A New Management Model for An Ancient Risk

—Combustible dust explosion bowtie analysis model

Most finely divided combustible materials are hazardous. When suspended in air and ignited, they can cause severe explosions. This phenomenon has been known for over 200 years. The first recorded dust explosion occurred on December 14, 1785, at a flour dust explosion in a warehouse in Turin, Italy. The entire industrial spectrum, including agricultural, chemical, metallurgical, mining, plastics, and woodworking industries, continues to be plagued by this problem.[1–5]

Although the basic principles for controlling dust explosions have been understood for many years, knowledge is becoming increasingly sophisticated as incidents continue to occur.[2,3–7]

Schwab, R. (2003). Dusts. In A. Cote, J. Hall, P. Powell, & C. Grant (Eds.), *Fire Protection Handbook* (19th ed.). National Fire Protection Association, Inc.

Combustible dust explosions have been troubling humanity for near 240 years

Vorderbrueggen, J. B. (2011). Imperial sugar refinery combustible dust explosion investigation. *Process Safety Progress, 30*(1), 66-81.

In contemporary times, combustible dust explosions remain a threat. On February 7, 2008, sugar dust explosions at Imperial Sugar factory, USA, caused 14 deaths and 36 severe injuries.

In New Zealand, the most devastating combustible dust explosion occurred on April 13, 1965, at the General Plastics (N.Z.) Ltd factory in Masterton. This disaster killed four workers and injured several.

According to our data collection, there were 17 explosions occurred in last 25 years in New Zealand, and several anecdotal explosions.

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(d) in which combustible dust is present in a quantity and form that creates a risk of fire or explosion

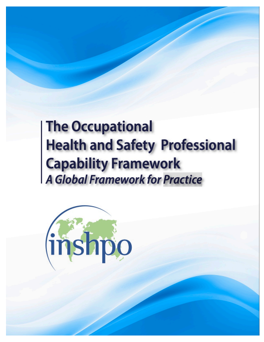
combustible dust means finely divided solid particles (including dust, fibres, or flyings) that are—

(a) suspended in air or settle out of the atmosphere under their own weight; and

(b) able to burn or glow in air; and

(c) able to form an explosive mixture with air at atmospheric pressure and normal temperature

This is a specific risk that New Zealand legislation require to be managed. Additionally, INSHPO mandates that OHS practitioners have knowledge related to explosions and understand when to involve specialists in the field.



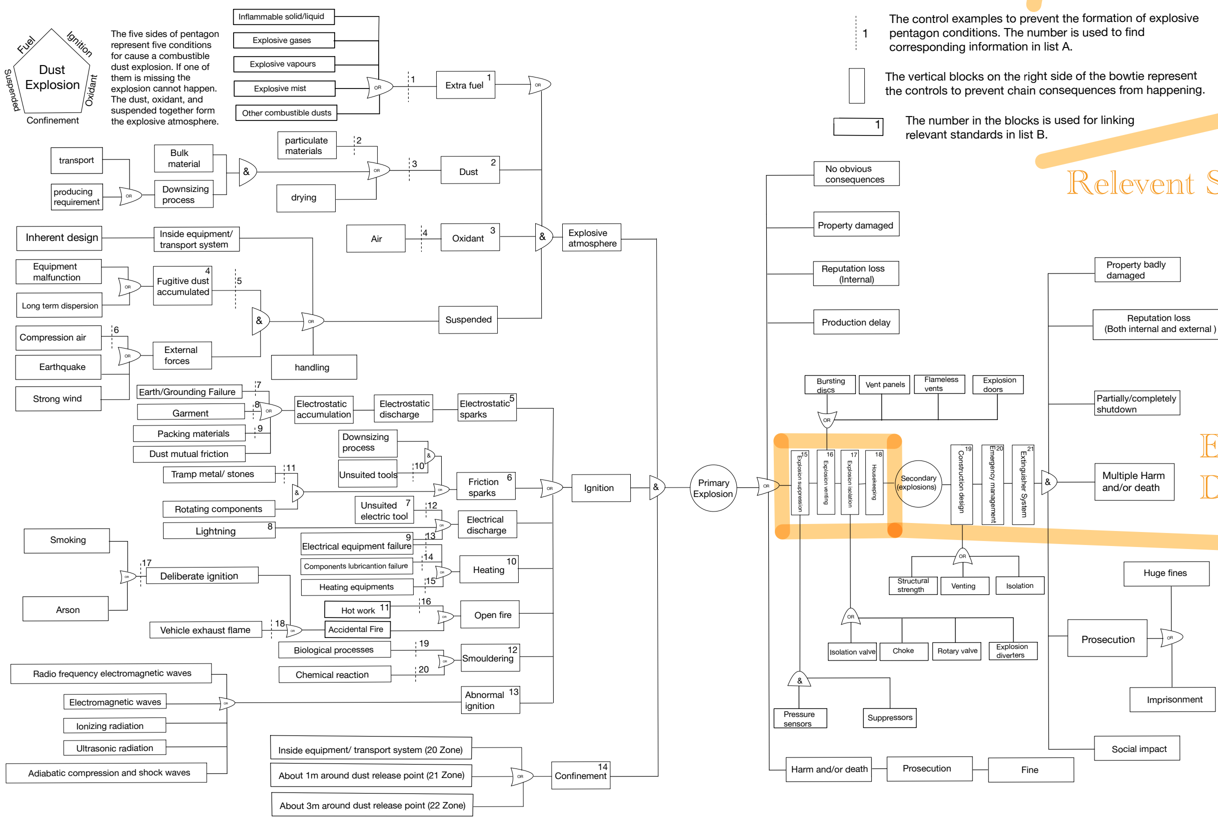
To provide OHS practitioners with a tool to understand, become familiar with, and manage combustible dust explosion risks, we have integrated the Combustible Dust Explosion Pentagon theory and the Bowtie Analysis tool from ISO31010 to create this management model.

