Chapter Fifteen – Analysis and Reporting

Analysis and Reporting Chapter

Documenting Fire Origin and Cause Responsibility

As covered in the *Methodology of Investigation Chapter*, an objective and systematic process is the starting point for an investigator's findings and opinions to determine the origin and cause of the fire.

NFPA 921, Section 4.4.5 states:

> *All collected and available data should be analyzed using the principles of the scientific method. Depending on the nature and scope of one's assignment, hypotheses should be developed and tested explaining the origin, ignition sequence, fire spread, fire cause or causes of damage or causalities, or responsibility for the incident.*

After developing and testing a working hypothesis, reviewing notes, references, photos, witness interviews, collected data, and other resources an investigator is prepared to compile a report. The extent of the investigator's assignment (scope), time and resource limitations may dictate the final report's format and content.[1] This chapter will provide further understanding of the fire cause and surrounding issues that led to the cause; identifying potential responsibilities, solidifying and strengthening a conclusion; and finally preparing a report.

NOTE: It is recognized that the analysis of the fire event, the developing and testing of hypotheses is an ongoing process during the entire investigative phase.

The Four Elements of Fire Cause

To determine the fire cause[2], the investigator must identify the first fuel ignited, the ignition source, the oxidizing agent, and those circumstances, and factors, which together resulted in the fire. The following are basic points based on *NFPA 921, Chapter 18.* These should be listed in the report.

The First Fuel Ignited

This is the material – the initial fuel – that sustains combustion. The first fuel must be capable of sustaining the combustion process beyond the ignition source. The heat source must not only have sufficient energy to ignite the first fuel, the fuel must also have sufficient duration of exposure to that heat.

NFPA 921, Section 18.1.2 states:

> *For example, the wood of a match would not be the first fuel ignited, but paper, ignitable liquid, or draperies would be, if the match were used to ignite them.*

In a commercial kitchen, an example of the first fuel ignited may be:

- The oil in the deep fat fryer
- Accumulated grease in the exhaust system
- The plastic housing of an electrical appliance
- Leaking gas from appliance piping
- Combustibles stored too close to cooking appliances

[1] See *NFPA 921, 1.3.4*

[2] The circumstances, conditions, or agencies that brought about or resulted in the fire or explosion incident, damage to property resulting from the fire or explosion incident, or bodily injury or loss of life resulting from the fire or explosion incident. (*NFPA 921, Definitions*)

The Source and Form of the Heat of Ignition

NFPA 921, paragraph 18.1.3 states in part, 'The ignition source will be at or near the point of origin at the time of ignition.' Evidence of the source of ignition will, therefore, often be found at or near the point of origin. Keep in mind the source may have been moved, transported away from the point of origin or altered and possibly destroyed. In any event, the source should be identified to correctly determine the cause.

Remnants of a deep fryer control panel

A competent ignition source must have sufficient temperature, energy and be in contact with the fuel long enough for ignition to occur. The ignition process involves:

- The competent ignition source must generate sufficient energy (heat) to raise the fuel to its ignition temperature
- The transmission of that energy (conduction, convection, radiation or direct flame contact) to raise the fuel to its ignition temperature
- Sufficient heating means that heat is being transferred to the fuel faster that the fuel can dissipate the heat, thus raising the fuel's temperature

Grease accumulation under a deep fryer

In cases where the first fuel ignited is a vapor (natural gas or other similar product) not only must a competent ignition source be present, but the fuel must be within the proper flammable limit flammable limit range. It may be difficult to identify the exact ignition source since it may have been an arc from an electric motor or switch or open flame from a cooking appliance.

Note: The response of the fuel to the energy is characterized by thermal inertia.[3,4]

The Oxidant

In most cases, the oxidant is the oxygen in the fire environment readily available from the earth's atmosphere. Generally in commercial kitchens there is ample oxygen present due to the design characteristics and specifications for the exhaust and replacement air systems. The functionality of those systems should be documented along with any other factors that may have affected the ambient atmosphere.[5]

The Ignition Sequence

This is the sequence of events, which allowed the source of heat energy and the first fuel ignited to come together, and establishes the fire cause.

With the deep fat fryer example, the fire cause involves more than the source of heat and the first fuel ignited.

[3] The properties of a material that characterize its rate of surface temperature rise when exposed to heat; related to the product of the material's thermal conductivity (k), its density (ρ), and its heat capacity. (*NFPA 921, Definitions*)

[4] See *NFPA 921, 5.5.2.3*

[5] See *Oxidation* in *Fire Science Chapter*

Questions need to be resolved regarding the ignition sequence:

- Did the thermostat fail, resulting in a higher temperature than designed?
- Was a manual control set too high?
- Was there a change in the cooking oil, which resulted in a lower autoignition temperature?
- Was there tampering or alteration of the appliance?

Answers to these questions will involve activities beyond the scene examination, such as:

- A detailed equipment examination in a laboratory
- Review of manufacturer's literature
- In-depth interviews concerning the appliance installation, maintenance and the cooking operation

Note: *NFPA 921 Sections 18.4.4.2 and 18.4.4.2.1* discuss the factors to be considered in the analysis of the ignition sequence.

Editorial Comment: The determination that the fire started in the duct is frequently incorrect. With the exception of solid fuel cooking, the possibility of some form of ignition taking place somewhere in the ductwork is practically nil. Kitchen grease residues are combustible not flammable and must be exposed to an ignition source such as a significant flame plume or flare-up from an appliance. For ducts to burst into flames with no outside source of heat is highly unlikely.[6]

However, when there is no other easily discernible explanation to satisfy the question: *Where was the origin (location) of the fire*? It would appear that the simple catchall phrase of *started in duct* is being used excessively.

Proper use of the scientific method to include hypotheses testing would eliminate this improper classification of fire cause. If the duct was listed as the area of origin, any competent technical review of that opinion would seriously question what was the ignition source for the fuel/ grease. (See the *Process of Elimination* section)

Restaurant kitchen staff performs under very stressful situations. They work under pressure and around a great deal of heat. Often, cleaning and maintenance, although an essential part of a restaurant's operations are overlooked.

When staff or management is questioned after a fire, everyone working in the kitchen may state that they are a model of cleanliness and protocol, doing things "exactly by the book." Often they will lead an investigator to the conclusion that the most likely origin of the fire was "*the duct*." Statistics on the origin of kitchen fires may be skewed because of overuse of the determination that the fire "started in the duct."

Process of Elimination

NFPA 921 includes discussion of the process of elimination as it relates to fire cause. Section 18.4.4.3 states:

> *There are times when there is no physical evidence of the ignition source found at the origin, but where an ignition sequence can logically be inferred using other data. Any determination of fire cause should be based on evidence rather than on the absence of evidence; however, there are limited circumstances when the ignition source cannot be identified, but the ignition sequence can logically be inferred. This inference may be arrived at through the testing of alternative hypotheses involving potential ignition sequences, provided that the conclusion regarding the remaining ignition sequence is consistent with all known facts (see Basic Methodology chapter)*

The inappropriate use of the process of elimination is discussed in NFPA 921 Section 18.6.5.

> *The process of determining the ignition source for a fire, by eliminating all ignition sources found, known, or believed to have been present in the area of origin, and then claiming such methodology is proof of an ignition source for which there is no evidence of its existence, is referred to by some investigators as "negative corpus." Negative corpus has typically been used in classifying fires as incendiary, although the process has been used to characterized fire classified as accidental.*

[6] UL 300 requires a 120 second live burn with the fuel source on before the suppression system activates.

