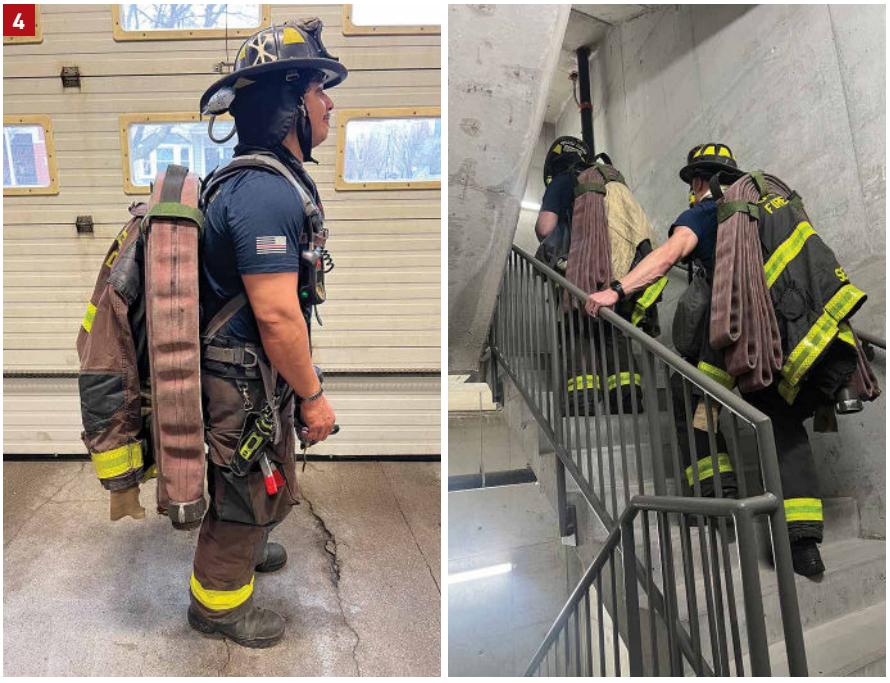
The net weight of equipment and how it's carried will affect firefighter climbing rates. Excessive weight will eventually slow their ascent. Regardless of their physical conditioning, the stair climb will still be cumbersome. The greater the load, the faster the onset of fatigue and physical exhaustion. Carrying the weight equivalent of a 135-pound barbell up 40 flights of stairs without using the elevator is an extraordinary challenge, even for an Olympic athlete.

The tenacity of firefighters is unmatched and unwavering. Realistically, they will carry too much weight without giving it a second thought. This is a concern with a low-response profile lacking sufficient personnel to help bear the weight of equipment. A staffing-lean response, by default, encourages firefighters to overburden themselves by carrying too much equipment, which will further delay their arrival on the fire floor in a stairs-only operation.

Unrealistic Climbing Load

Weight slows down firefighters. This method of equipment deployment is unrealistic and dangerous when a significant vertical distance must be covered using only the stairwell. The burden of carrying too much weight will eventually cause the stairwell operation to come to a grinding halt once the physiological and thermal consequences manifest. The goal is to get firefighters up into the building where they need to be. Expectations of what is to be carried—and how—must be realistic. This requires a well-thought-out approach for considerable stair climbs. The goal is to minimize the amount of weight carried per firefighter.

3. Bottle loading is a more realistic method for transporting hose bundles. Here, each firefighter deploys only one hose bundle. This method allows the weight to be distributed on top of the SCBA harness, the weight carried is reduced, and the hands are free to use the handrail to assist in more efficient climbing motion. *(Photos by author.)*



4. Disrobing is a technique that alleviates some of the heat buildup when climbing stairs by simply adjusting how the PPE is worn. This effective deployment model addresses heat-exhaustion concerns for stair climbs beyond 10 floors in a clean stairwell. In addition, to further reduce the effects of heat buildup, gloves, helmets, and flash hoods can be removed and properly stowed. *(Photos by author.)*

Besides weight, how firefighters carry equipment is another obstacle to efficiency. Shoulder-loading hose bundles tend to shift and slide off, forcing frequent stops to readjust. At the same time, carrying tools (such as a high-rise bag and air cylinders) in your hands leads to grip fatigue, also requiring frequent stops to switch hands. Weight must be high and close to the body, above your hips, preventing equipment from banging against your legs during the stair climb. The goal is to minimize the amount of weight carried, but it also requires a well-thought-out plan for efficiency.

SCBA Bottle Loading

Bottle loading is an effective method for carrying hose bundles. It distributes the weight evenly, resting neatly atop the SCBA air cylinder and tight against the firefighter's back (photo 3). Here, the weight is axially loaded close to the firefighter's center of gravity, freeing his hands to use the handrails when fatigue sets in. When properly worn, the waist strap of the SCBA absorbs 75% of the weight of the hose bundle, transferring the weight to the hips instead of the shoulders. It will be necessary for a second firefighter to assist in getting the hose bundle in position.

