Oil Burner Fires and Emergencies

by Battalion Chief Frank Montagna

Every fall, FDNY members respond to a flurry of oil burner emergencies as oil burners are fired up for the first cold night of the season. Frequently, these are minor emergencies, requiring shutting down the burner and ventilating the oil burner room or basement. But, sometimes, these emergencies are more than they seem and a few escalate to structural fires.

How does an oil burner work? Why does it fail? What action should we take when responding to these emergencies? To operate safely at oil burner fires and emergencies, you should know the answers to these questions. Ensuring that everyone knows the dangers and the appropriate actions to take at these incidents will help keep all FDNY members and those we protect safe.

Residential burners use number two fuel oil, a low-viscosity oil that flows easily and does not need to be pre-heated. The larger burners--found in large apartment buildings and commercial structures--require the heavier number five or six fuel oil. These high-viscosity oils are pre-heated to allow the thick oil to flow freely. The minimum flash point of fuel oil is 100 degrees Fahrenheit, but it can be as high as 130 degrees. This is an important safety factor because fuel oil is not ignited easily. In fact, fuel oil first must be vaporized in order to ignite it.

The fuel oil is stored in a storage tank. Typically, in private dwellings, the tank capacity is 275 gallons. Larger tanks can be found in other occupancies. Depending on the size of the tank and the occupancy, the tanks may be buried, above ground, inside the building or outdoors. Usually, the 275-gallon tank will have a fuel shut-off at the tank, as well as at the burner.

Fuel is delivered by gravity feed to the oil burner as required. Before it is fed into the burner, it passes through a filter that is found at the burner, just before the nozzle. After impurities have been filtered out, a motor-driven fuel pump injects fuel into a nozzle which, in turn, squirts it into the combustion chamber. The motor also drives a blower, which injects air into the atomized fuel spray as it enters the combustion chamber. A spark produced by two electrodes then ignites this oil vapor and air mixture.

There are several safety devices that ensure this process proceeds as designed. If the *stack switch*--located on the smoke stack--does not sense heat, it assumes that ignition has failed and cycles the ignition sequence on to initiate ignition. After 90 seconds, if it still does not sense heat, then it turns off the burner. The switch must be reset manually before it will allow the burner to turn on again.

On newer installations, a light-sensing cadmium sulfide cell is used instead of the stack switch. This is the *visual flame detector*. If it does not sense the light from the combustion process, like the stack switch, it will shut off the burner. These safety devices are intended to prevent the hazard of accumulated unburned fuel and vapor in the firebox.

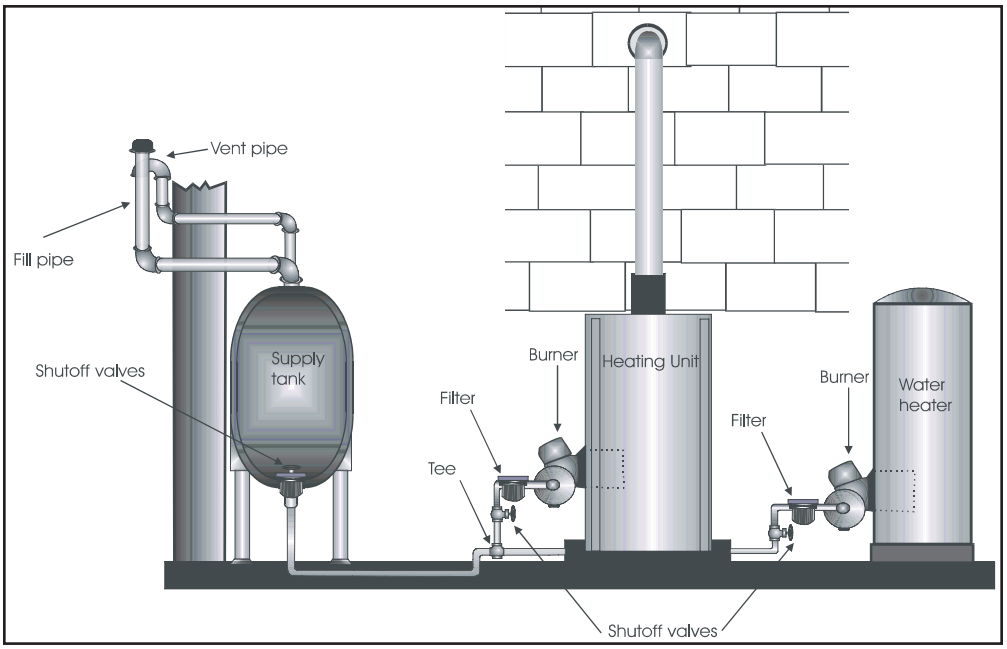
Unfortunately, like all manmade devices, they can malfunction and when they do, a call to the FDNY is the usual result. Typically, these and other safety devices fail because of old age and poor maintenance. Add an unhealthy dose of home handyman tampering and you have the prescription for disaster.

