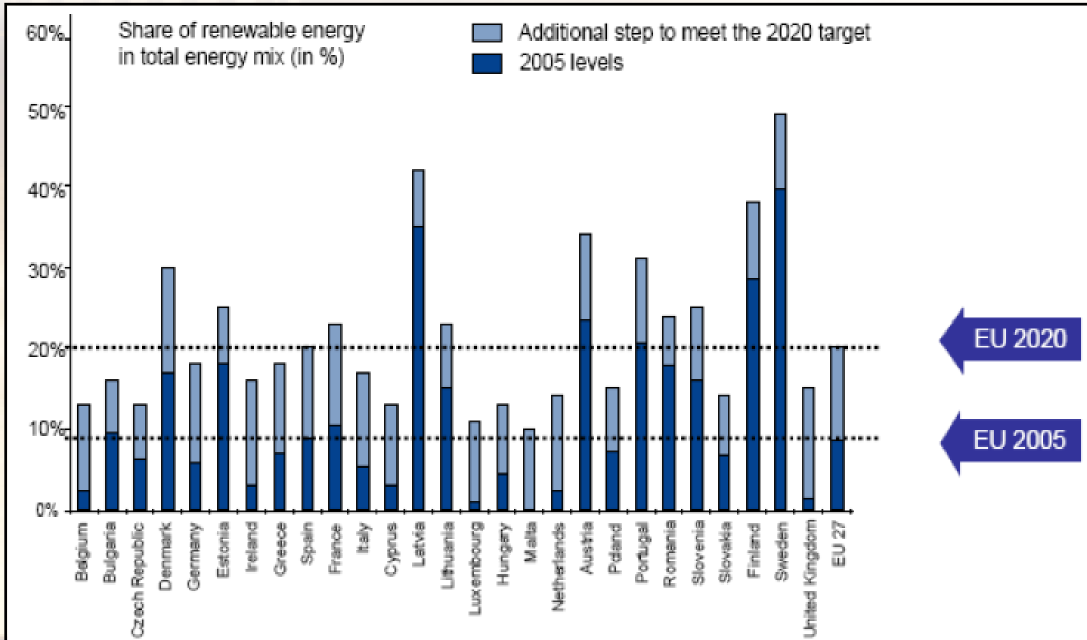
BiomassProduction and Safety

Day today operations issuesfaced by pellet mills

PFI Annual Conference 2013

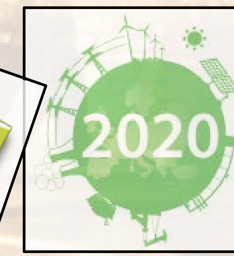
Nicole Forsberg
Firefly North America
July 29 2013



EU 2020

EU 2005

- Competitive (vs. fossil fuels)
- Avoid costly loss of production
- NGO critics
- Avoid injuries/fatalities



SAFETY IMPORTANT FACTOR FOR SUSTAINABLE (AND RELIABLE) GROWTH OF THE PELLET INDUSTRY

Dust Explosion in Wood Pellet Factory in Belarus Oct-2010

16 dead , 8 injured / Total loss of Wood Pellet and Particle Board factory

- Firefly AB – a Swedish company founded in 1973
- A leading supplier of fire prevention systems for the bioenergy industry
- Listed on the NASDAQ/OMX stock exchange in Stockholm

Industry applications

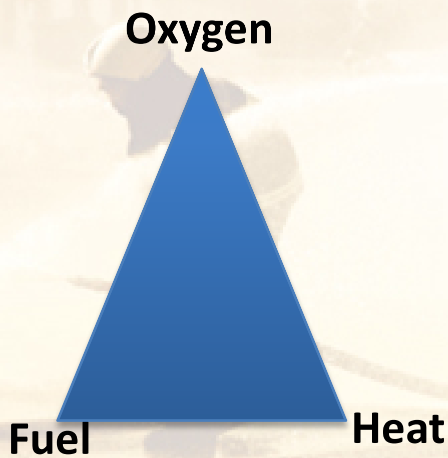
- IR Detection Systems
- Spot Protection of High Risk Machines

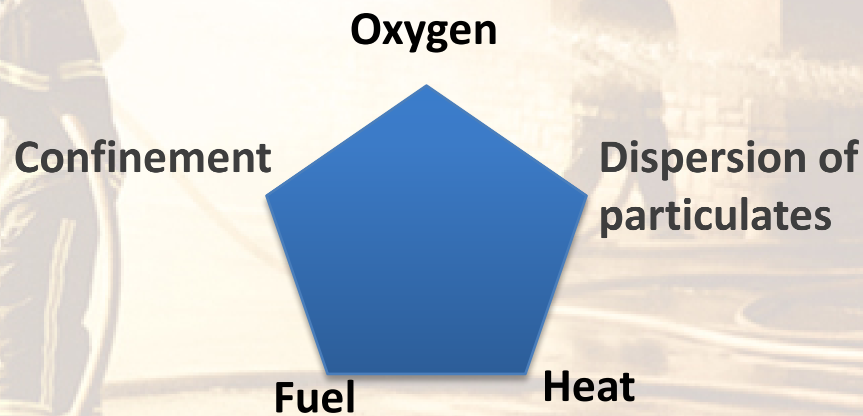
Infra Systems

Sentio®

- Early detection of combustion gases using intelligent multiple gas detection

What is Needed for a Fire to Occur?