Bunker Coat Disrobing

A more practical method for climbing stairs beyond 10 stories is to disrobe, granted that the stairwell is smoke-free and nontoxic. This method reduces heat buildup, maintains body core temperature, and allows heat to dissipate unrestricted from the upper torso, reducing the risk of heat-related injuries. Before a lengthy stair climb, remove your turnout coat and SCBA (photo 4). Don the SCBA first, then place the turnout coat neatly atop the air cylinder. The hose bundle is then placed over the turnout in a bottle-loaded fashion for the ascend. On arrival at the destination floor or when encountering changing conditions during the climb, you can don the PPE and SCBA in less than one minute. This time is minimal compared to the cessation of a stair climb due to fatigue and heat exhaustion.

Understanding Stair Climbing Dynamics

The operational impact of a stair-well-only operation creates many challenges, making the entire high-rise operation vulnerable to additional risks.

- Valuable time is lost when ascending stairs due to elevator unavailability.
- Make sure firefighters maintain a high level of physical fitness to meet the demands of high-rise fires.
- Examine efficient deployment models and explore lighter equipment options for high-rise fires.
- Include high-rise contingency plans that address stair-only vertical movement.
- Learn how to treat and remove a down firefighter descending the stairwell.

Understanding the unique dynamics of high-rise firefighting is vital for improving safety, reflex times, and operational effectiveness and will better prepare you for events like this. ■

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Coming to a Town Near You!

BY **TOM MERRILL AND MICHAEL M. DUGAN**

THE WAY AMERICA SHOPS has changed quite a bit over the past 20 years. And, to help support the new shopping habits, there has been an increase in the number of big-box warehouse type stores, supercenters, megastores, and distribution centers being built. Big box is a term used for industrial facilities or warehouses that store all sorts of products awaiting distribution throughout the region. They are often used by retailers catering to online customers but can also be used to stockpile products for the traditional brick and mortar stores as well. Commercial big-box stores can be broken down into two basic categories: general merchandise such as Walmart, Target, and Costco and specialty retailers such as Home Depot, IKEA, and Best Buy. These retailers specialize in goods within a specific category of merchandise. These might include hardware, books, furniture, and electronics.

The common denominator between the two categories is that the buildings are very large. A big-box warehouse has a minimum size of 200,000 square feet to 650,000 to 750,000 square feet. Fulfillment centers range in a size from 600,000 square feet to more than 1,000,000 square feet and most employ more than 1,000 employees in those facilities.

They are large in terms of quantity as well. In 2023, the big-box building inventory amounted to approximately 2.9 trillion square feet in the United States. In 2023, there were more than 6,000 big box buildings in the United States. Warehouse distribution centers have grown in numbers every year since 2013; in 2023 alone, 1,827 were constructed.

If you are not ready to operate in one of these large buildings, you are going to have a problem. You need a plan, resources, standard operating procedures, and breathable air to fight these fires. The question is, are you ready?

1. Depending on the resources of the responding department and the volume of fire, a defensive attack might be your only choice. *(Photo by Lloyd Mitchell.)*

There are many reasons for the explosive growth in the big-box world. Changing consumer habits in the wake of the COVID-19 pandemic, the closing down of many traditional retailers, and a switch over to e-commerce and online shopping are just a few of them. Small mom-and-pop stores are being driven out by high rent and the cost of doing business. The construction boom in big-box and mega warehouses does not appear to be slowing down anytime soon,

and if there isn't a big-box distribution center in or near your first-due area yet, there is a good chance one will be coming soon. If you want to know, use the map app on a phone or tablet and ask it to search for "big-box stores and fulfillment warehouses near me." You will be amazed.

Firefighters may find themselves driving by these buildings without even giving them a second thought. They take comfort in the fact that the buildings seem to be well built. It's easy to be complacent because the buildings may be relatively new and conform to all the latest building codes. Most have sprinklers systems, standpipes, and other modern fire safety systems in place, so you may think there is just no way that they can burn.

But they have burned, and there have been plenty of serious fires along with many near misses that firefighters everywhere need to be aware of and take note of the important lessons learned.

Fires and Near Misses

Here are summaries of some of the fires, incidents, and near misses.

- In Dayton, Ohio, in June 2024, there was a fire on the fifth floor of a big box facility.
- In Alcoa, Tennessee, in March 2024, there was a fire in a 634,812-square-foot warehouse that had 16 miles of conveyer belts to move one million packages a day. It had just opened a few months prior.
- In Staten Island, New York, in October 2022, there was a compactor fire on a loading dock that spread smoke throughout the building.
- In Huntsville, Alabama, in September 2022, a small and isolated fire was knocked down quickly in a big-box facility that had only been open for a year. There was a second fire there a week later.
- At a Walmart warehouse fire in March 2022 in Plainfield, Indiana, the 1.2-million-square-foot warehouse burned for days. It took 30 fire departments to fight the fire. Investigators are still unsure what started the fire, and a new warehouse is going up on the site now.