There are a number of home-heating emergencies and fires to which FDNY members respond:

Clogged flue pipe If the heat exchanger or flue pipe is clogged, flue gases will back up and escape from various openings in the burner or flue. These hot gases can ignite any combustible with which they come in contact. This condition also will result in a dangerous build-up of carbon monoxide in the structure.

Puff-back or delayed ignition This occurs when excess atomized oil accumulates in the combustion chamber, resulting in an explosion as the oil vapor suddenly is ignited. The explosion causes pressures inside the furnace that can cause the burner door to open or--in more extreme cases--structural failure of the burner. The weakest part of the furnace is the flue pipe, so this is the part that fails first. Once the flue fails, the hot gases that should have gone up the chimney now escape from the damaged flue and can ignite nearby combustibles. These carbon monoxide-filled products of combustion that normally vent harmlessly out the chimney fill the burner room, basement and, sometimes, the entire structure.

It is possible for a puff-back to result in a structural fire. The explosion that occurs when accumulated vapors ignite in the firebox can cause a tongue of flame to blow out the open fire door or peephole in the fire door. This flaming tongue can ignite nearby combustibles. If excess oil has pooled in the bottom of the firebox, droplets of burning oil can be expelled from the burner onto the floor, again igniting nearby combustibles.



artwork by Thomas Ittycheria

After-fire This is the burning of excess oil pooled in the bottom of the firebox, after the burner shuts down. To burn oil cleanly, a large amount of air must be supplied to the firebox with the atomized oil. When the burner shuts down, so does the fan that supplies this air. If oil has pooled in the bottom of the firebox, the heated walls of the firebox can atomize and even ignite this pooled oil. This ignited oil will continue to burn despite the lack of extra air. The result will be a very smoky fire. This smoke should exit the chimney, but may enter the burner room, where members will be met with a heavily charged cellar area. It is possible for the after-fire flames to reach up into the flue pipe and result in extension to nearby combustibles.

Oil spill An oil leak or fuel line rupture that results in oil accumulating outside, though near the furnace, can be heated

by the operating furnace and the resultant vapor then ignited by an ignition source. Additionally, if the heat is intense enough and the spill large enough, it can be the source of atomized oil for the *white ghost* (explained later). Excess oil leaking into the firebox can result in a puff-back, a smoky burn or, if conditions are right, a visit from the white ghost.

Damaged firebox or heat exchanger Time and lack of maintenance can result in holes in the firebox. A damaged or deteriorated firebox can result in hot gases escaping and ignition of nearby combustible material. The heat exchanger is a series of metal tubes that transfer heat from the firebox to either air in a hot air system or water in a hot water system. Any holes in the heat exchanger in a hot air system will allow CO to enter the heated air that is being circulated throughout the house. This will create a CO problem throughout the structure.

Pulsation This is a condition that results in the flame jumping away from the nozzle and then returning to its original position. This occurs rapidly, over and over again, setting up a vibration that can be severe enough to be felt throughout the entire structure. It has been likened to the vibration that is caused by a train passing close to a house. An occupant experiencing an episode of pulsation in his home might think that an earthquake has occurred. The vibration can cause the fire door to open. Opening the door relieves the pressure and stops the pulsation.