Removingone of these elements prevents an explosion, but not necessarily a fire

Typical Risk Areas




- Dryers
- Dryercyclones
- Intermediatestorage
- Pellet presses
- Coolers
- Screens
- Pellet silos
- Hammer mills
- Filters
- Conveyors

”Friction, heat, oxygen, fine material”

Which particles are dangerous?

TABLE 5-9A. Explosion Characteristics of Various Dusts

(Compiled from the following reports of the U.S. Department of Interior, Bureau of Mines: RI 5753, The Explosibility of Agricultural Dusts; RI 6516, Explosibility of Metal Powders; RI 5971, Explosibility of Dusts Used in the Plastics Industry; RI 6597, Explosibility of Carbonaceous Dusts; RI 7132, Dust Explosibility of Chemicals, Drugs, Dyes and Pesticides; and RI 7208, Explosibility of Miscellaneous Dusts.)

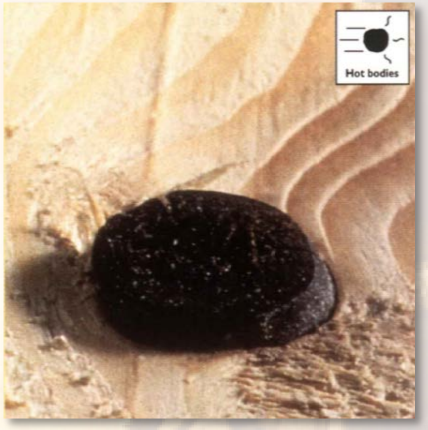
Type of Dust	Explosibility Index	Ignition Sensitivity	Explosion Severity	Maximum Explosion Pressure psig*	Max Rate of Pressure Rise psi/sec*	Ignition Temperature† Cloud °C	Ignition Temperature† Layer °C	Min Cloud Ignition Energy joules	Min Explosion Conc oz/cu ft‡	Limiting Oxygen Percentage§ (Spark Ignition)
Agricultural Dusts										
Cellulose	2.8	1.0	2.8	130	4,500	480	270	0.080	0.055	C13
Cellulose, alpha	>10	2.7	4.0	117	8,000	410	300	0.040	0.045	—
Cocoa, natural 19% fat	0.6	0.5	1.1	68	1,200	510	240	0.10	0.075	—
Coffee, fully roasted	<0.1	0.2	0.1	38	150	720	270	0.16	0.085	C17
Corn	6.9	2.3	3.0	113	6,000	400	250	0.04	0.055	—
Cornstarch commercial product	9.5	2.8	3.4	106	7,500	400	—	0.04	0.045	—
Cork dust	>10	3.6	3.3	96	7,500	460	210	0.035	0.035	—
Cotton linter, raw	<0.1	<0.1	<0.1	73	400	520	—	1.92	0.50	C21
Cube root, South American	6.5	2.7	2.4	69	2,100	470	230	0.04	0.04	—
Grain dust, winter wheat, corn, oats	9.2	2.8	3.3	131	7,000	430	230	0.03	0.055	—
Lycopodium	16.4	4.2	3.9	75	3,100	480	310	0.04	0.025	C13
Milk, skimmed	1.4	1.6	0.9	95	2,300	490	200	0.05	0.05	N15
Rice	0.3	0.5	0.5	47	700	510	450	0.10	0.085	—
Soy flour	0.7	0.6	1.1	94	800	550	340	0.10	0.06	C15
Sugar, powdered	9.6	4.0	2.4	109	5,000	370	400‡	0.03	0.045	—
Wheat flour	4.1	1.5	2.7	97	2,800	440	440	0.06	0.05	—
Wheat starch, edible	17.7	5.2	3.4	100	6,500	430	—	0.025	0.045	C12
Wood flour, white pine	9.9	3.1	3.2	113	5,500	470	260	0.040	0.035	—

Enough temperature (MIT for dust cloud)

Enough temperature (MIT for dust layer)

Enough energy (MIE)

A hot particle of 470°C can be much more dangerous than a 1000°C spark



• A particle of **470 C** with an energy of **40mJ** is enough to start a fire or a dust explosion