2. The footprint of the structure is going to be a key point in determining the resource needs. Some of these fires burn for days at a time. *(Photo by Tim Olk.)*

- In Edwardsville, Illinois, in December 2021, a tornado destroyed an Amazon warehouse, killing six people when the warehouse collapsed. Amazon said in response it has reviewed its emergency procedures, increased manager training, mandated drills (two per quarter), and issued cards to all employees outlining safety procedures for severe weather events. It has also assessed where severe weather assembly areas are to ensure they are in the right place.
- In Redlands, California, in June 2020, an Amazon warehouse caught on fire. A quick search will lead you to video of the gigantic warehouse filled with flames.
- At a Gap warehouse in Fishkill, New York, in August 2016, the 1.3 million-square-foot building was reduced to rubble. Firefighters from 23 departments fought the fire. Officials ruled the fire was intentionally set.

Preplanning

Fire departments charged with protecting these structures must recognize that they present many serious challenges. A lot of planning needs to be done well ahead of time, before the emergency call comes in, preferably even before any shovels hit the ground to build the structure. You need to have a seat at the table to ensure the fire department needs are addressed. There at the table, you can discuss what special equipment you may need or what management can put in place to make emergency operations easier, safer, and more effective. Preplanning is not often at the top of the chief's "to-do" list, and that can be understandable with everything department leaders are responsible for. But it is imperative that the preplans are put in place ahead of time, before the call comes in.

A normal size building has plenty of hazards to be aware of and operational strategies to consider, but the big-box structure takes planning to another level. Proper preplanning prevents poor performance and can make the difference between success and failure. Even if your department has a robust preplan program in place, these facilities can prove problematic to train in or even conduct a walk-through in. Management must understand that a plan needs to be worked out that allows departments time on site to not just conduct a walk-through but to train there as well.

The planning process must encompass many levels. Management and contractors need to understand the needs of the first responder agencies. As much as we are going to want fire crews to have a basic understanding of the building layout and operational procedures, building employees must understand the need to relay important

3. If an advanced fire problem is present, there will be a need for resource management to maintain a continuous operation. *(Photo by Tim Olk.)*

directions to the dispatch center as well. The dispatch center must also be involved in the planning process so dispatchers can update their computer system with important notes and be trained to ask the right questions when calls come in from a big-box complex.

The planning needs to also include neighboring departments as well because chances are they will be responding to any serious emergency involving these structures. The planning must include someone in the facility in charge of employee safety. This person should also be assigned as the communications director to immediately report to a predetermined location to inform the incident commander (IC) of the situation. The IC will also need information about the fire safety system in the building. What types of standpipe, sprinkler, communications, and air systems are in the building to support the firefight?

Most of these buildings are operational 24 hours a day, 7 days a week. We must be proactive, or we will allow a certificate of occupancy to be issued without getting much needed guarantees that we can drill in the building on a regular basis. Most of these big-box complexes are always operating and may not want to allow fire departments access for training because it doesn't fit in with management's schedules for the facility. If the facility shuts down on July 4 or on Christmas, that may not be the best time for a volunteer fire department to assemble members for a training drill. It's best to work out agreements ahead of time and in writing to accommodate fire department training drills.

The critical conversation is about how you are going to handle any type of fire in these facilities. Some municipalities have chosen to hide their head in the sand and not get involved. This is a huge mistake because you lose all your bargaining power after the certificate of occupancy is issued to the facility. Staffing expectations and mutual-aid agreements need to be factored into the conversation. Playing catchup is never a good fireground strategy.

It's important to note that this topic and these challenges do not just apply to big city fire departments, as these structures are in just about every geographic area. Even in rural America, large retailers and manufacturers are building an increasing number of big-box buildings. Land can be less expensive, and highway and interstate access can be more convenient than in a city, so distribution centers, warehouses, and industrial spaces continue to absorb land.

In many of these settings, that land is protected by volunteer or smaller fire departments. The local municipality is also looking for employment for

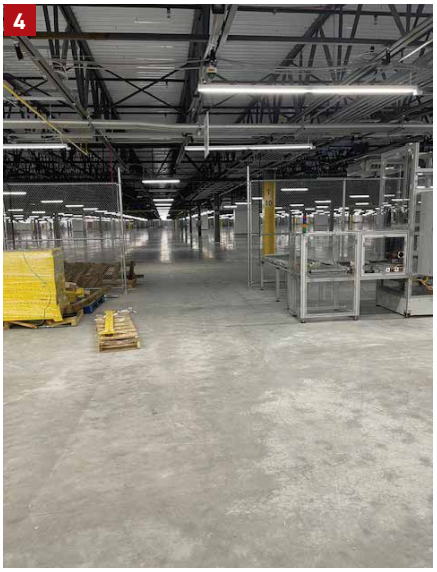
citizens, income generated by construction, and the tax revenue these businesses create. This is a serious topic that is equally important to all firefighters everywhere.

