

A fresh look at two-in/two-out

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The fire service has now had over a year to read, study, interpret and try to come into compliance with osha's Respiratory Protection Standard, cfr 1910.134. Published in the Federal Register on Jan. 8, 1998, with an effective date of Oct. 5, 1998, the standard has been the focus of many articles, editorials and letters to the editor in fire service journals.

From reading those offerings from the members of the fire service, it's apparent that there's no clear consensus on what the standard really requires in terms of structural firefighting. [Ed.: See "Three to get ready, four to go," Sept. 1998, available at .] This article is one more view of the standard, including in-depth analyses of the letter of the law, the intent of the law, the interpretation of the law, and the practical application of the law, each as they apply to that relatively small portion of the standard relating to interior structural firefighting.

The standard's intent is to provide for the protection of employees' respiratory systems from exposure to toxic chemicals that might produce some negative health consequences. It includes provisions for determining the fitness of employees to wear respirators, fit testing to ensure proper respirator protection and training on the use of respirators prior to exposure to toxic materials. The standard requires that a written program be developed, implemented and periodically monitored for effectiveness.

A small part of the whole osha 1910.134 is not a fire service standard; it applies to the industrial community at large and is very broad in its scope. Only a small portion of the standard, commonly referred to as the two-in/two-out rules, focuses on the specific tasks associated with interior structural firefighting.

The two-in/two-out provisions constitute little more than 150 words of an 18,000-plus-word document. A great deal has been written about this section of the standard, with varying degrees of accuracy. Less has been written on how to actually comply with either the intent or the letter of the two-in/two-out provisions. If you believe your department is in compliance with the standard simply because you've figured out how to free up two firefighters to stand by outside whenever there are two firefighters inside, you're kidding yourself.

This article will focus on the two-in/two-out provisions and try to make some practical application of them. Much of the discussion will center on what constitutes an "immediately dangerous to life and health" atmosphere, though not to create any excuses for not wearing respiratory protection.

The use of scba in all atmospheres where the products of combustion are present, whether or not osha requires it, should be mandated by your department's rules and regulations. However, the wearing of scba doesn't automatically constitute compliance with the standard, any more than assigning two firefighters to stand by in case of an emergency automatically equates to increased firefighter safety.

Paragraph (g) of the standard covers the use of respirators. Paragraph (g)(3), "Procedures for idlh atmospheres," contains general requirements for working in all idlh atmospheres. Paragraph (g)(4), "Procedures for interior structural firefighting," contains additional requirements for interior structural firefighting.

These two paragraphs contain the requirements that include the two-in/two-out rules. Complying with them requires an understanding of some key concepts. The process involves defining idlh, determining the extent of the idlh atmosphere and establishing effective communications between the two-in and the two-out.

What IDLH means We'll begin with some observations and conclusions about idlh atmospheres. Section (b) of the standard defines idlh as "... an atmosphere that poses an immediate threat to life, would cause irreversible adverse health effects, or would impair an individual's ability to escape from a dangerous atmosphere." If that were the only information available to us, we might believe that the term idlh covers a relatively broad range of smoke conditions in a burning building.

However, the preamble to the standard, which was published with the standard in the Federal Register, offers some enlightening information regarding the intent of the idlh definition: "Under the final standard's definition, atmospheres where a short, one-time exposure (i.e., an acute exposure) may cause death or irreversible adverse health effects immediately, within a few hours, or within a few days or weeks, are considered idlh atmospheres.

"... many situations involving atmospheres exceeding short-term or ceiling exposure limits are not idlh atmospheres; most short-term or ceiling limits are designed to reduce the risk of less serious effects, such as sensory irritation. Thus, only those situations where the acute exposure would threaten life, initiate an irreversible process that threatens life or health, or impede the ability of the worker to escape from the atmosphere would constitute idlh conditions."

Further, regarding the ability to escape, the preamble states: "osha wishes to clarify that the proposed terminology, 'interfere with an individual's ability to escape' was not meant to cover a minor or even moderate degree of interference but to address interference of a kind sufficiently serious to impair the individual's ability to escape from exposure to a dangerous concentration of an air contaminant."

It's clear from the preamble's language that the definition of idlh involves permanent, irreversible health effects resulting from a single acute overexposure and/or an extreme degree of interference in a person's ability to escape from a dangerous atmosphere. The term idlh doesn't include atmospheres where years of cumulative exposure might damage a person's health. A true idlh environment is incredibly dangerous. With that understanding of what constitutes an idlh atmosphere, the next step is to determine the extent of the idlh atmosphere.