- *Note that this is a "black" particle*

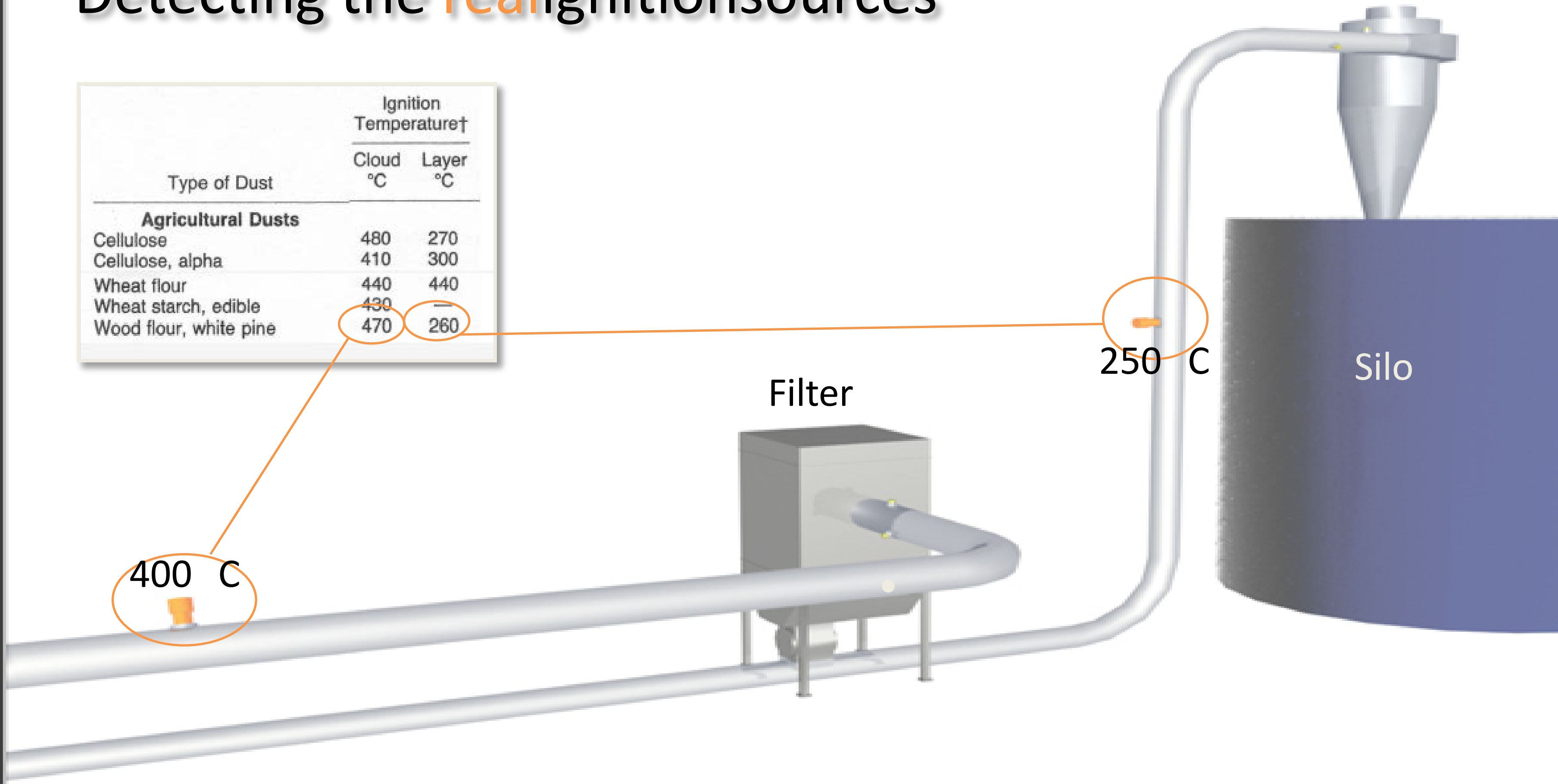
• A spark has a temperature of about **1000 C**