These meetings are also a great time to discuss emergency action plans and recommend that someone needs to be on duty, on all shifts, to ensure the safety of employees. A system must be put in place that allows for effective communication throughout the building and even to the 911 center in case of emergencies. There may be restrictions placed on employees regarding cell phone use, and perhaps they are not even allowed to have cell phones while working. If that's the case, there needs to be a designated person located in strategic areas, on all shifts, who can call 911 for help and get the word out regarding an emergency and what actions need to be taken.

It's important to remember that proper planning and preparation are not limited to fire incidents. Consider the risk of snowstorms, tornadoes, floods, power failures, and even civil unrest and the impact on the big-box facility and, by extension, the nearby fire department. A hazardous materials incident on the highway nearby can have severe consequences on the facility's operation if deliveries can't be made.

Remember, many of these complexes are built near major thoroughfares. If they are closed for an extended period, it can have a serious financial impact. Evacuating these complexes can be extremely difficult for first responder agencies already dealing with a hazmat spill or even an impending weather event.

It's important to understand that a "routine" medical call or alarm activation investigation may not be so routine at these big-box facilities. If responding units do not know what entrance to use, they may park a long distance away from the distressed party or from the fire alarm panel. A simple request that is easy to accommodate during the planning process is for numbers or letters to be assigned to all the entrance points. These can serve as a point of reference for firefighters making entry and can also help when directing crews on a medical call. The dispatcher can relay what door letter or number to use to quickly get to the patient, and building staff can be waiting at the entrance to lead crews to the patient or location of a problem. Of course, this only works if the staff is trained and educated on the procedure, which is another reason to have a seat at the table ahead of time.



4. On a good day with no heat or smoke, how far into this building could you get in full gear and SCBA? What if the building is loaded with materials? *(Photo by John Feehan.)* **5.** Imagine this space in a heavy smoke condition with sprinklers discharging water. How deep are you willing to get without protection of a handline or an air source? *(Photo by John Feehan.)*

Challenges for these structures include the need for people, water, and air. The need for water will require you to be involved with standpipe systems. What type of system is it? What is the water supply? What size water mains are supplying this building? Is there a yard hydrant system, which may have limited water supply? Is it a dead-end main system? You need to know this going in, because any type of fire in this building is going to require a large volume of water to fight.

What is your number of personnel responding? How many members in your volunteer department are interior certified and willing to show up at a fire? If you are a small career department, how many members do you have on the apparatus? Any fire is going to be labor intensive.

Once the building is up and operational, departments should conduct regular walk-throughs and gain familiarity with the building layout. Note where all the fire department connections are located, what area of the building they supply, and how they will be supplied. Do they have locking caps requiring a special key to unlock them? Do all nearby departments have that key?

Record the location of nearby fire hydrants and whether they are private hydrants or municipal hydrants. Locate, mark, and record the fire department connections. It's also critical to note how they are supplied.

At one recent fire, the water supply line supplying the sprinkler system was on a dead-end main. A pumper tapped into a hydrant a few hundred feet back from the building, limiting the sprinkler's output and effect on the fire. Obviously, this is something to address before shovels even hit the ground, with looped hydrants being the preferred method.

Crews need to understand how the machinery works, especially the robots that zip around from point A to point B gathering inventory for shipment. They

6. The column closest to the camera is marked D-21. There are at least 20 additional bays between the columns. If you haven't adequately planned before the fire, it will be way too late to do it during the fire. *(Photo by John Feehan.)*

are programmed to "go and get" and, if a human gets in the way, may not know to stop, causing serious injuries. There are specific directions that can help "nest" these robots, but the time to learn how to do it is at a preplan drill. You also need to know where the power shutoffs are located for the conveyor system. In some buildings, there are miles of conveyer belts that may need to be shut down during a fire or other emergency.

It's always a great idea to test the radio and communication equipment and see how it works from inside the building. Determine if repeaters or signal enhancers are going to be needed to help facilitate radio transmissions. Be sure to work with the communication center to see if the dispatchers can effectively transmit as well as hear the radio traffic.

Training

Assembling a plan is one thing, but ensuring it is understood is another. Preplan binders gathering dust on a shelf or locked away inside a computer do no one any good if you do not occasionally review and drill on plans. Crews coming in on mutual aid will not be very helpful if they are coming in blind.

Add training and familiarization drills into the department schedule and review them often. Members come and go. Make sure you educate new members and bring them up to speed. Even veteran members will appreciate the refresher as well as build muscle memory that comes from regular drills and training.

