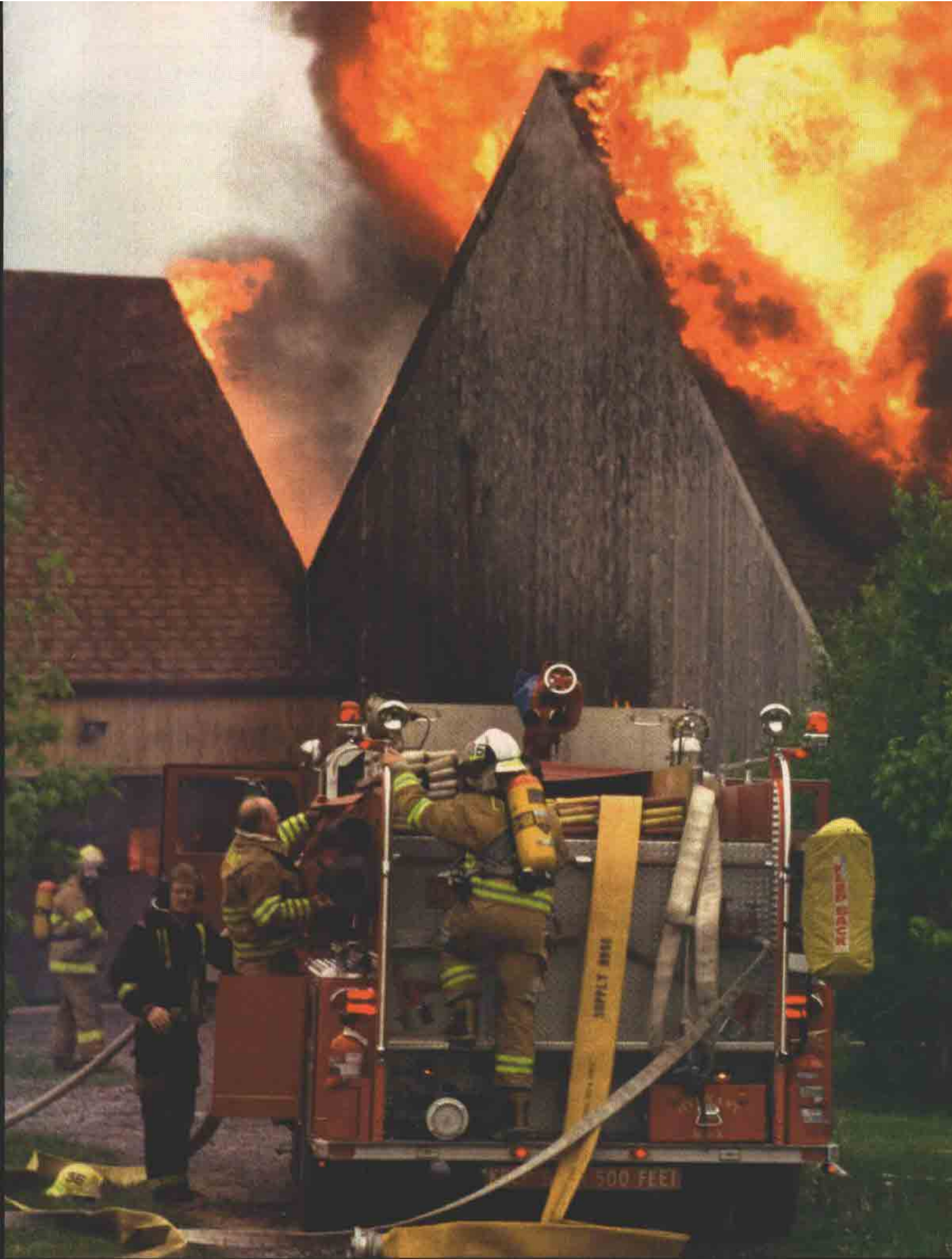

500 FEET

Preventing House Fires

Knowing where fires commonly start can help builders to avoid tragedy during construction and even after the job is finished

BY CHARLES BICKFORD

Back when I worked as a carpenter, I started a job in midwinter with a commercial outfit that was building a large apartment building. A few weeks before, carpenters had dug and formed the footings in the main utilities trench. It was cold when they poured the footings; the thermometer didn't rise much past the teens during the day. Worried that the fresh concrete would freeze, the carpenters put a propane torpedo heater in the trench to keep the pour warm overnight. They also were concerned about the 100-lb. propane tanks freezing, so before leaving for the day, the crew put the tanks in the trench and covered everything with a sheet of plywood.

