

SiloGuard - Concept

How to prevent fires and
dust explosions

PREDICTION / PREVENTION / PROTECTION

Who am I?

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23 years with Firefly

Involved in fire incident investigations within various process industries, Wood pellets, Wood Panel, Biomass, etc.

Involved in the development of advanced fire protection solutions

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Firefly in brief

- Firefly AB – a Swedish corporate group, founded in 1973
- Focus on innovative solutions and development of high-tech fire protection systems
- A leading developer of Spark detection and Quick suppression systems
- Listed on the NASDAQ First North stock exchange in Stockholm
- Head office in Stockholm, subsidiaries in USA, Poland and Italy
- Agents and distributors worldwide
- Multiple service centers located in all continents of the world
- Customers in over 90 countries
- Over 22 000 protection systems worldwide





Industrial fire protection



Woodworking



Wood panel



Hygiene



Power generation



Pulp and paper



Tissue



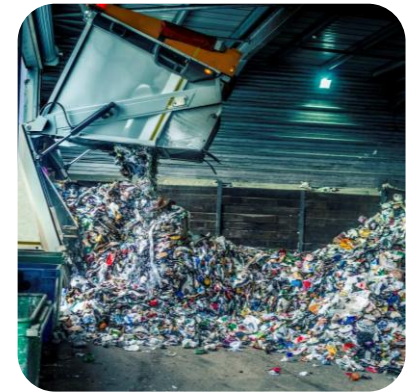
Food



Bioenergy



Ports



Recycling

Example of large enterprises protected by Firefly



Predictive, Preventive and protective fire protection systems

Firefly offers complete solutions protecting everything from individual machines, filters and silos to complete processing lines.



Prediction

Identifying a problem, in a machine or a process part, even before ignition sources have been .

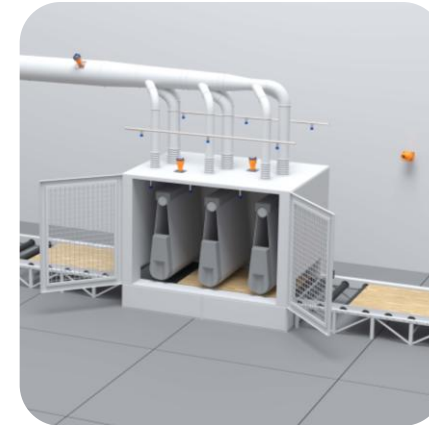
**MGD – Electronic nose
GAS Monitoring**



Prevention

Detection and Extinguishing of ignition sources **before** a fire or Explosion has occurred.

Spark Detection Systems



Protection

Quick Detection and Suppression of Flames / Fires.

**Quick Suppression Systems
Fast Water Mist Systems**

Fire risks Biofuel Storage



Statistically **8 out of 10** large losses in the industry are caused by fires



The background image shows a large industrial fire at a facility. Thick white smoke billows from the top of a large, multi-story building. A fire truck's extended ladder is visible, with a hose reaching towards the building. In the foreground, a large fire hose discharges a powerful stream of water. The facility is situated in an urban area with other buildings visible in the background.

Still, it is not the large incidents that are most costly for the industry;