When training on these buildings, consider strategy and tactics. Take search rope procedures, for example. First, ensure that your search ropes are uniform throughout your companies. All search ropes should be the same on every apparatus and should be marked in a similar fashion to indicate what company or unit deployed that rope. Second, take into account the type of search you are doing. Are you searching for fire or for missing employees with a hoseline operating on the fire? This is vital to the safety of your personnel. If you are searching for fire, members should not be entering the building more than 50 feet without a hoseline for protection. If you are operating up to 50 feet inside and still haven't found the fire, bring a hoseline to protect those members' escape. Once you have water on the fire, the searches can be more extensive and deeper into the structure.

The protection of members is essential to all successful operations. Are you allowing them into the building? You must decide how you plan on fighting this fire and how you are going to protect your members. A lot of progressive fire departments are using the method of thirds of an air bottle: one-third for operations, one-third for exit, and one-third for emergencies. Many others are using the half bottle rule: half a bottle in, half a bottle out. Many departments are also installing Firefighter Air Replenishment Systems (FARS) to provide air refill on the interior of the building. Normally located near standpipe outlets or egress areas, "the air standpipe" allows refill while being under full respiration. Firefighters can continue operations without having to leave for a refill of their second bottle. This would prevent the loss of critical reflex time for fires that can be fought from the interior.

Big-box stores and distribution centers are being built at an increased rate and in all types of areas. Because they are new and must conform to all the latest building codes, they'll have modern fire protection systems in place. This may cause leadership and responders to discount the serious challenges in these structures. But recent history has proven that big-box structures do catch fire and present many hidden dangers and obstacles, even during nonfire incidents. It's imperative that responders work to understand the risks and educate themselves so they can be better prepared and educated ahead of time. Department leaders need to ensure they have a seat at the table from the start. The time to be proactive is before the emergency call comes in and the tones drop. Are you ready? ■

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Instant City! Meeting Service Demand and the Need to Breathe

BY DANIEL E. DEYEAR

YOU HAVE BEEN PROUDLY serving your community at your firehouse for years. There has been a steady increase in service demand as your community has grown, nearly doubling in size over the past 45 years. Your routine structure fires are in single-family homes with three or four bedrooms averaging 1,500 square feet in size. You respond to the occasional two-story apartment building, a few schools, churches, an old downtown historic district, a few strip shopping centers, fast food restaurants, and a couple of motels. You know your community well and are prepared.

Imagine if, overnight, your community population expands by more than 50% as a construction camp materializes, and the largest buildings you have ever seen begin to be erected in your first-due district. Infrastructure, traffic, economics, shipping centers, and support ventures begin to arrive. How are you going to meet the service delivery expectations, and is there anything that can help you? Is there a tool that would be your friend?

1. Photos courtesy of author.

Welcome to Taylor, Texas

Just 30 minutes north of Austin, the state capital of Texas, sits a small community called Taylor, Texas (photo 1). This community was established in 1876 due to the growth of the International Great Northern Railroad and was initially named Taylorsville after Edward Moses Taylor, who was a railroad official.

Two years later, the community boasted 1,000 residents and 32 businesses, both of which were impacted by a serious fire in 1879 that destroyed 29 of those businesses. By 1886, the Taylor Volunteer Fire Department had been established, and the community was named Taylor in 1892.

Taylor was all about the cotton industry for decades, specifically focused on harvesting and gin processing. In today's world, the Taylor Fire Department is like many communities and jurisdictions found across the United States that evolved from a volunteer to a paid fire department. The Taylor Fire Department provides fire protection, EMS first response, special operations, wildland response, and auto extrication while responding to every possible emergency service need the 19,000 residents could require.

The Taylor Fire Department responds to about 3,000 incidents annually from two firehouses with an engine company and a truck company, which is a quint. Eight on-duty firefighters (minimum of seven firefighters) provide emergency response in addition to an administrative chief officer who responds from office or home after hours. Add in the visitors, commuters, and workers in a rapidly growing region of central Texas, and you will see many challenges.

In late 2021, Samsung announced plans to develop a semiconductor facility on 1,300 acres of unoccupied farmland in Taylor, Texas. This project is the largest foreign development project in history within the state of Texas. The initial $17 billion development will involve six million square feet of buildings, factories, warehouses, and offices for semiconductor creation, expansion, and production. This will be Samsung's flagship project in the world, and a large berm was constructed where traveling dignitaries from South Korea can observe the construction progress.

10,000 Construction Workers

Beginning in early 2022, an instant city was created to accommodate 10,000 construction workers, contractors, engineers, architects, and support services who all began arriving en masse, seemingly overnight (photo 2). A fire department that had been protecting 19,000 citizens now had an instant city that was erected to temporarily house, support, feed, and serve this new development.

The 28-member Taylor Fire Department is led by Chief Daniel Baum, who immediately foresaw many of the challenges that would alter his fire department and the community forever. He was successful in immediately getting support and finances to hire an outside firm to analyze, evaluate, and develop a master plan that would assist

the community and fire department with this unprecedented service demand.