Where IDLH starts Determining where the idlh stops and starts, for tactical purposes, is critical in complying with the two-in/two-out provisions. The standard states, "The employer shall identify and evaluate the respiratory hazard(s) in the workplace; this evaluation shall include a reasonable estimate

of employee exposures to respiratory hazard(s) and an identification of the contaminant's chemical state and physical form." (d)(1)(iii)

Concentration levels that constitute idlh atmospheres are chemical-specific. For example, the idlh threshold for acetone is 2,500ppm; for carbon monoxide it's 1,200ppm. In the uncontrolled environments in which the fire service operates, however, it's impossible to quantify the contaminants to which we may be exposed.

There is no idlh threshold assigned for the substance we know as smoke. The products of combustion are so vast and variable that it's senseless to think that concentrations of chemicals can be meaningfully measured at a structure fire. The standard goes on to say, "Where the employer cannot identify or reasonably estimate the employee exposure, the employer shall consider the atmosphere to be idlh." (d)(1)(iii)

How much latitude will osha allow the on-scene firefighters to "reasonably estimate" conditions that constitute an idlh atmosphere? In an Aug. 3, 1998, memorandum to regional osha administrators, the director of compliance programs for osha, John B. Miles Jr., published questions and answers regarding the respiratory-protection standard. In response to a question regarding the difference between incipient-stage firefighting and interior structural firefighting, Miles states:

"The two-in/two-out requirement does not take effect until firefighters begin to perform interior structural firefighting. Interior structural firefighting is firefighting to control or extinguish a fire in an advanced stage of burning inside a building. Because the fire is producing large amounts of smoke, heat and toxic products of combustion, exposure of firefighters is extremely hazardous and is considered an 'immediately dangerous to life or health' (idlh) environment. Incipient stage firefighting, on the other hand, involves the control or extinguishment of a fire in the initial or beginning stage, using portable fire extinguishers or small hose lines without the need for personal protective equipment. Interior incipient fires expose firefighters to limited amounts of smoke and heat. Firefighters can approach and extinguish these fires without the need for self-contained breathing apparatus and, sometimes, without turnout gear. It is the incident commander's responsibility, based on training and experience, to judge whether a fire is an interior structural fire, and how it will be attacked."

The issue here isn't whether firefighters should be wearing scba. Respiratory protection should be required for any magnitude of smoke conditions. What will prove to be problematic is the operational implications of declaring every level of contamination to be idlh. To differentiate between attacking the fire and standing by for rescue, an imaginary line must be drawn between "in" (idlh) and "out" (non-idlh).

When "out" isn't out Although we refer to the regulation as two-in/two-out, the actual number of firefighters in and out will vary. The fundamental role of the "in," fire suppression, is significantly different from the role of the "out," standby for rescue.

Consequently, each member must know precisely which role they're in and take appropriate positions at the fire scene in consideration of where the idlh line is drawn. Understanding that concept is central to complying with the two-in/two-out requirements.

The preamble describes a true idlh atmosphere as one that's significantly dangerous, easily recognizable as a killer. It doesn't describe an atmosphere where, in many situations, a light haze of smoke would be thought to "initiate an irreversible process that threatens life or health...." That view follows with Miles' statement that "Interior incipient fires expose firefighters to limited amounts of smoke and heat."

It's a fact that in one area of a building a fire may be raging which clearly presents itself with idlh amounts of combustion products. In another area of the same building, a firefighter may be exposed to little or no smoke or heat, much like Miles describes in an incipient-stage fire, although firefighters should still be required to wear scba and turnout gear even in limited smoke conditions. However, the extreme conditions the preamble describes as constituting an idlh atmosphere, coupled with Miles' statement about limited amounts of smoke in an incipient-stage fire, must grant the two-out a degree of latitude to work (while wearing scba) in areas of limited exposure to smoke.

A determination of the idlh threshold is critical in deciding where the two-out are going to locate themselves and how far in the two-in are going to be able to penetrate. Many articles, editorials and letters to editors have been written that erroneously present the view that the two people outside must literally be outside the burning building.

Nowhere in 30 pages of standard or 300 pages of preamble does it state that "outside" means outside of a structure. Where you find a reference to employees located "outside," it's always outside of the idlh atmosphere, not completely outside of a building of which only a portion is idlh. Paragraph (g)(4) states, in part,

"... in interior structural fires, the employer shall ensure that:

- * At least two employees enter the idlh atmosphere and remain in visual or voice contact with one another at all times;
- * At least two employees are located outside the idlh atmosphere; and
- * All employees engaged in interior structural firefighting use scbas."