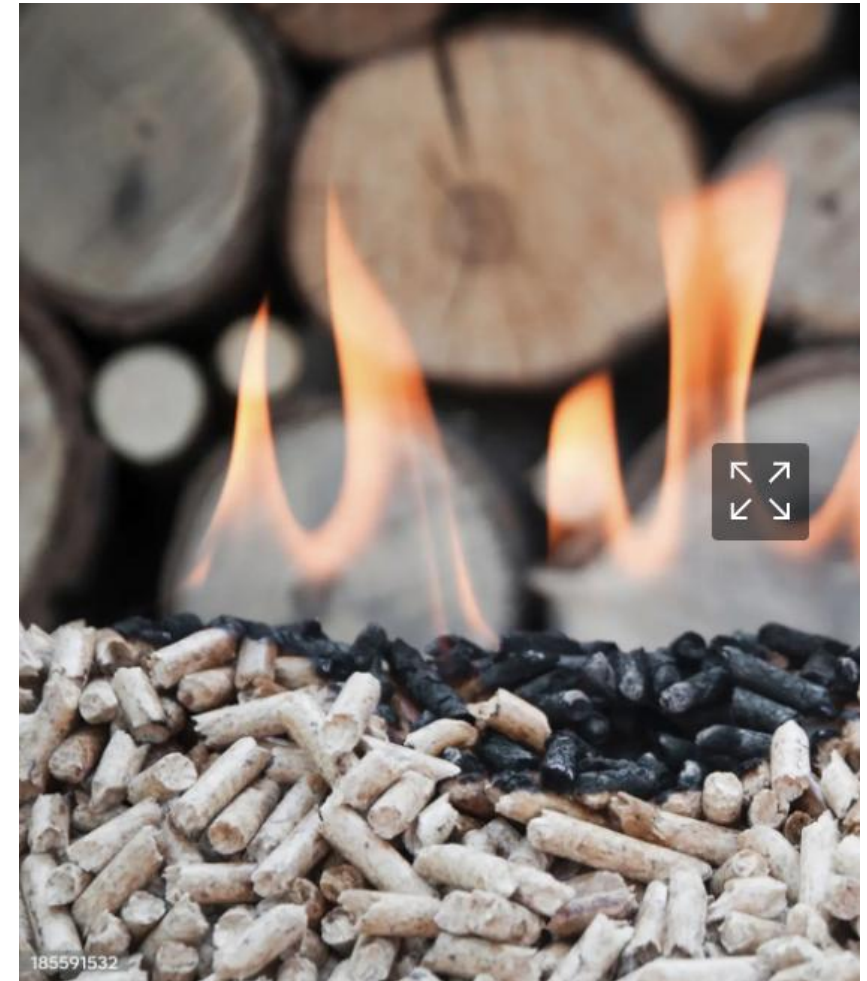
The high frequency of smaller incidents is even more costly to the industry when adding up the loss production.

WHY?



Finding the risk factors in Biomass Storage Fires

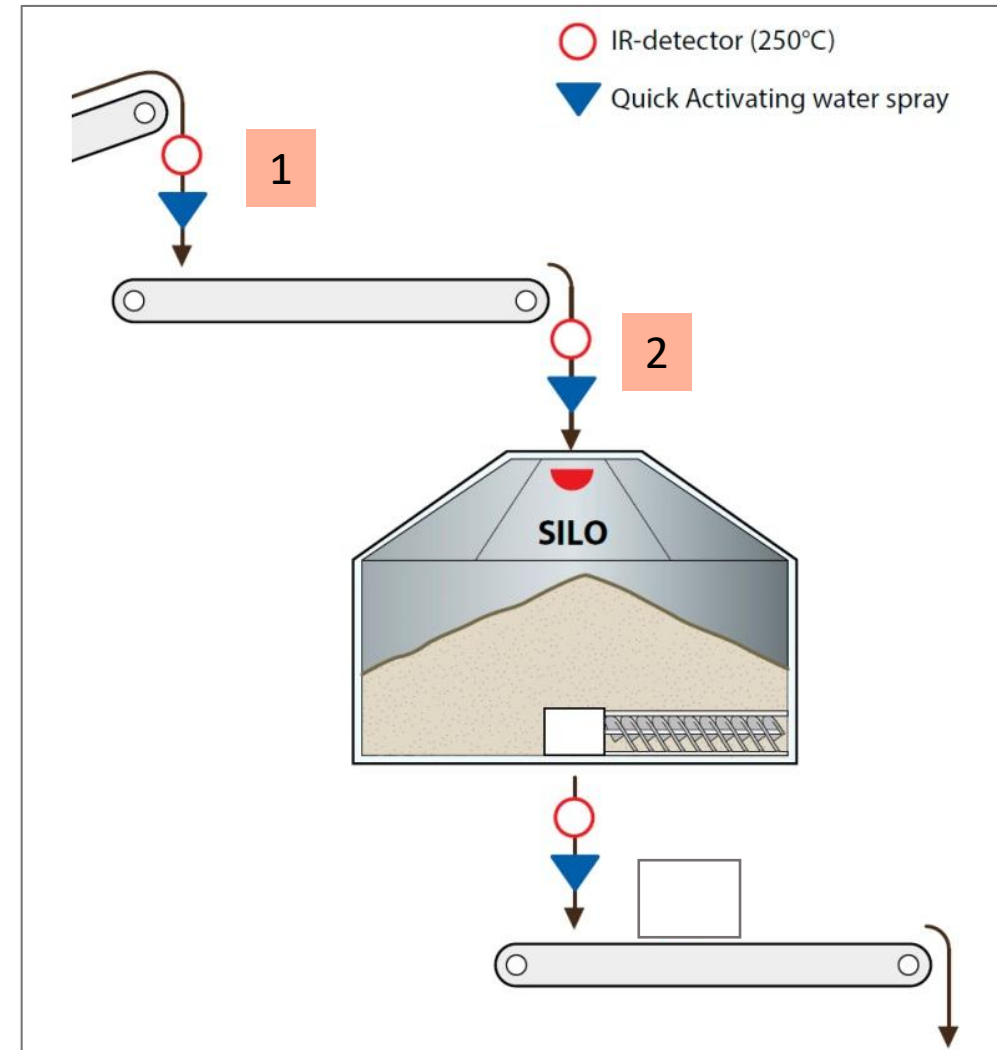
- Ignition Sources arriving with the Feed Stock
- Mechanical failure in the feed mechanism, Conveyors, Screws, etc.
- Spontaneous combustion / Self-Ignition
- Mechanical failure in the storage out feed mechanism