It was nearly midnight when the propane tanks began to explode. A couple of tanks roared out of the trench like miniature ICBMs, one landing about 150 ft. away. Frightened neighbors thought they were under attack. Luckily, the police station was in direct line of sight, and the dispatcher called in the alarm as he watched the tanks take off. The incident became a grim joke among the crew, but they could laugh because they knew they were lucky: Nobody was killed or maimed, and the property damage was limited to a few toasted wooden forms.

Let me repeat myself: They were lucky. Every year, residential fires kill about 3,000 people, injure thousands more and cause about $4 billion in damages. Most fires are caused by someone smoking in bed, by kids playing with matches or by plain bad luck, but some are the direct result of a builder's negligence. After all, a house is really a large stack of firewood. To find out what builders can do to make fires less of a problem, I talked to fire marshals, building inspectors and fire-safety experts from around the country.

Job-site fires often result from not keeping an eye on heaters

I called Chris Siwy, the Glastonbury, Connecticut, fire marshal who was in charge the night of the propane-tank fiasco. He told me the heater in the trench was old and that its legs were wobbly, so the carpenters had propped up the heater with scrap wood. The wood gradually got hot enough to burst into flame, which melted the heater's supply hose. Spewing flames, the hose whipped around in the trench, finally igniting the tanks.

Siwy recommends that heaters be placed at least 10 ft. away from combustibles and never be left unattended. In particular, hanging tarps and polyethylene vapor barriers tend to get blown into heaters and can ignite in a heartbeat. Siwy also said that portable heaters need periodic safety checks to ensure that everything, especially pilot lights, is in good working order. Tanks ought to be stored safely so that they can't be knocked over or ruptured; spare tanks should be locked up or fenced in as protection against vandalism.

Winter is also the prime season for trash fires. Framing in the dead of winter seems to be unavoidable, and it's always tempting to keep a merry fire of lumber scraps burning in a metal barrel. In dry areas of the country such as California and Florida, the risk (and recent memory) of wildfires is too strong, and job-site fires are usually not permitted. In locales where burning is not banned outright, the fire officials I interviewed discourage the practice whenever they can because fires can get out of control. Again, it's usually a problem that starts when someone leaves a fire unattended. The barrel is too close to the house, or it gets knocked over, or flying embers land on dry grass. Pretty soon, you've got a raging fire.

Finally, it's a good idea to keep Dumpsters and piles of lumber or trusses separate from each other and not next to the house. If a fire starts in one area, you don't want it to spread to the rest of the site.

Keep electricity safe and in its place

Extension cords take a beating on a job site and should be inspected periodically for breaks in the insulation and for potential shorts. It's worth $20 to buy a new extension cord if you need it. Siwy told me about a job-site fire that started when worn extension cords that were plugged into a portable generator became overloaded and set the generator and a nearby pile of framing lumber ablaze.

On a job site, where electrical outlets can be rare, it's often tempting to plug as many power tools as you can into one extension cord. But an extension cord is meant only to be a temporary power conduit, and it is rated for a certain amperage. Asking an extension cord that's rated for 20 amps to pull twice that load is asking for trouble.

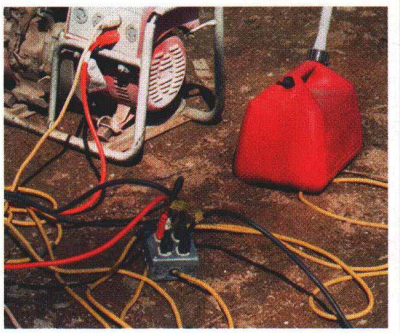
Any electrical modifications performed by nonlicensed personnel can mean trouble, too. Rex Cauldwell, a master electrician and plumber, told me the cautionary tale of some workers who drilled into a crawlspace and accidentally severed several wires. They tried to splice the wires using wire nuts but couldn't regain power. When Rex showed up, he found evidence of a small fire in the crawlspace that luckily had put itself out. Apparently, when the workers had stuck the loose wire ends into the wire nuts, they hadn't twisted the wires together first; the wires had

Photo: David Reimer

WHERE JOB-SITE FIRES START

Building a house involves the use of open flames, flammable chemicals, electricity and lots of wood, all ingredients for a potentially dangerous house fire. Usually perceived to be a lesser concern than unstable ladders or careless use of a circular saw, fires can appear when least expected. The best fire prevention is an awareness of where trouble can start.