It is difficult to imagine the challenges a community and fire department this size would have to address as electricity, water, sewage, traffic flow, access, food, medical, and other services popped up nearly overnight, not for the multimillion-square-foot project but for the temporary construction project that would make it all happen. The response, access, hazards, life rescue, and reflex time will look nothing like your normal routine. The longest preconnect fire hose on your fire apparatus is only 250 feet in length.

The Fire Marshal's Office for the Taylor Fire Department consists of Assistant Chief Robert Copeland, who serves as the fire marshal, and Lieutenant Eric Engelke, the fire prevention officer. Their normal routine of serving a fast-paced growing community now had a challenge never before seen. As temporary roads and utilities were being installed, construction trailers began arriving by the dozens. It is estimated that this new instant city contains more than 300 construction trailers. Although they are numbered for clarification, lined up in hundred block series (100, 200, 300, etc.), there is one trailer with the number 599 on it (photos 3 and 4).

Some of the construction trailers are so large that the fire code required them to be fully sprinklered, another challenge in a farm field where water service was not originally planned (photos 5 and 6). The construction trailers basically sit in two separate construction camps. One is dedicated entirely to Samsung and consists of more than 10 trailers that are all sprinklered due to their size. In the contractor camp, two trailers, each exceeding 12,000 square feet, occupied by Yates Construction and Henzel Phelps, were required to be sprinklered by the fire code. The fire department connections are supplied by Storz connections.

This instant city of 10,000 people required electricity, which is being augmented with dedicated circuits for about half of the trailers and power generators for the other half. Temporary water distribution is a challenge as well as septic and sewage disposal. Water tanks for domestic water usage and tanks for wastewater exist throughout the construction camp. Entry to the site is through security access gates and temporary roads where responding apparatus would be escorted to the correct location (photo 7). Approximately 25 fire hydrants were installed to provide fire protection for the construction city. Each row of trailers has three hydrants for fire protection service. Some of the biggest challenges for fire prevention officials have been the use of extension cords for powering the water pumps and fire lane blockage. Recently, the mass number of ATVs and golf carts became so excessive, causing traffic jams and safety concerns, that a limit of two vehicles per company was instituted.

EMS for this area and job site is provided by Williamson County EMS, and there is an on-site medical clinic with a nurse practitioner and a contracted rescue team within the construction project. At present, the Taylor Fire Department and Williamson

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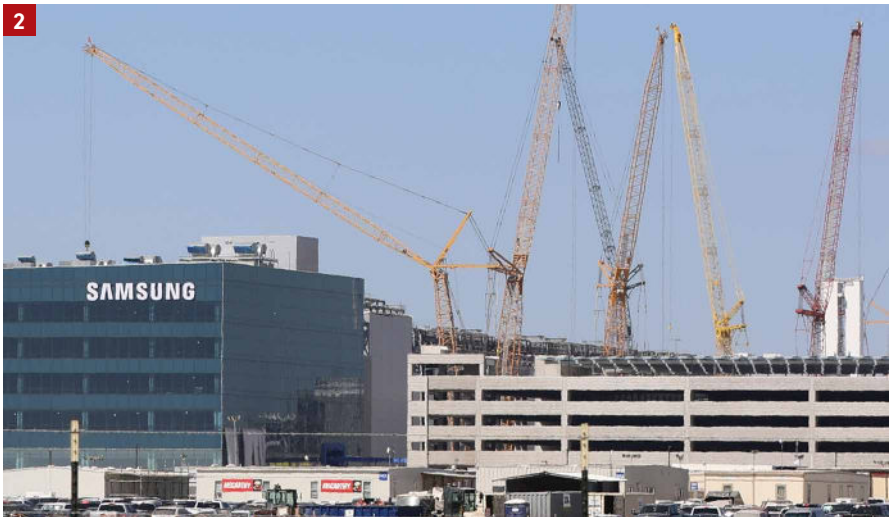

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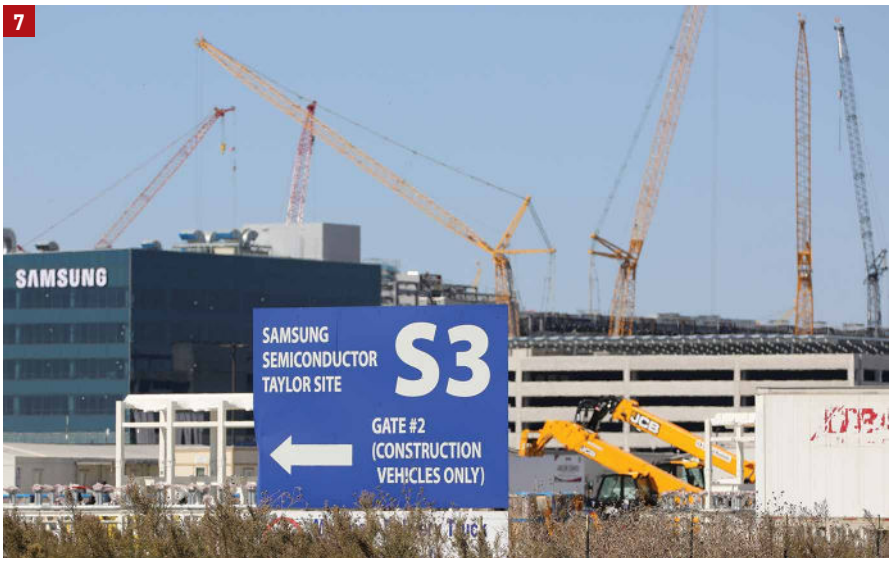

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County EMS are responding daily, sometimes more often, to the site.