The confusion is understandable. When the standard was written, it included a provision that allowed one of the two people "out" to engage in another activity, "such as incident commander ... or safety officer, so long as this individual is able to perform assistance or rescue activities without jeopardizing the safety or health of any firefighter working at the incident." Note 1 to Paragraph (g). The examples given are clearly outside-the-building activities, but don't fit with the real responsibilities of either of the two-out members, which will be discussed later in detail.

So where is the idlh threshold? There's no pat answer. The standard refers to reasonable estimates of idlh atmospheres, and Miles stated that, "It is the incident commander's responsibility ... to judge whether a fire is an interior structural fire, and how it will be attacked."

I agree. While this standard has gone a long way toward removing the element of judgment from the incident commander, the "reasonable estimation" responsibility clearly falls back on both the ic and the two-out. In the world of industrial hygiene, exposure limits are based on measurements that include the toxicity and concentrations of particular chemicals, plus the length of the exposure. However, in the fire service application we're not talking about direct exposure to any chemicals. All firefighters are going to be wearing scba, so the issue is a little more practical in nature.

Certainly, if you can't see through the smoke, you must consider it to be idlh. If the fire is growing and the level of contamination in the area is likely to increase, the area should likewise be deemed idlh. Areas where the presence of flammable or highly toxic vapors is likely should also be considered idlh. While giving due consideration to all of the other fireground hazards, such as structural collapse, the idlh threshold should be established at a point outside any obvious hazard area, outside any areas even moderately charged with smoke.

That threshold must be constantly monitored and evaluated for changing conditions. The outside team must be ready to move and adjust in response to any changes in the level of atmospheric contamination. Subjective monitoring of the idlh threshold is going to be a concept and task that will take some vigilance on the part of the fire service, but it's critical to completing the two-in/two-out puzzle, and leads directly to the next issues, accountability and communications.

Communications/accountability Having come to some conclusion regarding the idlh threshold, the task at hand becomes accountability through establishing and maintaining some means of communications. The implications of determining the location of the idlh threshold are significant and will heavily affect your efforts to comply with the rest of the two-in/two-out regulations.

The standard requires that the two-in remain in visual or voice contact with each other at all times. In most heavily involved fire situations, visual contact won't be possible, so the two-in are going to have to make an effort at staying together. Their ability to communicate will be severely limited, so they will have to remain within several feet of one another. A couple of practice sessions with blacked-out masks will let your teams soon determine the limitations of their voice communications.

The more complicated issue deals with the requirement for the two members outside of the idlh to be ready to rescue the inside team. While the standard's general intent is respiratory protection, the specific intent of the paragraphs on idlh atmospheres and interior structural firefighting is accountability. This is accomplished by having the two members outside the idlh keep track of the two members inside the idlh through voice, visual or signal-line communications, per (g)(3)(ii). I'm afraid that this is where many departments are going to drop the ball.

The preamble includes many examples of worker injuries and fatalities. Here's one:

"In yet another case, an employee (No. 1) was sandblasting inside a rail car A standby person (No. 2) was stationed outside the car. During the operation, employee No. 1 ... lost consciousness. Employee No. 2 had not maintained constant communication with employee No. 1 and only discovered that employee No. 1 had been overcome too late to save his life. This case shows that the demanding work often required by a worker constrained by respiratory equipment in an idlh atmosphere may lead to accidents that can disable the worker and require immediate rescue efforts. It also illustrates that the need for emergency assistance can arise at any time and without warning, and that standby personnel must therefore maintain constant communication with the worker(s) inside the idlh atmosphere."

How can the two-out rescue the two-in if they're unaware that their colleagues need to be rescued? If the two-out are outside the structure, with one of them nearby but clearly focused on other fireground activities, under what conditions will the outside team be activated for a rescue? If the outside team members can't keep track of those inside, it won't matter if you have two-in and 200-out. That's why there's the requirement for voice, visual or signal-line communications. In situations where the inside team is working in a truly idlh atmosphere, visual contact by the outside team isn't going to be possible.

As far as signal-line communications go, I'm not aware of any proven way of using a signal line that's effective on the fireground or that doesn't present its own entanglement hazards. The signal-line option was probably included in paragraph (g)(3) with an industrial confined-space application, not the fire service, in mind.

The uncertain role of radios The standard doesn't specifically provide for radio communications as does nfpa 1500. I've taken the position in the past that radio communications are good, but they don't meet osha's requirement for voice communications simply by virtue of their absence from the standard.