Keep job-site heaters isolated and safe. Any temporary heat source should be in the center of the room, at least 10 ft. from tarps, trash piles and other flammable materials.



Too many power tools can overload an extension cord. When a wire is overloaded, its insulation can melt and short-circuit, sparking a fire in the surrounding area.

Careless smokers can start fires by dropping lit cigarettes onto tarps or piles of scraps and trash.

Trash fires are potential hazards if not closely monitored. Even fires in barrels can easily spread if the barrel is tipped over or high winds send burning embers into the air.

arced inside the wire nuts, starting a fire. The first lesson is to call a licensed electrician if you're not sure what you're doing. The second lesson is that all splices and junctions made midline must have good mechanical connections and must be protected by a junction box.

Hot work needs to be watched carefully, too

Cauldwell also admitted that he was responsible for a 1-acre brush fire that started when he was working outside with a torch. He had turned off the valve and set the torch on the ground. Unfortunately, the valve was worn, leaking just enough gas to sustain a small invisible flame. The flame set a patch of brush on fire, which leapt to the surrounding brush. Cauldwell now replaces torch valves every year and no longer sets his torch down on anything that might burn. The use of torches, abrasive cutting wheels and the like is referred to as *hot work* and is a major cause of job-site fires.

Stressing the need for caution, fire officials recommend that if you're sweating pipes or throwing sparks with a grinder, it's a good idea to check back in a few minutes to make sure that you haven't left any little hidden fires, and always to keep an ABC-rated fire extinguisher handy. If you're using a belt sander to grind metal, remove the

Drawings: Dan Thornton

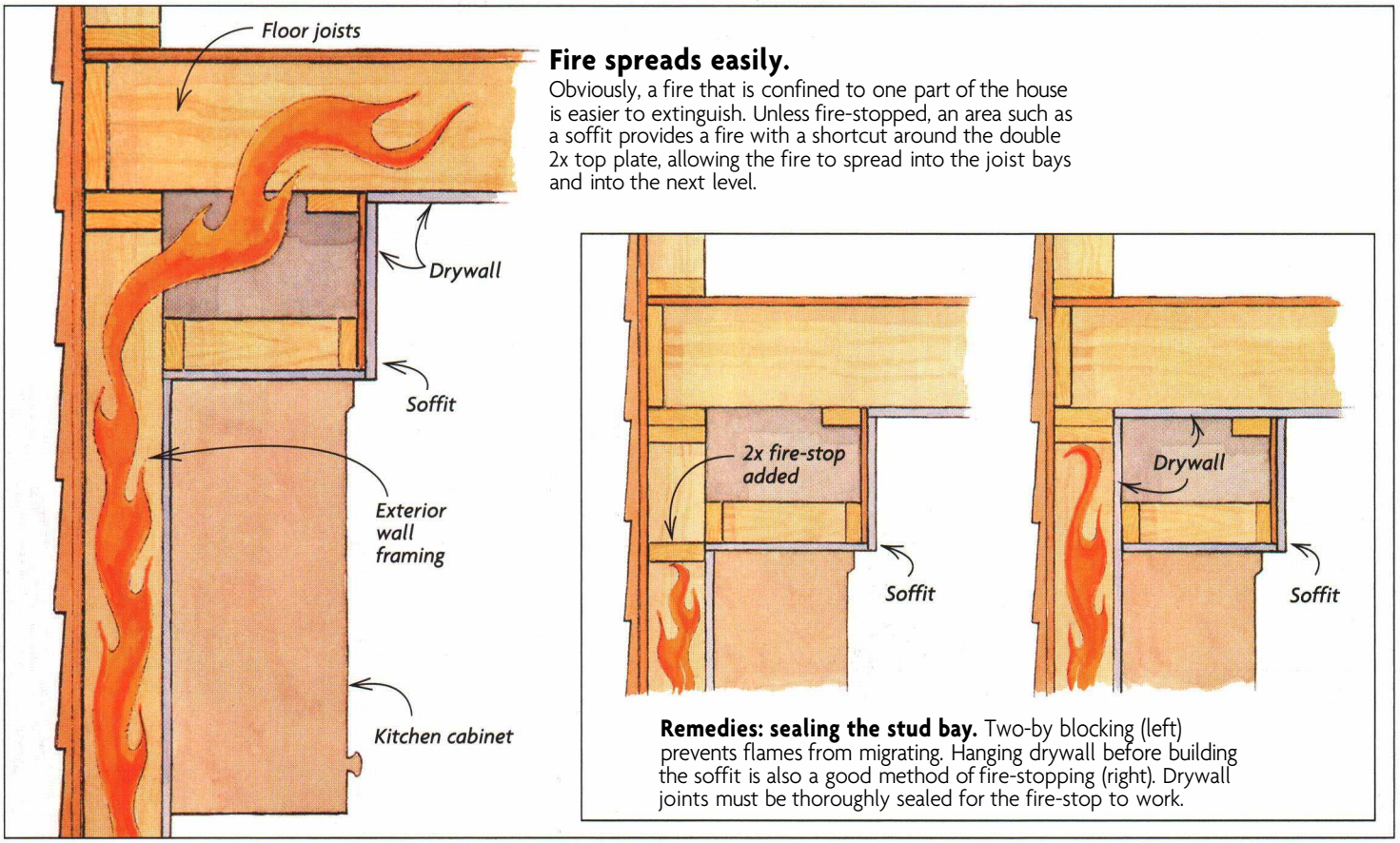
dust bag to minimize the chance of sparks igniting sawdust in the bag. When using a torch, protect framing and other combustibles with a fire-resistant shield. Cauldwell says that the flexible fiberglass types wear out quickly; his favorite shield is a piece of 1-in. thick concrete block, which absorbs heat and lasts forever.