Homeowners sometimes try to prevent the firebox door from popping open by blocking it shut. A firebox door blocked shut by a two by four or bolted closed is a dangerous condition. If pulsation occurs and the pressure is not relieved, the burner could rupture, injuring anyone in the vicinity as the burner is blown apart.

When responding to a pulsation incident, shut the emergency remote, shut the fuel and open the burner door. When opening the door, remain low and to the side of the door, out of the path of danger should the door be blown off its hinges. Consider using a hook to open the door from a distance, thus putting you farther from danger. Opening the door is dangerous, but it stops pulsation.

White ghost The white ghost can result in a devastatingly deadly explosion. Fortunately, it is rare, occurring when a large amount of atomized oil, which has filled the firebox or even the entire basement, ignites explosively. The explosion can result in structural damage and be accompanied by a blowtorch-like orange flame pushing out of all the cellar or basement openings. It is similar to a puff-back of great proportions.

At a typical oil burner emergency or fire, you will encounter thick, black smoke. This smoke, while seemingly easy to tolerate, is carcinogenic and, consistent with FDNY policy, should not be entered without use of SCBA. If the black smoke suddenly turns white, either water was put on the fire and what you are seeing is steam or the white ghost has made an appearance. If the smoke is pearly white with a heavy oily odor and taste, it is probably the white ghost. A large amount of atomized oil has become entrained in the thick, black, oily smoke and turned it pearly white. You smell and taste oil because the smoke actually contains millions of atomized particles of oil.

If oil is atomized and fails to ignite, the burner should shut down. If the safety systems fail and additional oil is injected into a hot firebox, it, too, will be atomized. In large commercial installations, this can result in large amounts of unignited, atomized fuel. When the ignition sequence again cycles on or another source of ignition is present, the accumulated vapor can ignite explosively.

A hot firebox, accompanied by ignition failure and a continued supply of fuel oil or excess oil pooled in the firebox, results in vaporization of fuel oil. If a large amount of oil is atomized and does not exit up the chimney, the vapor can fill the entire basement. If it is ignited, a large explosion--accompanied by a flame front that will fill every basement opening--can result.

The sudden color change of the smoke from black to white, accompanied by the oily odor and taste, are the only warning signs before the sudden ignition of the white ghost. The ignition can be likened to a natural gas combustion explosion. The confined oil vapors ignite and as the temperature increases, the gases expand. This sudden expansion is capable of pushing down partition walls and destroying other structural elements of the building.

Accompanying this pressure build-up is a massive flame cloud that will fill the area that contains the cloud. You can expect to see orange flames blowing out of all the cellar or basement windows. Anyone in the vicinity of the burner will be hit by the force of the combustion explosion and engulfed in flame. The flame front can push up the interior stairs, blow the cellar door open and fill the public hallway with flame. Firefighters near the windows will feel the force of the blast and may suffer burns as the flames blow out the cellar windows.

Oil burner fire and emergency tactics

Stretch a hose-line. As you enter the burner room, if you notice that the smoke is cool, you probably have an oil burner emergency (fire is confined to firebox)--not a fire. This may change, but it is likely that fire has not extended from the firebox. If the smoke is hot, then you have an oil burner fire. Fire has extended and this is no longer an emergency--it is a structural fire.

Even if the fire can be handled with an extinguisher, a hoseline should be stretched. The line serves as a safety precaution for firefighters entering the smoky basement. If the fire has extended to combustibles in the basement or structural elements of the building, you will need the line.

Some large commercial oil burners have gas ignition. An oil fire can damage the gas line or safeties, resulting in a gas leak in addition to the oil burner fire. Should the white ghost appear or the oil burner emergency be accompanied by a natural gas leak, the line will be there to protect firefighters from the ignition of the resulting combustion explosion

Shut the oil burner remote switch. It is usually red in color and located at the top of the stairs in private dwellings. In commercial installations and apartment buildings, the switch can be found outside the burner room or just inside. It should be shut off early in the operation to remove electric power from the burner, stop the flow of fuel and prevent the burner from cycling into the ignition sequence while members are operating on the fire.