Preventions

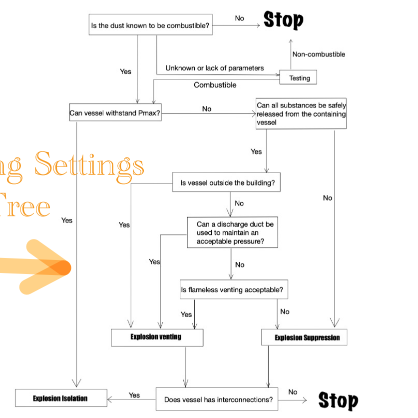
Number	Controls	Effectiveness rating (5%-95%)
1	Prevent been mixed with more explosive materials	
2	Substitute with bulk materials	
3	Mixed with non-combustible materials which will be used in the production processes	
4	Inert the system atmosphere	
5	Construction and system design to reduce the place that can accumulate dust Implement effective housekeeping	
6	Use explosion-proof vacuum	
7	Check equipment grounding regularly	
8	Anti-static uniform and set static eliminator	

Relevent Standards

Number	Standard Code/ Clause	Content
1	AS/NZS 61241.2.3	Test Methods-method for determine the minimum ignition energy of dust/air mixtures
2	AS/NZS 4745 3.4 and 4.5	Determination of dust characteristics Sample of dust for testing
	NFPA 652 3.3.6	Combustible dust definition
3	AS/NZS 4745 6.5.2.4	Inert
4	NFPA 652 Annex C	Accumulated fugitive dust
5	AS/NZS 4745 5.7 and 7.2.9	Static electricity and protective measures
	NFPA 652 9.4.7	Prevent four types of electrostatic discharge
6	AS/NZS 4745 5.4 and 7.2.6	Mechanically generated sparks and protective measures
7/9	AS/NZS 60079.14	Explosive atmospheres, Part 14: Design selection, erection and initial inspection
	AS/NZS 60079.17	Explosive atmospheres - Part 17: Electrical installations inspection and maintenance
8	AS/NZS 4745 5.8 and 7.2.10	Lightning and protective measures
10	AS/NZS 4745 5.2 and 7.2.4	Hot surface and protective measures
11	AS/NZS 4745 5.3 and 7.2.5	Flames, hot gases and hot particles and protective measures
	NFPA 652 8.5	Hot work
12	AS/NZS 4745 3.3.1, 5.14 and 7.2.16	Smouldering Exothermic reaction and protective measures

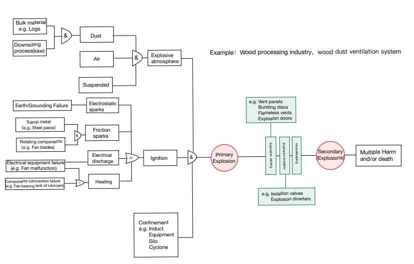


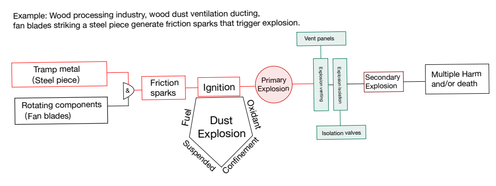
Engineering Settings Decision Tree



Based on: Taveau, J. (2014). Application of Dust Explosion Protection Systems. *Procedia Engineering, 84*, 297-305.

For a specific workplace, a particular OHS meeting, or a specific report, this model can be simplified as needed.





Mr Yu has about five years of occupational health and safety experience. In his previous career, he was involved in frontline OHS management in industrial enterprises, the promotion of safety communities, and served as an OHS inspector. During his time as an inspector, he conducted extensive safety inspection work related to combustible dust and other OHS inspection tasks.
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Dr Peace is Lecturer in Occupational Health and Safety at Victoria University of Wellington but had previously set up Risk Management Ltd in 2003 to help clients carry out major risk assessments. Between 2005-2012 Chris was part-time Lecturer in Risk Management Studies at Massey University and re-wrote the course handbooks to align them with ISO31000:2009 Risk Management – Principles and guidelines and IEC31010: 2009 Risk Management – Risk Assessment Techniques. Chris is currently finishing an eBook to aid teaching two postgraduate papers in occupational health and safety.
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