

# FIRE SERVICES EXAMINATIONS BOARD

## STUDY NOTE

EXAMINATION

LEADING FIREFIGHTERS EXAMINATION

PAPER

OPERATIONS

SUBJECT

FIREFIGHTING & RESCUE INCIDENTS

ITEM

DUST EXPLOSIONS

STUDY NOTE No.

1106

### ***INTRODUCTION TO THE STUDY NOTE***

***This study note has been prepared as the basis of study in connection with the qualifying examinations for promotion.***

***Candidates will be expected to demonstrate knowledge of the information contained in the study note and understand how it should be applied:***

***The 'References' made at the end of the Study Note are included for information only and candidates will not be expected to study these as part of the bibliography.***

## DUST EXPLOSIONS

### 1. Introduction

When dusts or powders, of organic materials particularly, are lying in heaps or layers, it is quite common for a smouldering fire to start in or under them - such a fire may have been originated by some small source of ignition, such as a cigarette end, or by spontaneous combustion. When the layer or pile is thin, the fire will be easily detected - in a large or deep heap, however, it has been shown that a fire can smoulder for as long as a week or more with little external evidence.

It is particularly important to treat such fires with special care, since in many cases a slight disturbance is capable of causing the upper layer to fall into the cavity that has been burned away. This might give rise to a minor explosion, which in turn might disturb further dust and create a major one.

### 2. Fires in Dusts

It is a characteristic of almost every combustible material, including some which are not by any means readily combustible when normally encountered, that when they are in the form of a finely divided powder, they present special dangers to those who work with them and to the firefighter. These dangers are associated on the one hand with the possibility that they contain materials of extremely rapid combustion, and on the other with the characteristics of very slow combustion. Indeed, at one end of the scale is the dust explosion, while at the other is the phenomenon of smouldering, both these require special attention from firefighting personnel. These forms of combustion offer a variety of causes of fire and ways in which a fire can spread.

The factors which decide whether a dust burns very slowly or with explosive violence are, firstly, the nature of the materials (materials classed as high explosives offer a good example of the effect of this), and secondly the readiness with which air can reach individual particles of the dust.

### 3. Nature and Behaviour

The greatest danger associated with combustible dusts is the dust explosion. This is the term commonly used to denote the very rapid flame propagation that can occur when particles of a finely divided combustible solid, suspended in air or in a gas which will support combustion, are ignited. The almost instantaneous combustion which is characteristic of a dust explosion is due to the very high specific surface area of the particles, ie the very high proportion of surface area exposed to the air by each particle in relation to its mass.

Each particle burns very readily due to the ample supply of oxygen available, and its small mass is consumed in a fraction of a second. The heat of combustion, however, manages to bring the next nearest particles to their ignition temperature, and the process spreads with the rapidity of an explosion.

A dust cloud containing the right proportions of a combustible solid of the right particle size and air is capable of completely wrecking the building in which it occurs, and in some cases, has razed whole industrial plants to the ground. Many lives have been lost, including those of firefighters, in such disasters.

If the dust particles are not of ideal size, or if the degree of concentration of the particles in the cloud is not favourable, the explosion is either inhibited altogether or occurs comparatively slowly and 'mildly'.

In some cases the explosive force of a mild explosion has been equal to that of a severe one, but because the force has been developed slowly, the relatively gradual rise in pressure has been neutralised by the escape of gases through windows, doorways, vents, etc and the damage has been reduced.

The degree of concentration of the dust particles is critical, both to the likelihood of the explosion occurring and to the severity of the detonation. Too high a concentration prevents the free access of oxygen to the particles and inhibits combustion, while too low a concentration prevents the heat of combustion of one particle being carried to the next, and makes continuation of the explosion impossible.

#### 4. Precautions When Fighting Fires

When fire-fighting is in progress in any place in which flammable dusts or powders might be encountered in any quantity, the dangers of an explosion will be much reduced if:

- (a) The firefighter is aware that he is in circumstances which offer a special risk, and of what that risk consists.
- (b) They avoid the use of jets, or even of sprays, which strike harshly against piles or layers of dust, and use only a fine spray or any low-velocity, gentle form of water application. They should use even this with scrupulous care to avoid the stirring up of any cloud of dust in the presence of flame or heat.
- (c) In the case of metal powders, they use extinguishers such as powdered talc, powdered asbestos, graphite, soda ash or dry sand, and avoid the use of water, foam or chemical extinguishers, except where necessary for the protection of surrounding risks, (avoiding the use of vaporising liquid extinguishers under any circumstances).
- (d) They avoid handling bins, cartons, drums or open containers of any flammable dust or powder in such a way that a dust cloud could be produced by the action or by inadvertence. Such containers, if free of fire, should be covered before removal, if they still contain fire, they should be carefully drenched or flooded before handling by means of open ends or sprays. If metal powders are involved, treat correspondingly with extinguishing materials as in (c) above.
- (e) Consideration could also be given to the use of high expansion foam in certain circumstances.

## 5. Trunking and Ducts

Dusts and powders create special conditions for the firefighter, apart from the risk of explosion. Deposits of finely divided solids, even when they do not become suspended in air but remain spread on horizontal surfaces, can cause fire to spread through a building with exceptional speed. This applies particularly to dust fires inside trunking and ducts, and for this reason it is vital to see that extractors, exhaust systems or any machinery creating a draught in trunking systems are shut off at once.

In cases where a flammable dust is being fed from, produced in or passed through machinery, it is also urgent to see that the product supply is cut off, since cases have been known of the supply lines continuing to feed a fire while it was being fought.

Where fire has been caused by a dust explosion, it is very likely that small pockets of the dust may still be alight on all sorts of horizontal surfaces, whether visible or hidden, and these should be searched for with a hose reel spray or diffuser branch. It is especially important that all communicating compartments and those linked by conveyors, however remote, should be thoroughly searched.

## 6. Smouldering Fires in Dusts

If an approach to such a fire is always made with a spray branch, and care taken to avoid disturbance of the heap, it is virtually certain that explosive conditions will be avoided.

**Note:** This study note does not deal with metal powder fires.

## References

Manual of Firemanship Part 6c, Section 1