If oil vapor or natural gas is mixed with the smoke, an explosion could be triggered by the burner's ignition. Shutting the switch, however, is not a guarantee that the ignition will not cycle on, nor that fuel will not continue to be delivered to the burner by gravity. The switch may not be functioning and it may have been installed upside down. In the case of the latter, switching it off actually would result in supplying power to the burner. A second switch can be found at the burner that also should be shut as a precaution.

Shut the fuel supply. Close the fuel valves even if you have shut the burner emergency remote switch. As mentioned above, the switch may not work and fuel still may flow as a result of gravity. The fuel shut-off can be found just before the filter and in 275-gallon tanks, another shut-off often can be found at the tank. Both valves should be closed. Be aware that there may be more than one tank supplying the burner and that each tank might have its own individual shut-off. If the shut-off is defective or missing, try to crimp the supply-line. In most home systems, a $^1/_2$-inch copper tube is used as a supply-line and it can be crimped easily with the back of an axe. Be careful not to rupture the line. Doing so would add an oil spill to the problem.

Search for extension. You must check thoroughly for possible fire extension at all oil burner emergencies and fires. The law requires that there be at least 18 inches of clearance between uninsulated smoke pipe and combustible material. When sufficient clearance does not exist, heated pipes can ignite combustibles. If flue gases are backing out of the flue pipe or burner, nearby combustibles

can be ignited. Flames or burning oil escaping from the burner also can ignite combustible material. Flames that extend up into the flue pipe can heat up the pipe and ignite any combustible that is too close to it.

Search for life. At oil burner fires and emergencies, you must search for possible victims. Was a janitor or homeowner in the boiler room when a puff-back occurred? Is someone in the home overcome by carbon monoxide? Your search should include taking readings throughout with a carbon monoxide meter.

Ventilate. Ventilation at oil emergencies can be broken into two categories. *Initial ventilation* is performed to clear the area of smoke and heat, allowing a safer operation for firefighters. This might include opening or breaking windows, opening doors and performing vertical ventilation when needed. It is similar to ventilating for fire.

Secondary ventilation should concentrate on removing residual smoke and carbon monoxide from the building and is performed after the fire is extinguished or the emergency controlled. Remember, at CO incidents, we do not let occupants of a home re-enter if the CO level is 100 ppm or greater. We suggest they leave if it is between nine and 100 ppm.

We should enforce the same rules and take the same precautions at oil burner incidents. This, too, is a CO incident and the occupant should not be allowed to re-enter until the CO level is safe. This may necessitate the use of vent fans to clear the atmosphere in hard-to-vent, below-grade areas.

Spill fire. If the fire turns out to be burning in an oil spill in front of the burner or in the pit, a foam extinguisher usually will do the job. If the spill is large, a foam hand-line may be needed. Some larger burners have an extra grated door near the bottom of the burner to supply additional air to the burner. Putting foam into the pit may allow it to flow through this door into the bottom of the burner. This should not be a concern. You may have to place additional foam onto the spill if it is breaking down from the heat. Having a back-up foam can is a good idea. Stretching a foam-line may be even better.

Splash fire. A thorough search for extension must be made at all oil burner fires and emergencies. It is possible for burning oil to be splashed out of the firebox through an open door or the peep hole and ignite nearby combustibles. This is one reason that the law requires movable combustibles be kept at least five feet from the heating apparatus unless they are protected by fire-retarding material.