I've been advised, however, that U.S. Labor Secretary Alexis Herman has said that compliance with nfpa 1500 would be deemed compliance with osha's two-in/two-out standard. Nonetheless, a document titled "Inspection Procedures for the Respiratory Protection Standard," written for osha compliance officers, states:

"Electronic methods of communication such as the use of radios shall not be substituted for direct visual contact between the team members in the danger area. However, reliable electronic communication devices are not prohibited and certainly have value in augmenting communication and may be used to communicate between inside team members and outside standby personnel."

It's not certain whether any given osha inspector would interpret this to mean that radios are permitted as a useful adjunct to the required voice communications, or that radios qualify as the sole source of communications between the inside and outside teams. This is an example of how osha has made compliance with the regulations nearly impossible, even for strong supporters of this standard.

In one paragraph it states that the two-in must maintain voice or visual communications with each other. In another paragraph it states that voice, visual or signal-line communications must be maintained between the inside and outside teams. Beyond that, no more information on communications is given to the fire service, either in the standard or in the preamble. However, in a

document written for their inspectors, they say that "voice or visual communications" (between the inside team members) doesn't allow for the use of radios, but "voice, visual, or signal line communications" (between the inside team and the outside team) does allow for the use of radios.

It's not clear to me how osha expects the fire service to know what's permitted and what isn't when they keep their interpretations to themselves, or when it takes a detailed study of adjunct documents to finally uncover their intent. If radios are permitted in one instance but not another, that should have been written into the standard.

The interpretation in the inspection document and nfpa 1500 notwithstanding, I question the efficacy of relying on a firefighter's ability to operate a radio to communicate a distress signal while accurately indicating a location in what may be total darkness. The greatest chance for the successful rescue of a team of disabled firefighters begins with the immediate knowledge of their need to be rescued, in concert with an accurate knowledge of their location. Strict reliance on radio communications does little to accomplish either of those objectives.

I'll concur that radios have great value on the fireground and that every firefighter should carry one. But they'll also provide a false sense of security to whoever believes they're the answer to keeping track of the inside team.

If radios are used as the sole means to track the welfare of the inside team(s), to do so effectively will significantly jam up the frequencies with "howyadoin?" radio traffic. Imagine the chatter on the radio from two or more two-in/two-out teams of firefighters trying to figure out who's talking to whom, who's okay and who's not. In addition, imagine yourself as a member of an attack team needing to stop what you're doing every minute to talk on your radio. The use of radios as the sole means to satisfy the communications requirements between the attack and standby teams will do little, if anything, to facilitate an expedient rescue of endangered firefighters.

Tracking the two-in The following paragraphs describe how I believe the solution to this maze of interpreting and applying the standard can be reached. As with the idlh issue, a certain level of reasonableness needs to be applied to any attempt at compliance with the standard. There are a couple of pieces to this puzzle that will take a conscious effort on the part of everyone at an emergency scene to put together.

To begin with, the interior team must not charge ahead (with the exception of immediate rescue situations) without knowing that the outside team is ready. When they enter the idlh atmosphere, they must make the effort to maintain voice communications with each other, within a proximity that allows for them to keep track of each other's location. That means they can't split up to search separate rooms or areas of the building. At the same time, they must consider themselves at least 50% responsible for maintaining contact with one member of the outside team. This is where a reasonable interpretation and determination of where the idlh atmosphere begins and ends must be made.

Although the standard permits one of the two-out to engage in peripheral activities, both members of the standby team should be able to focus on their primary responsibility, oversight of the two-in,

without the distraction of being assigned other responsibilities. To fulfill that obligation, they must strategically position themselves outside the idlh in a location that allows for effectively monitoring what's happening with the inside team.

There are subtle ways of tracking the inside team that need to be included in training drills. Those include direct voice contact, sensing and hearing water flow through the hose, listening to the communications between the two-in, hearing and monitoring their distinct scba breathing sounds, and listening for trouble signs such as falling debris or other unusual noises.

While the standard refers to other endeavors one of the two-out might engage in, except for a limited period at the time of the arrival of the first-due company, their role should be limited to tracking and assisting the two-in. Except for those first minutes, when staffing limitations require it, the role of rescuer should never be assigned to the incident commander.

The rescue scenario In the event of the need for a rescue, the ic will be one of the most important positions on the fireground. If the two-out are genuinely involved in fulfilling their responsibilities to the two-in, there's no practical way that they're going to be able to do so from the porch or the pump panel.

One of the two-out members should be positioned at or near the idlh threshold, tracking the two-in. The other of the two-out should be positioned in a relay position, able to communicate both with his or her partner while establishing a line of communications to the real outside. The standard states, "For all idlh atmospheres, the employer shall ensure that: ... (iv) The employer or designee is notified before the employee(s) located outside the idlh atmosphere enter the idlh atmosphere to provide emergency rescue." (g)(3)(iv)

To prevent a succession of would-be rescuers from entering and succumbing to idlh atmospheres in any number of situations not related to fighting fires, osha requires the notification of someone outside that a rescue is taking place. On the fireground, that would be the incident commander, who then makes the appropriate changes in the tactical plan to accommodate that situation.