•If the energy is higher than **40mJ** it is dangerous and must be detected

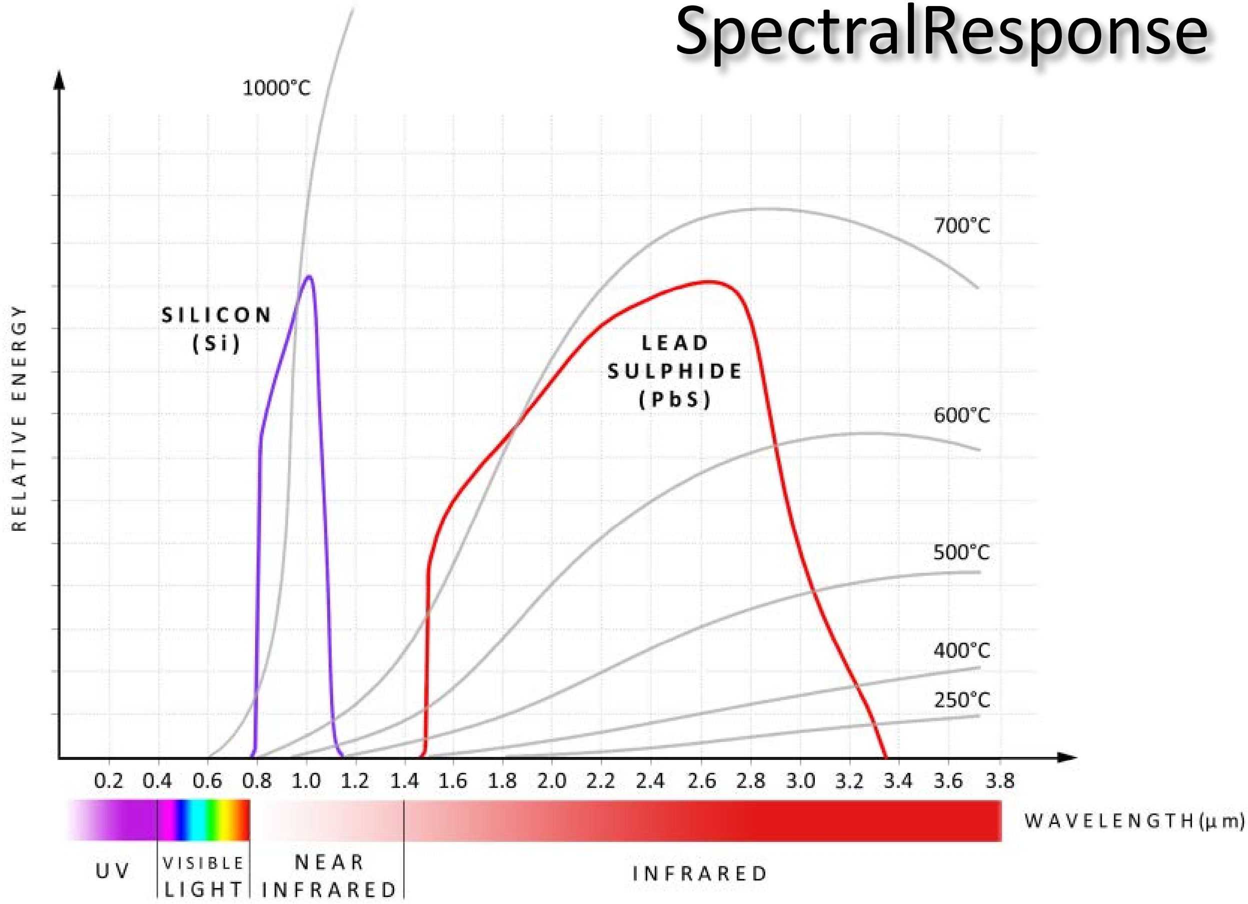
Many sparks have much LESS energy
- i.e. too little energy to ignite

Detecting the realignitionsources

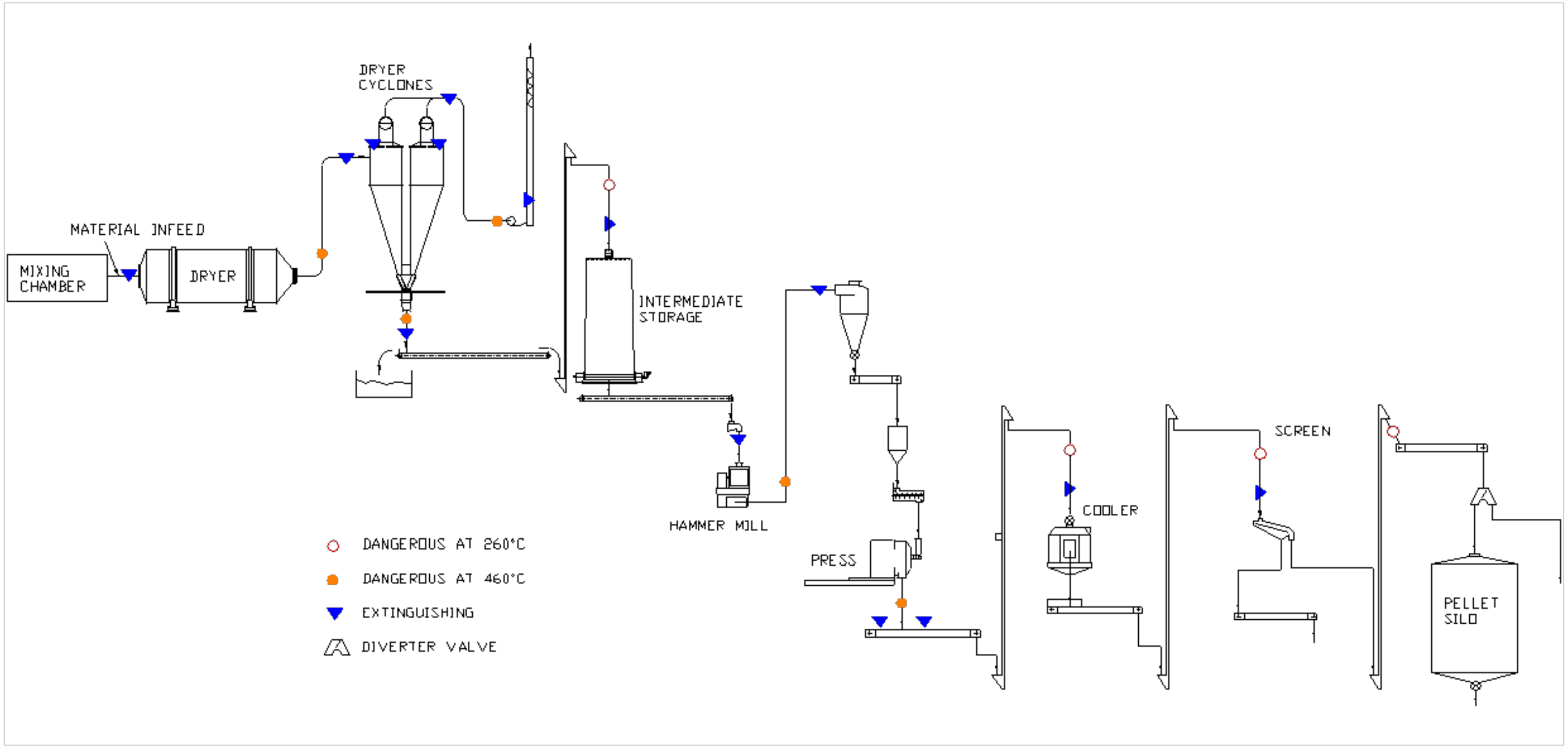
Type of Dust	Ignition Temperature† Cloud °C	Ignition Temperature† Layer °C
Agricultural Dusts		
Cellulose	480	270
Cellulose, alpha	410	300
Wheat flour	440	440
Wheat starch, edible	430	—
Wood flour, white pine	470	260



