TABLE 15
Relative Flammabilities of Dusts

Powder	Volatile ratio (%)	Relative flammability (%) In furnace test	Relative flammability (%) In spark test
Metals			
Aluminum, atomized		10	78
Aluminum, stamped		60	80
Antimony		65	18
Cadmium		18	0
Chromium		0	0
Copper		3	0
Dowmetal		90	90
Iron, hydrogen reduced		90+	55
Iron, carbon reduced		90+	43
Iron carbonyl		85	60
Magnesium, stamped		90+	90+
Magnesium, milled		90+	90
Lead, stamped		20	0
Manganese		40	25
Silicon		0	33
Tin		10	30
Titanium		90	85
Titanium hydride		80	70
Zinc		35	45
Zirconium		90+	90+
Zirconium hydride		85	80
Miscellaneous dusts			
Corn starch		90+	90
Peat moss		90+	80
Anthracite	5.0	0	0
Low-volatile coa	18.5	60	0
Medium-volatile coal	27.2	85	40
High-volatile coal (Pittsburgh seam)	40.7	90	65
Subbituminous coal	42.8	90	75
Lignite	47.3	90	75
Coal-tar pitch, hard	45.1	—	68
Coal-tar pitch, soft	60.1	—	80
Water gas-tar pitch	49.0	—	70
Petroleum pitch	66.3	—	85

Powder	Relative flammability (%) In furnace test	Relative flammability (%) In spark test
Resins		
Cellulose acetate	90+	83
Cellulose acetate butyrate	90+	83
Chlorinated paraffin	0	0
Coumarone-indene	90+	90+
Lignin	90+	78
Phenolic	90+	90
Polystyrene	90+	90
Polyvinyl acetate	90+	73
Shellac, rosin, gum	90+	90+
Urea	85	60
Vinylbutyral	90+	80
Molding compositions		
Cellulose acetate	90+	80
Cellulose acetate butyrate	90+	90
Ethyl cellulose	90+	90
Methyl methacrylate	90+	78
Phenolic	90+	80
Polystyrene	90+	90+
Rubber, synthetic	90+	80
Urea	90+	68
Vinyl chloride–vinyl acetate	5	0
Resin ingredients		
Hexamethylenetetramine	90+	90+
Pentaerythritol	90+	90
Phthalic anhydride	90+	90
Rennet casein	90	35
Fillers for molding compositions		
Ground alpha pulp	90+	85
Ground cotton flock	90+	73
Ground wood flour	90+	80

considerably greater than for the same materials in bulk. In general the dusts ignite at lower temperatures, they burn more rapidly, and the fires are more difficult to extinguish than for larger pieces.

The ignition temperatures of undispersed layers of dusts (see Tables 1 and 2 and Figure 1) are one index of the potential fire hazard. Another index is the minimum spark energy required for ignition of dust layers (see Table 8). This shows that fires in dusts might be started by weak electric sparks or arcs, including static sparks, as well as by heating from hot surfaces, by glowing particles, frictional sparks, open flames, or other causes.

Under ordinary circumstances of handling and storage, most dusts oxidize so slowly that the heat of oxidation does not produce an appreciable rise in the temperature of the dust. However, there are some dusts, including certain agricultural products, activated carbonaceous materials, and some metal powders, that oxidize rapidly and heat to the point of ignition under suitable conditions. Heating is influenced by the exposed surface, the density and depth of the stored dust, the temperature of the surroundings, air flow, heat losses from dust, time between preparation of dust and its storage, moisture content, etc. Some metal powders react with moisture, especially at elevated temperatures, to form hydrogen, which reduces the protective oxide film on the metal particles, facilitating their ignition.

Recent experiments in England indicate that many dusts are capable of prolonged, often undetected, smoldering, even in thin dust deposits. The smoldering can be initiated by very small sources, such as a glowing cigarette end, and under right conditions it can result in a delayed, severe fire. The opinion is expressed that many fires, formerly thought to have originated by spontaneous heating, might have started in this manner.

A. PREVENTION OF DUST EXPLOSIONS AND FIRES

The problem of preventing dust explosions is of such great importance in industrial plants that considerable effort has been devoted to its solution. To this end the Dust Explosion Hazards Committee of the National Fire Protection Association through its subcommittees has formulated a series of safety codes[17a] that embody detailed recommendations for a number of industries; much of the technical information in these was derived from the experiments to which reference has been made here. The reader is referred to these codes as a helpful guide in the design and construction of buildings and equipment and in regard to safe operating procedures. The subject is also being considered by the Research Committee of the President's Conference on Occupational Safety, by the National Safety Council, and by other groups concerned with reduction of accidents. So far NFPA dust-explosion codes have been prepared for the following operations and situations:

1. Aluminum-bronze powder manufacture (No. 651)
2. Magnesium powder or dust (No. 652)

[17a] *The National Fire Codes*, Vol. II, *Combustible Solids, Dusts, Chemicals, and Explosives*. Natl. Fire Protect. Assoc., Boston, 1956.