Oily rags can start a fire without help from a match

Some common job-site fires that often occur when the house is nearly complete seem to be caused by spontaneous combustion. Contractor Leo Blickley of Santa Barbara, California, told me that when he was building his own house, an employee wadded up a linseed-oil soaked rag and left it on the floor at the end of the day. Three hours later, Blickley was next door and saw flickers of light inside the house. He ran over and found flames starting up the stairs. Luckily, he put out the fire before it did serious damage.

Don Bliss, the New Hampshire state fire marshal, says that the term *spontaneous* is a misnomer. The heat produced when oil oxidizes and hardens is usually dissipated in a large space. But when oxidation takes place in a confined space (such as in a balled-up rag), the heat builds quickly to about 400°F, the temperature required to set a rag

FIRE-STOPS CONFINE HOT SPOTS



Fire spreads easily.
Obviously, a fire that is confined to one part of the house is easier to extinguish. Unless fire-stopped, an area such as a soffit provides a fire with a shortcut around the double 2x top plate, allowing the fire to spread into the joist bays and into the next level.

Remedies: sealing the stud bay. Two-by blocking (left) prevents flames from migrating. Hanging drywall before building the soffit is also a good method of fire-stopping (right). Drywall joints must be thoroughly sealed for the fire-stop to work.

on fire. Bliss said the best way to dispose of oil-soaked rags is to put them in a tightly sealed metal can (a gallon paint can works) and to put the can outside. Blickley says that on his job sites, he now makes sure all oily rags are either submerged in a bucket filled with water or laid out flat to dry on concrete.

Draft-stops and fire-stops hinder the spread of fire

In addition to keeping the job site safe, you want to make sure that the house you're building will be as resistant as possible to fire. If a fire does start, the idea is to slow the flames' progress with materials such as drywall or to cut off the fire's air supply with blocking called draft- and fire-stops. Such measures give the house's occupants time to get out and minimize damage until the fire department arrives.