White ghost tactics

- Treat any occurrence of the white ghost as a gas leak. Give these phenomena all the respect you would give to a serious gas leak.
- Shut the oil burner remote switch and close the fuel valve if possible. This removes a potential source of ignition and cuts the fuel supply to the burner. The sooner you cut the fuel supply, the less fuel will be vaporized.
- Do not enter the vapor cloud unless absolutely necessary. Remember, this is similar to a gas leak and there is a real danger of ignition and combustion explosion.
- Stretch a hose-line with a fog nozzle. A narrow fog pattern can be used to quench the vapor cloud and lessen the likelihood of ignition, as well as vent the area. Also, stretch a back-up line to protect these firefighters if they enter the basement.
- Ventilate the involved area. This must be accomplished without unnecessarily endangering firefighters. If ignition occurs, every opening to the basement may be filled with flame. A fireball can roll up the stairs and blow the interior basement door open. Any firefighters in front of these basement openings will be engulfed in flame and blown backward. Stay to either side of the opening when venting or operating the hose-line. Firefighters or civilians in the first-floor hallway may be burned if the white ghost occurs, so they should be removed from this hazardous position. It is also possible for structural damage to be done by the force of the explosion, so expect at least partition wall failure.

Issuing Fire Prevention Orders

When responding to a call for a defective burner or an oil burner fire, issue *NOV rule 19/SFO #FO-5*, which requires that the occupant provide an affidavit from a licensed fuel oil installer that the oil burner is clean and in operating condition. On building inspection or other times you find yourself in the vicinity of a building's oil burner, consider issuing the following orders when warranted:

- *NOV rule 8/SFO #FO-3* Removes all combustible material within five feet of heating apparatus, except where protected by fire-retarding material.
- *NOV rule 13/SFO #FO-9* Protects ceiling within 18 inches of smoke pipe with fire-retarding material.
- *NOV rule 9/SFO #FO-10* Ensures that the distance between smoke pipe connections and combustible material is at least 18 inches. If the pipe is protected by asbestos and meets other requirements, it can be as close as nine inches to combustible material. (See *Fire Prevention Manual*, chapter 4, page 21.)
- *NOV rule 9/SFO #FO-11* Requires that combustible material be kept 24 inches from heat-producing parts of the boiler unless fire-protected. Then, it can be reduced to 12 inches. (See *Fire Prevention Manual*, chapter 4, page 22.)
- *NOV rule 26/SFO #FO-13* Requires that a remote control shut-off be installed outside the entrance to the burner room or just inside the entrance.
- *NOV rule 26/SFO #FO-15* Provides shut-off valve in supply, at tank.
- *NOV rule 26/SFO #FO-16* Provides a shut-off valve at the burner.

Issuing the above Fire Prevention orders, when warranted, can reduce the number of times the FDNY is called for emergencies and make oil burners safer for members when we do respond. When on inspections, CFR-D runs or entering a building in an official capacity, keep a sharp eye out for conditions that we can correct before they put the building occupants and/or members at risk.

Fire prevention enforcement considerations

A malfunctioning burner will not make itself better. It will continue to malfunction and, as time progresses, the condition will worsen. Hard-starting will lead to a puff-back. Smoky burning will coat the sensors and safeties with soot, which eventually may cause them to malfunction. When responding to oil burner emergencies, an essential part of FDNY operations is issuing fire prevention orders to have the malfunctioning burner repaired. Failure to issue the appropriate order could result in the burner being restarted after members leave without the needed repair work being done. The result is that we likely will be called back at some time, perhaps to a more serious emergency or fire. (See sidebar.)

In addition to issuing the appropriate orders, members should explain to the homeowner or caretaker why he/she should not fire up the burner after the FDNY leaves. Impress upon the homeowner that he/she was lucky this time and the next time, he/she might not be so lucky. The next time the homeowner might suffer injury or death from fire, explosion or carbon monoxide poisoning. At the very least, the building might be filled with sooty, oily smoke that will coat everything in the building. This would be a good time to check for and encourage the use of smoke detectors and carbon monoxide detectors. It is easier to get the home owner's attention and cooperation after just experiencing the intense smoke of an oil burner emergency or fire.

About the Author...

Battalion Chief Frank Montagna is a 31-year veteran of the FDNY, currently working in Battalion 58. He is the author of Responding to "Routine" Emergencies. *He holds a Bachelor's degree in Fire Science and is an editorial advisor for* Fire Engineering. *He has published numerous articles and is a frequent guest speaker on a variety of firefighting topics.*