The magnitude of the fire or the size of the building may exceed the voice communications ability of two-in and two-out. To maintain an effective, unbroken chain of communications between the nozzle and the incident commander, it may take three- or four-in and/or three- or four-out. The standard doesn't require a one-to-one ratio of rescuers to attack team members. Separate entry teams will probably require their own rescue teams, but the incident commander will have to use his or her judgment on the number of firefighters who comprise each team.

In addition, as the fire progresses, the first of the two-out may need to enter the idlh atmosphere to maintain contact with the entry team as they proceed further into the building. In that case, he/she becomes another member of the entry team and must be replaced by another rescue team member outside the idlh. Immediate communication of this development to the incident commander or sector officer is critical.

This is a situation where good radio communications could significantly improve the transfer of information to the outside. Situations such as this need to be practiced in training drills. The ability to initiate a rapid "move-up" of personnel to maintain the integrity of the communications link is vital.

As a part of tactical operations, positive-pressure ventilation may be used to manipulate the idlh threshold. Clearing out as much smoke as possible from involved and uninvolved areas can significantly improve the environment and alter the two-in/two-out assignments.

Two-in/two-out in use Recognizing the old adage "Every situation is different," the following scenario provides for an attack team inside the idlh atmosphere, two personnel outside the idlh ready to effect rescue, and a chain of communications that extends from the nozzle to the ic.

This situation is a second-story room-and-contents bedroom fire, with nobody left inside. The first-arriving engine has three firefighters and reports fire venting from the second story. The owner of the house assures them that nobody is left inside.

The engineer sets up the pump while the other two stretch a line into the house, finding a light haze of smoke on the first floor. The fire room is heavily involved, and the second story is unquestionably an idlh atmosphere. While those operations continue, the second-due engine arrives with three more firefighters. Two of them are assigned the two-out duties, and they assist the attack team with advancing the hoseline. All members are fully bunkered, with scba.

The attack team proceeds up the stairway and down the hall toward the fire room, clearly in an idlh atmosphere. One of the two-out assists with feeding the hoseline up the stairs and around the first corner while staying out of the heavy layer of smoke. The second of the two-out is in the middle of the room downstairs, and can see his or her partner sitting on the stairs. The ic is positioned at or near the front door, in sight of the second "out" member.

There's a chain of communication between the attack team and the first of the two-out, extending to the second of the two-out and outside to the incident commander. If all goes well, the two-in will perform their duties under the watchful ears of the two-out. If something goes awry, the backup team is immediately available for assistance with the full knowledge of the "employer," the ic.

In this illustration, all firefighters were fully protected from any direct exposure to smoke. The firefighters within the idlh atmosphere maintained communications between themselves and the firefighter on the steps, who was outside of the idlh. The stage was set to expand operations or to effect a rescue if either was necessary. Other situations might require a more complex tactical plan and assignment of personnel, but this is a scenario on which many other successful training sessions and fireground operations could be based.

Compliance with the two-in/two-out rules doesn't constitute compliance with the entire respiratory-protection standard. Many other provisions of the law apply directly to fire departments, for which compliance is mandatory in states covered by osha regulations. The two-in/two-out provisions have

generated the most controversy and have received the most exposure in the fire service because of the history of the issue, which is rooted in NFPA 1500.

The rest of the standard is straightforward and understandable, at least in its fire service application. When complied with, it really can create a safer environment for firefighters because of the medical evaluations and fit-testing requirements.

Compliance requires a thought process that may be radically different from that for which we've been conditioned in the past. Every firefighter must be trained to make a reasonable evaluation of the ever-changing environmental conditions in the fire building. They must be trained to respond as part of a team, in addition to responding as a part of a team of teams, two-in and two-out.

With that response come some specific communications obligations that travel from the first firefighter along an unbroken chain out to the incident commander. Practice communications and accountability drills in your department with blacked-out masks. The mechanics of complying with the standard will take repetitive drilling before they become a natural part of the operation. The days of grabbing a hose and running headlong into the building have passed.

The greatest challenge most departments will face in complying with the standard won't be trying to find the people to fill the assigned slots, although that may be a struggle for many. The greatest challenge will be in instilling a more global perspective of the relationships between the people at the scene, specifically the two-in and the two-out, and maintaining the communications channels when the heat is on.