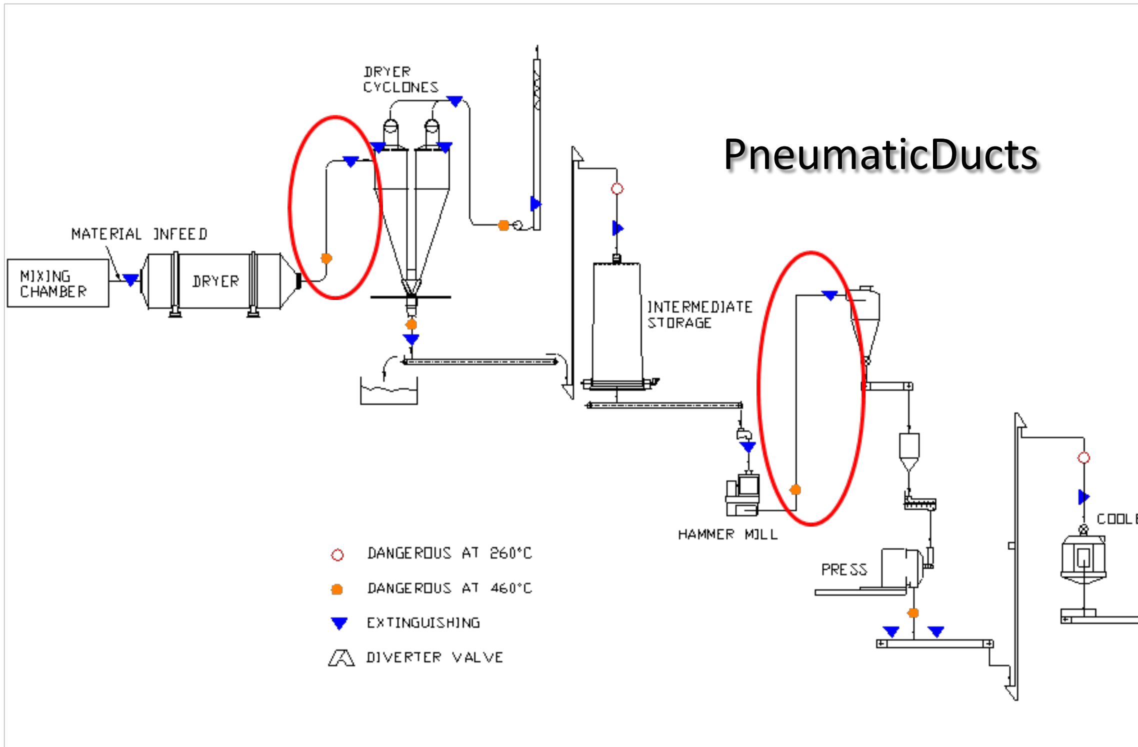
SpectralResponse



Howcanwe best monitor the production process

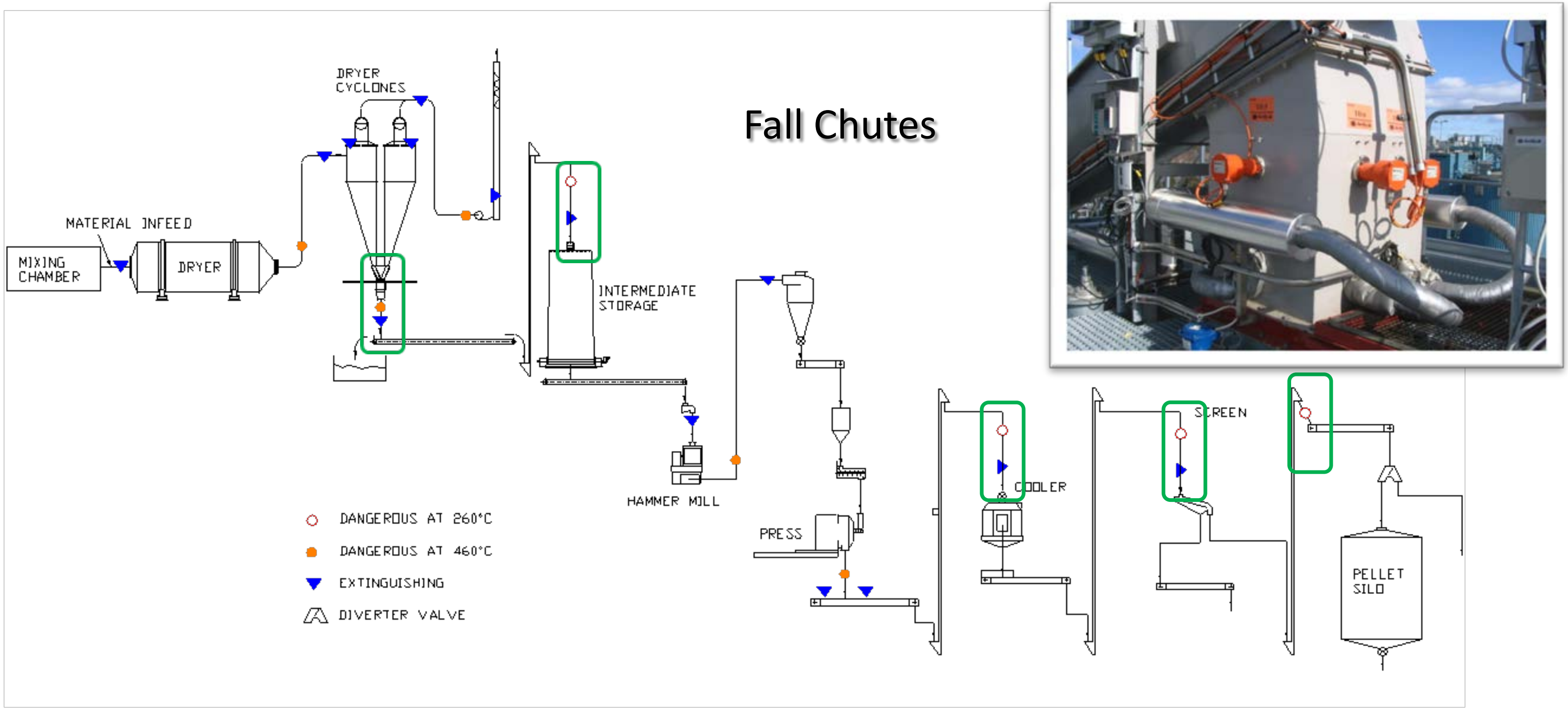


Howcanwe best monitor the production process



PneumaticDucts