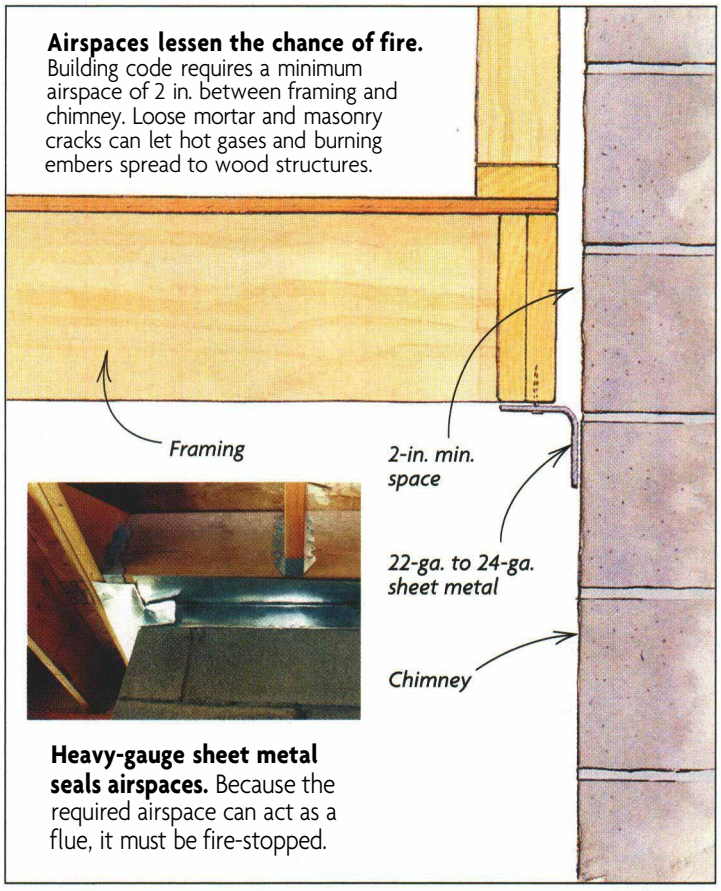
Older balloon-framed houses often proved to be fire traps because there was nothing to block the path of flames as they raced up stud bays and spread quickly into the attic and along floor joists. Although platform-framing incorporates solid plates that slow the spread of fire between floors, additional draft-stopping is mandated by code to stop flames from traveling through soffits, partitions and penetrations.

Francis Brannigan, an authority on construction and fires, cites physics to explain draft stops: If the temperature of a gas rises and the volume remains the same, the pressure increases. Theoretically, a draft-stop is meant to contain the expansion of heated gas. But any perforation in a draft stop, in Brannigan's words, "is like a pinhole in a condom." Under pressure, a small hole becomes a nozzle that injects fire into an adjacent area ripe with fresh oxygen and fuel, thus spreading the blaze. Draft-stops must fill the entire cavity; partial blocking might provide adequate nailing for a soffit, but it won't slow the migration of a fire in a wall.

As a rule of thumb, draft-stops of 2x blocks are required at floor and ceiling levels of walls or every 10 ft. Draft-stops are also required under staircases and in walls adjacent to soffits or dropped ceilings. Grease fires on kitchen stoves often spread to upper cabinets and into the ceiling, where an unblocked soffit provides fire with a perfect path to the rest of the house. The safest way to build a soffit is to frame over the drywall (drawing above), which makes a continuous fire-stop.

In places where wiring and plumbing penetrate between floors or fire walls, the spaces between the utilities and the framing must be sealed with intumescent caulk (photo right, facing page). Unlike standard caulk, which melts and falls away in a fire, this caulk expands as much as ten times its volume when exposed to flame. The foam that's generated protects the opening around plastic plumbing and wiring by absorbing heat energy. These caulks are relatively expensive ($15 to $20 per tube), but they are the only choice for sealing through-penetrations. Using silicone, foam sealants or anything else may save you a couple of bucks initially, but it just won't hold up to heat. (Expanding foams typically used to seal window-frame cavities are, in fact, downright explosive.) Rock wool, a type of mineral-based insulation, has been used for draft-stopping in the past, but it should be covered with intumescent caulk to make it effective. Although it won't burn easily, rock wool is still gas permeable.

Plywood, sheet metal and drywall are used for larger-area fire-stops, like those that block a vertical pipe chase between floors. If you use sheet metal, it should be 22-ga. to 24-ga. steel. Don't use aluminum—it melts at 1100°F, about half the temperature of a roaring fire. Brannigan also stressed that drywall is not effective as a fire-stop unless all seams and fasteners are sealed with joint compound.