With seven or eight initial firefighters responding to the site, it is worth noting that the Taylor Fire Department only owns 19 self-contained breathing apparatus (SCBA) units. The SCBA program is overseen by Lieutenant Cody Kraemer. Each of the two fire apparatus have four SCBA, and the fire marshal has one assigned. There are additional SCBA on order that will augment the reserve apparatus in the future. The Taylor Fire Department has a rehab vehicle that consists of a cascade system that could fill 20 to 40 SCBA bottles, but the vehicle would have to be staffed by a volunteer from the community emergency response team or an off-duty member. The vehicle does not have a compressor. Presently, there are 32 air bottles within the department. There are plans for up to 60 bottles in the future. Once the cascade system has been used, it must be refilled by the compressor back at the fire station.

Nearby fire departments would respond on automatic assistance or mutual-aid agreements for a major incident. Hutto Fire Rescue is the closest department. It would respond with an engine company with four firefighters and would be approximately 10 minutes away. Additional responding departments would include Pflugerville, Round Rock, and Georgetown, all at least 20 or more minutes away, depending on traffic and time of day. Although Hutto is in the process of obtaining a mobile air supply cascade unit, Round Rock would be responding with the nearest air cascade compressor unit.

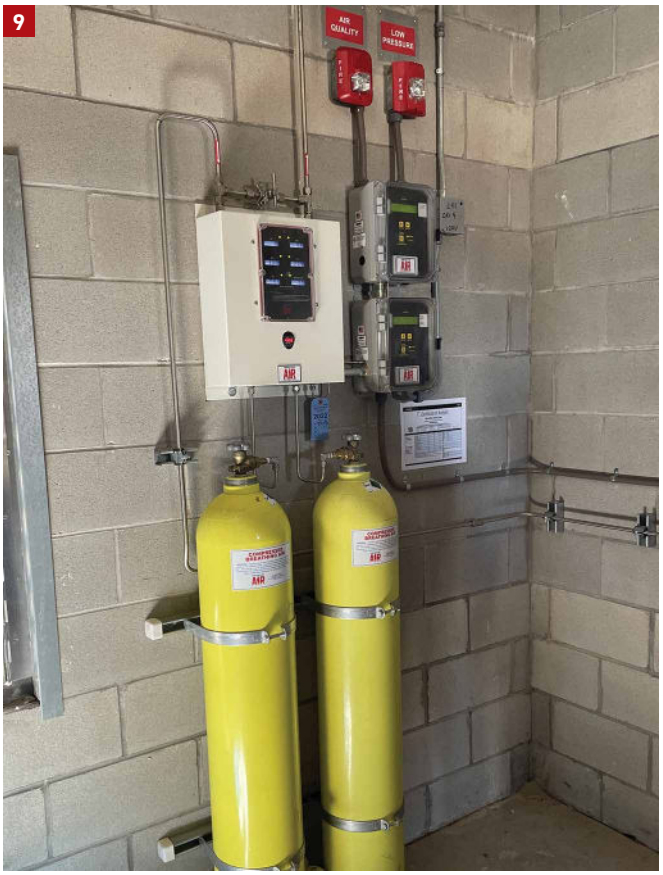
In addition to the ever-present fire safety concerns, hazardous materials will be used in large quantities within the complex. For example, Soulbrain TX, LLC, will provide electronic grade phosphoric acid to the site, which will be used as an etching agent for the electronics and semiconductor manufacturing processes. This company is building a $175 million 60,000-square-foot plant east of the Samsung location to meet this demand.

Just like every fire department in the country, the Taylor Fire Department and surrounding communities rely on air supply when responding to fire incidents, chemical or hazardous material spills, or whenever there is a potential immediately dangerous to life or health (IDLH) environment.

So, how do seven breathing firefighters arriving on two fire trucks respond to a potential life-threatening emergency in a six-million-square-foot facility? They will be arriving wearing an SCBA but will be unable to carry additional bottles because their hands will be full of firefighting gear and equipment.