Howcanwe best monitor the production process



The Hammer Mill

Frequent source of fires!

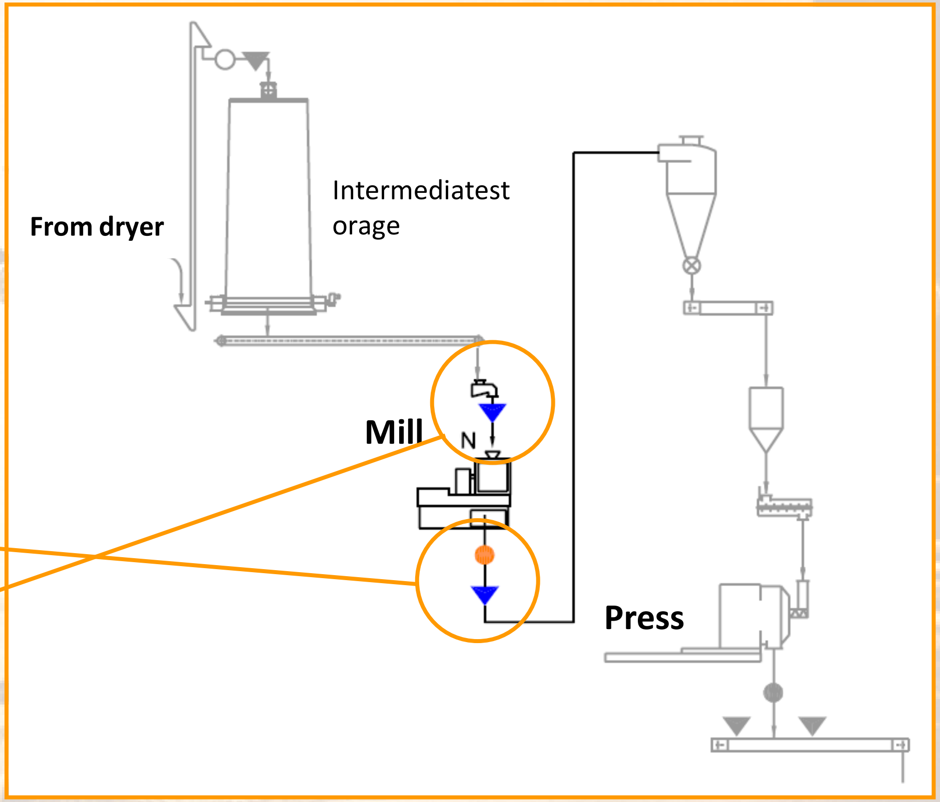
- Pieces of Metal / stones / etc.
- Overheating

(overloading, material build-up etc.)