Airspaces lessen the chance of fire. Building code requires a minimum airspace of 2 in. between framing and chimney. Loose mortar and masonry cracks can let hot gases and burning embers spread to wood structures.

Heavy-gauge sheet metal seals airspaces. Because the required airspace can act as a flue, it must be fire-stopped.

If a house has an attached garage, UBC code requires that it be separated by a fire wall that consists of one layer of $\frac{5}{8}$-in. drywall on the garage side and a weatherstripped, $1\frac{3}{8}$-in. thick solid door (or a door that's rated to withstand a fire for 20 minutes) with self-closing hinges. Drywall is the wall material of choice here because of its ability to keep fire at bay. When exposed to fire, water added to gypsum during the manufacture of drywall is released as steam, which absorbs the fire's heat energy, delaying the fire's progress. The drywall begins to crumble only when the water is driven out. Type-X drywall is reinforced with chopped fiberglass, which maintains the structure of the drywall even after the water is gone, increasing its ability to withstand a fire. Type-C board is made with a combination of fiberglass and vermiculite. A wall faced on both sides with $\frac{5}{8}$-in. Type-X drywall is considered to have a fire rating of one hour, which means that if a blaze engulfs the garage, the wall will remain structurally sound for 60 minutes.

This rating won't mean much, however, if the wall is breached. Redwood Kardon, a building inspector in Oakland, California, says that one of the most common code violations he sees is an electrical subpanel that has been cut into the fire wall between the garage and the house. When they are installed on a fire wall, subpanels should be flush-mounted on the drywall. Remember, too, that nailing/screwing patterns should be about an inch tighter when you're working on fire-rated drywall.

Fireplaces and chimneys account for a large portion of newer-house fires

A colleague of mine bought a new modular house a few years back, a two-story colonial whose living room was over the garage. He and his wife liked to use the living-room fireplace even though the chimney didn't draw well. One night, his wife woke him up because she smelled smoke. After repeated trips downstairs to clear the fireplace of smoldering logs, he discovered smoke seeping between the mortar joints in the brick hearth. He went down to the garage below and saw smoke curling down from where the garage-door struts disappeared into the ceiling's drywall. He quickly called the fire department, then got a stepladder and a wrecking bar to investigate the source of the smoke. Wedging the bar into the ceiling, he began to loosen the drywall, and two things happened nearly simultaneously: a large flame shot out toward his face, vaporizing part of his beard, and a pair of hands grabbed him by the shoulders and pulled him off the ladder. The fire department had arrived. The fire marshal subsequently discovered that the raised-brick hearth had been built directly over the subfloor (a code violation) without any clearances. Hot coals from the fire had dropped through cracks in the mortar and started a smoldering fire in the plywood and joists.

The lesson here is that the hearth should be at least 4 in. thick. There also has to be a minimum clearance of 2 in. between the framing and any flue or chimney as it passes up through the house, fire-stopped with sheet metal at each floor level (photo left). This clearance keeps the transfer of heat from the chimney to the framing to a minimum and will greatly improve a house's survival in the event of a chimney fire.

FIRE-RATED CAULK

Intumescent caulk makes a fireproof seal. Holes between floors are potential flues for fire and must be sealed. If fire melts the insulation or pipe, the caulk expands and forms a fire-stop.

Get to know your local fire marshal

During my conversations with various fire marshals, one topic came up repeatedly: the need for cordial relations between the local fire service and the builders. By exchanging phone numbers and discussing potential hazards, the fire department and the builder would have a head start in the event of any emergency that might arise.

Another point other marshals made was the importance of a clearly marked site. A legible sign that indicates the house number and location will ensure that fire trucks don't waste time if they're looking for a fire. It's important to maintain good access for fire equipment, too. Adrian Hise, the fire marshal from Boulder, Colorado, said, "I know it's asking a lot, but it would be great if roads into a development were paved early on in the process.... Many fire trucks only have 6 in. to 8 in. of clearance underneath and can't navigate rough roads." Most fire officials recommend that access roads have an all-weather surface at least 12 ft. wide. There also should be a clearing next to the house that's at least 22 ft. long and 12 ft. wide, and stable enough to support a pumper truck. □

Charles Bickford is an assistant editor at *Fine Homebuilding*. Photos by the author, except where noted.