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PROBLEMS, PROSPECTS  
AND INNOVATIONS**



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# **SCIENCE AND TECHNOLOGY: PROBLEMS, PROSPECTS AND INNOVATIONS**

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УДК 351.861

**SEPARATE ISSUES OF IDENTIFYING CENTRAL SIGNS AND WAYS OF  
SPREADING EMERGENCY SITUATIONS DUE TO FIRE AT CRITICAL  
INFRASTRUCTURE FACILITIES**

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**Abstract:** A non-destructive method of determining the source of an emergency situation as a result of a fire at critical infrastructure facilities, which is based on the analysis of the soot layer, is considered.

**Keywords:** emergency, fire, critical infrastructure facility, soot analysis

As a result of the combustion that takes place in a fire, materials, structures, equipment and individual objects, which were in the zone of action of high temperature, undergo various destructions, deformations or are completely destroyed - they burn.

As a rule, the destruction occurs unevenly and this circumstance is often used when establishing the source of the fire. The location of the cell is often associated with the place of greatest burnout and destruction. In such a case, they proceed from

the assumption that the greatest destruction is due to longer burning, longer effect of high temperature, i.e. the time factor, and, as a result, they come to the conclusion that the fire could have originated in this area. Most often, this is the case.

It is obvious that a long duration of burning will lead to great destruction, it can also cause the development of a higher temperature in the center of the fire, which will also inevitably affect the intensity and degree of destruction. However, such a circumstance as the duration of burning is not the only one, and in some cases it cannot be the cause of the greatest damage to structures and materials in a certain area of the fire, including in the cell.

The destruction that occurs during fires depends not only on the duration of the burning, but also on a number of other factors and conditions associated with the development of the fire, and, first of all, on the temperature regime in the burning zone. The development of the temperature is connected, of course, not only with the time factor. The temperature in individual areas of the fire also depends on the amount and nature of combustible materials located in this area, their burning conditions, in particular, the conditions of gas exchange (air access), determined by the development of convection, fire extinguishing features. All this will determine the conditions and causes of repeated burning, the formation of local centers of combustion or individual, better-preserved areas in the fire zone. As we already know, even in the center of the fire, the smallest damage can also occur due to the architectural and construction features of the building.

Soot in a fire burns out when the surface of structures is heated above 600-650 C. Therefore, there may sometimes be less soot closer to the source of the fire than far from it. Above the center of the fire and secondary centers (combustion centers), soot often burns out in local spots. These spots are often preserved during the further development of combustion - the structure (ceiling, wall) in the focal zone is well heated, and soot, as mentioned above, settles not on "hot" areas, but on colder ones. Local burning of soot is a good guide when searching for a fire source. However, if the soot has not burned out and relatively evenly covers the structure, it becomes almost impossible to navigate in the search for the fire source and the ways

of the spread of combustion without special instrumental methods.

When the surface of the polymer is exposed to high temperatures, it decomposes into a complex mixture of volatile hydrocarbons. When approaching the flame front, the temperature of the gas mixture rises. Oxygen from the surrounding air diffuses into this gas mixture, and when the appropriate concentration and temperature conditions are reached, the mixture will ignite. The flame again supplies the energy needed to thermally degrade the polymer surface. Part of the hydrocarbons undergoes pyrolysis in the space between the surface of the polymer and the flame front, if their temperature is high enough - up to 1000 °C, and the oxygen concentration is still low enough. The described mechanism is valid for all polymers only at the initial stage of combustion. Thermoplastics melt and spread under prolonged heat exposure of the flame, the polymer heats up to the temperature of pyrolysis, and flammable gaseous products are intensively released from the melt. As a result, the polymer either completely burns out, or a non-combustible liquid or solid residue remains. When burning, a carbon dioxide layer is formed on the surface of thermosetting plastics, which isolates the polymer mass from the radiation effect of the flame and prevents the release of thermal degradation products. If the formed carbon layer has a thickness greater than the critical one, and there are no conditions conducive to its heating, cracking or burning (external heat flow, heat accumulation, influx of oxidant), then combustion may stop. The release of volatile substances is often accompanied by the scattering of the surface of the solid phase, and the removal of the latter into the gas phase in the form of particles with a burning surface, on which, in turn, the release of gas, ignition and burning occurs. are intense. During combustion, a non-combustible mineral residue or coke is formed.

Only porous materials that form a solid residue when heated can independently support smoldering combustion. This includes a wide range of materials of plant origin, such as paper, cellulose fabrics, sawdust, laminated boards and latex rubber, as well as some thermoset plastics in the stretched distance. Materials that can melt and shrink under the influence of a heat source will not exhibit the type of combustion under consideration. The reason for this can be understood by

considering the decay mechanism.

**Three combustion areas can be set, namely:**

Zone 1. The pyrolysis zone, characterized by a sharp rise in temperature, where the visible volatile products of the source material end;

Zone 2. The carbonaceous residue zone, where the temperature reaches a maximum, and the evolution of visible pyrolysis products stops, and glow begins:

Zone 3. Zone of highly porous carbonaceous residue where the residue is no longer heated and the temperature drops slowly.

To date, specialists [1-5] have made only separate attempts to determine the nature of burned materials by the structure and composition of soot, as well as to establish the fact of the presence of leaded fuels in the combustion zone by the presence of lead oxide and non-leaded petroleum products in the soot by detecting their quantities sorbed by particles soot. The task of determining the burning conditions in different zones of an emergency situation due to a fire and identifying focal signs of a fire was not considered and solved. The analysis of the electrical resistance of the soot layer makes it possible to study smog directly at the site of the fire and, thus, to identify the paths of propagation of the main convective flows and the focal zone.

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