•Failure

Detection (400°C) and extinguishing after the mill

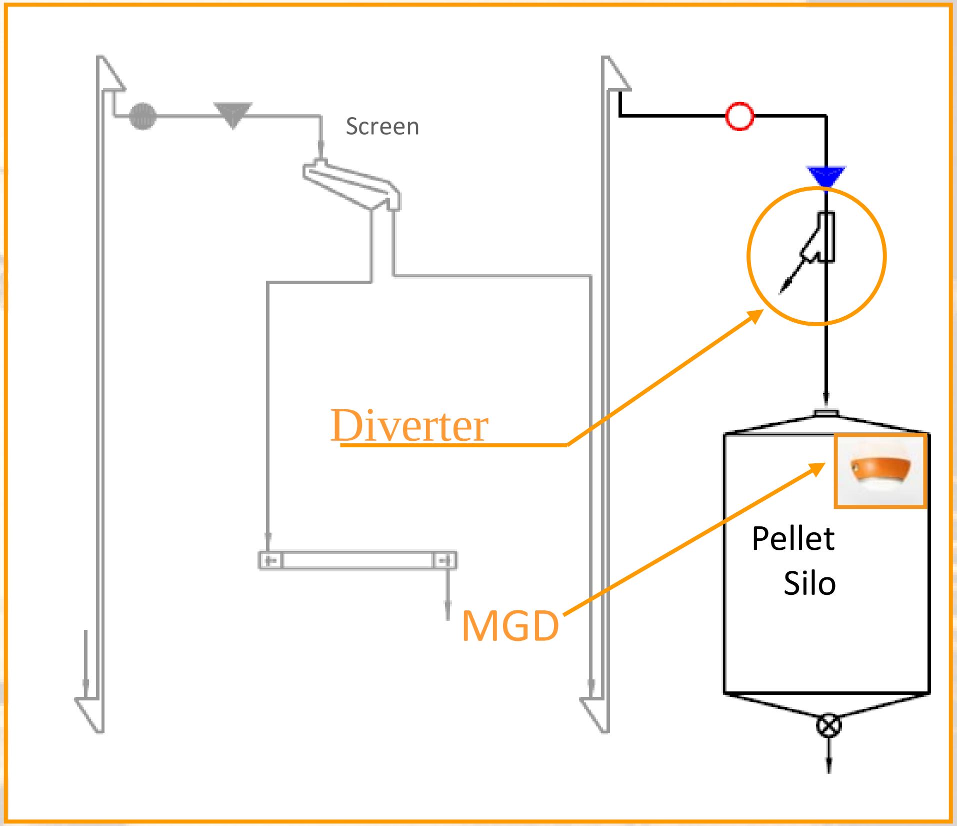
Suppression in the mill when there is a High Risk



Pellet silo

Material storage = Lower ignition temperature (260°C)

- Detection at inlet to silo (250°C)
- Note! Avoid water entering the silo (e.g. with a Diverter valve)
- Risk for transfer to trucks/trains, etc.
- Multi Gas Detection (MGD)



Biomass Handling, Storage, Shipping

Start | Knowledge Centres | SP Fuel Storage Safety | Publications about fuel storage

Publications about fuel storage

The following lists contains reports and articles in the area of fuel storage in connection with work performed at SP.

2012

Lönnermark, A., Persson, H., Blomqvist, P., Larsson, I., Rahm, M., Dahl, J., Lindholst, S., and Hansen, P. L., "Self-heating and Off-gassing from Biomass Pellets during Storage", World Bioenergy 2012, Jönköping, Sweden, 29-31 May, 2012.

2011

Dahl, J., Lindholst, S., Hansen, P. L., Lönnermark, A., Persson, H., and Blomqvist, P., "Large scale Utilization of Biopellets for energy Applications", 19th European Biomass