Doing the right thing in the construction world is rare when it comes to fire safety—hence, the fire code requirements and subsequent inspections and enforcement. It is also rare that the fire code would give a tool to a firefighter. Thankfully, the *International Fire Code* (*IFC*) now addresses the health and safety of firefighters through air management. The Firefighter Air Replenishment System (FARS) is simply a tool for real-world firefighters. It is not a fire prevention issue. Unfortunately, previous generations of firefighters did not have these systems, which contributed to the increase in cancers and health issues within the firefighting community, especially those who ever blew "snot rockets" out of their nose because they didn't have access to or were not using state-of-the-art air systems. The Firefighter Air Coalition (FAC) is dedicated to and focused on firefighter air management in any situation, especially when it comes to firefighters' safety and health. The FAC is a big supporter of FARS, dedicating technology, training, and research to firefighter air management. These systems are required by code to be monitored and tested for air quality ensuring firefighter health and safety (photo 8).

The need for a standpipe is an admission that the fire protection system has failed. If some of the hundreds of fire extinguishers required in many buildings are used, if the fire detection system operates, if the sprinkler system triggers, then why is a firefighter potentially hooking up to a standpipe? It would seem as if something failed within the fire prevention system. Any firefighter who connects to a standpipe must be able to breathe. Water systems fail or break, sprinkler systems are shut down for service and maintenance, and things simply go wrong in the fire service world—not to mention chemical spills or hazardous materials where fire prevention systems are useless but breathing becomes



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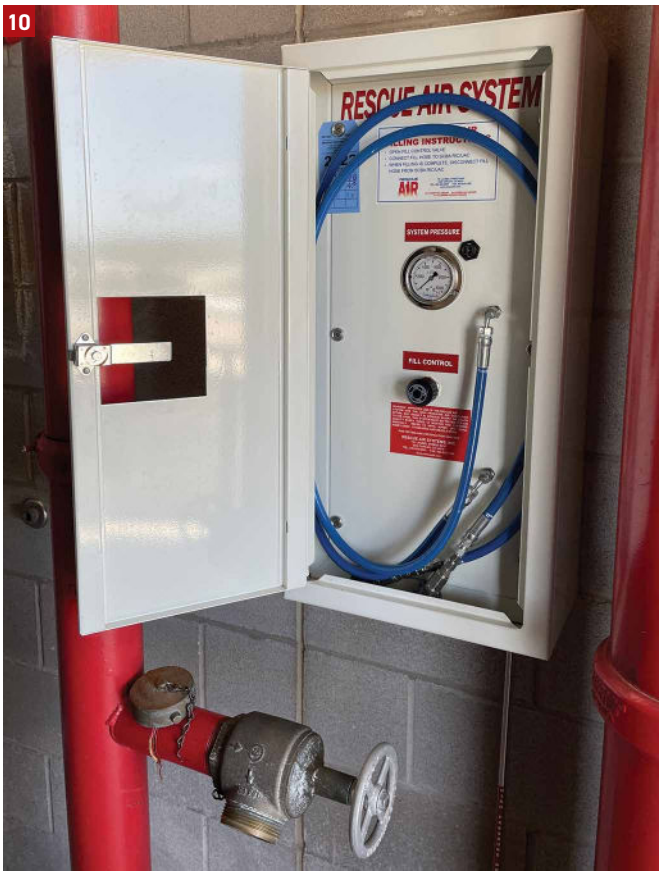

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more important than ever to save lives and mitigate the emergency.

Thankfully, Samsung is a forward-thinking company with an eye and value on safety. In addition to state-of-the-art fire detection and fire suppression systems, the property also has standpipes and FARS. Considering that responding firefighters could easily walk hundreds of yards within one of these structures, possibly even as far as 1,000 feet, air supply could be compromised before the initial firefighters could be in place to mitigate the emergency or even possibly save lives and effect a rescue. As Kraemer stated, "There is no way we could do our job without the system" (photos 9 and 10).

The Samsung project has four distinct buildings with a FARS. The fabrication building has 26 air filling panels, the central utility building has 12 air filling panels, and the office and gas chemical storage facilities have 10 in each. These buildings all have a dedicated cascade room that is capable of filling 50 SBCA air bottles, which is more than the Taylor Fire Department presently owns. There is also a connection for a mobile air compressor system to connect and supplement the air system.

The initial price tag for the completion of this massive complex has risen to $37 billion. The Taylor Fire Department is facing future challenges that could easily come and already exist in many jurisdictions around the United States. It is imperative that forward-thinking fire chiefs and fire code officials work together to address these massive developments that local fire services are expected to respond to and mitigate, none of which can be accomplished without breathing firefighters. It is comforting that the *IFC* places this tool in the hands of serving and committed firefighters.

Lastly, the framework of regulations on the American fire service advocates that fire services be delivered with the health and safety of firefighters as well as the community as a focus and not an afterthought. Productive stress exists while balancing the desired level of fire service delivery and the cost associated with such a plan. While the cost of growing a department and providing the necessary resources to respond to a monster-sized structure or complex such as Samsung is unrealistic from a cost perspective, the challenges and dangers are very real. What local communities, developers, builders, and owners do today will serve as a measurement of our responsibility and promise for the future. ■

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