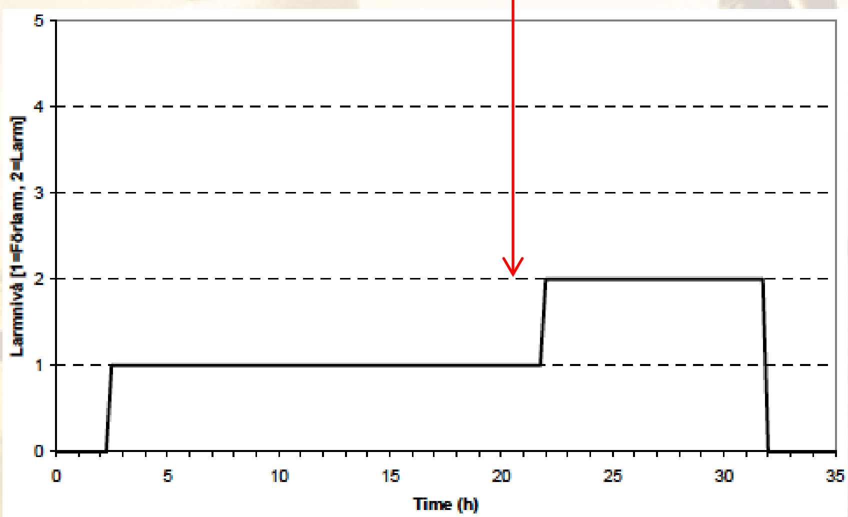
Study on silo fires

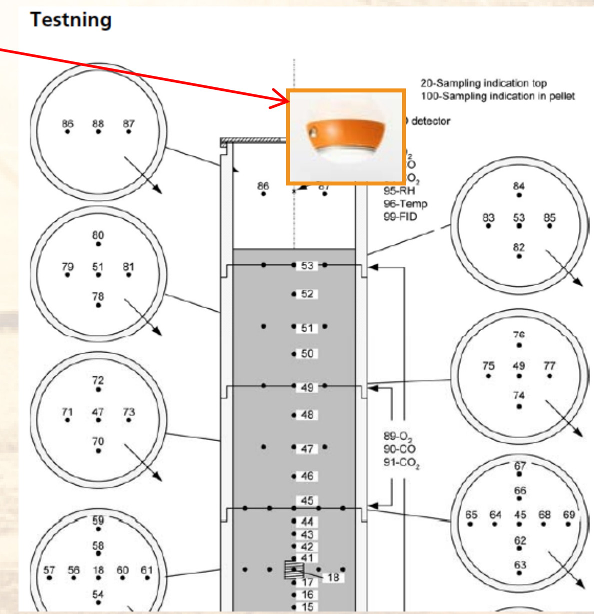
Severaltests of wood pellets stored in silos

Characteristicsofself-heating (exothermicreaction)

MGD detectorextremelyearly pre-alarm

~20 hrsbeforeothersafetyequipment





Fire Risks - Material Storage

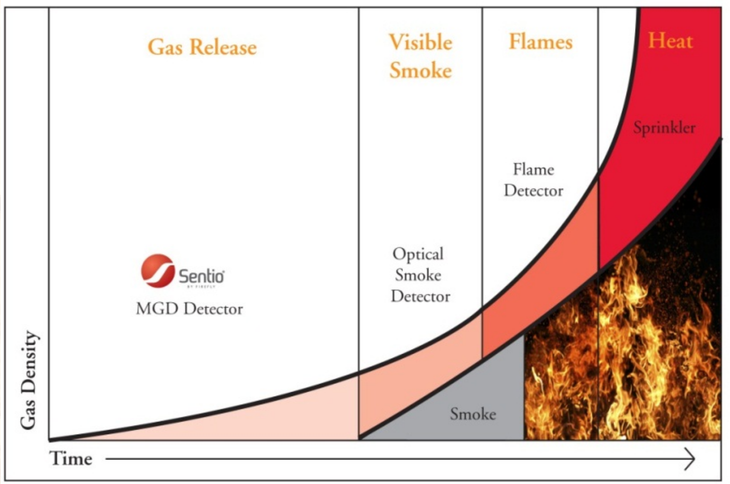
Identifysmell (composition of gases) from a beginningfire

Six different gas-sensors measure an arrayof different gases

By patternclassification, eachsmell forms a unique ”fingerprint”

Different ”fingerprints” can be saved and used for suppression of ”non-dangerous” combustiongases (such as diesel fumes from a truck)

MGD Technology® is used for detecton in intermediatestorage bins, silos and storagewarehouses. It is alsoused in the miningindustry, subway systems, tunnels and otherinfrastructure.



2012-2014

• SME-industry partners and research institutes - total 15 partners

• Support international standardization work by developingguidelines for the safeproduction, handling, and storage of pellets from different sources

Partner Firefly to develop new sensor solutions to detectfires and off-gases in pellet storages of different scale

•Findingsto be implemented as qualityassurance and safetymeasures in guidelinesserving the European biomass pellets industry and itscustomers.

USIPA SafetyWorking Group

•Chartered by the USIPA Board of Directors on 8/22/12
• First meeting 10/17/12
•Paralleling international consortiums with the same focus (i.e. SafePellets)

Objective

Promote the improvedsafety of pellet production, storage and transportationthrough the interchange of technicalknowledge, experience, and data

Homeworkkeytosafer pellet manufacturing

- Consider the risk for fire and dust explosions already in the design of the process
- Protection of all main risk zones
- Detecting the right temperature
- Efficient extinguishing
- Proper housekeeping
- Proper service and maintenance of machines
- Proper service

A littlehomework up front can save youthousands of dollars down the road…

Nicole Forsberg
Director of New Business - North America

nicole.forsberg@firefly.se

(480) 340 86 66