Ignition Sources arriving with the Feed Stock or failure in the feeding mechanism

- The LIT (Layer Ignition Temperature) for most Biofuel is around 260-270°C, Wood Pellets, Wood Flakes, etc.
- Ensure the Detection System can detect below the LIT
- Avoid the suppression water to enter the Silo
 - Location 1 is preferable, worse case location 2

NOTE: Location 1, after system is active the down stream conveyor will be reversed to dump the wet material, adding water into a storage silo will increase the risk of Self combustion.



Self-Ignition / Spontaneous Combustion

- Complex, challenging to detect an ongoing self-ignition and almost impossible to extinguishing
- Unfortunately, very common that the local fire brigade have limited knowledge how to extinguishing fire in Silos
- There is available knowledge and equipment to detect self ignition early and suppress it safely



Parameters that will influence Self-ignition

- **Moister Content**
 - Higher moister content, higher microbial activity and oxidation, both generate heat.
- **Biomass type and composition**
 - Vergin wood have a higher degree of oxidation, build up heat faster
 - Dust content, more dust greater risk of a dust explosion.
- **Air flow and Oxygen availability**
 - Microbial oxidation and chemical oxidation in biomass can start from low level of oxygen, it can start with O₂ levels >5%



Self-ignition – From microbial activity to Fire

1. Microbial Activity (Initial Heating Stage),

- ✓ Heat, CO₂ and Water vapor is generated
- ✓ Temperature rise from ~30-70°C
- ✓ Time: days or probably much longer if poorly ventilated volumes



2. Chemical Oxidation (Self-Heating Stage)

- ✓ As temperature rises past 70–80°C, microbial life dies off.
- ✓ Heat generation accelerates if heat can't dissipate which will happen in large biomass storage.
- ✓ Temperature will rise to ~150-200°C
- ✓ Gases released CO, CO₂, H₂O, CH₄, VOCs



Self-ignition – From microbial activity to Fire

3. Pyrolysis (Thermal Decomposition)

- ✓ Around 200-300°C biomass begins to thermally degrade without a flame.
- ✓ Produces:
 - ✓ Combustible gases (CO, CH₄, VOCs)
 - ✓ Char
 - ✓ Tar

4. Ignition / Fire

- ✓ If the local temperature reach ~270-280°C and oxygen is available a self-ignition can occur
- ✓ The smouldering fire can start deep inside the biomass
- ✓ First progress is slow
- ✓ If the smouldering part reach the outfeed of the Silo it will ignite into a fire immediately due to the Oxygen level (21%), if dust is present there is a high risk of a dust explosion.



VOCs stands for Volatile Organic Compounds. VOCs are organic chemicals that have a high vapor pressure at room temperature, which means they easily evaporate into gases. In the context of biomass and combustion, VOCs are released during: Microbial activity, Chemical oxidation, Pyrolysis. During the pyrolysis and self-heating phases in biomass (e.g., wood chips or pellets), VOCs are released such as: Formaldehyde, Acetic acid, Methanol, Terpenes, Toluene, Benzene. Many VOCs are highly flammable and can form explosive mixtures with air. Can be really dangerous when discharging a Silo.

Self-ignition – From microbial activity to Fire

Example Timeline

(Under Poor Storage Conditions)

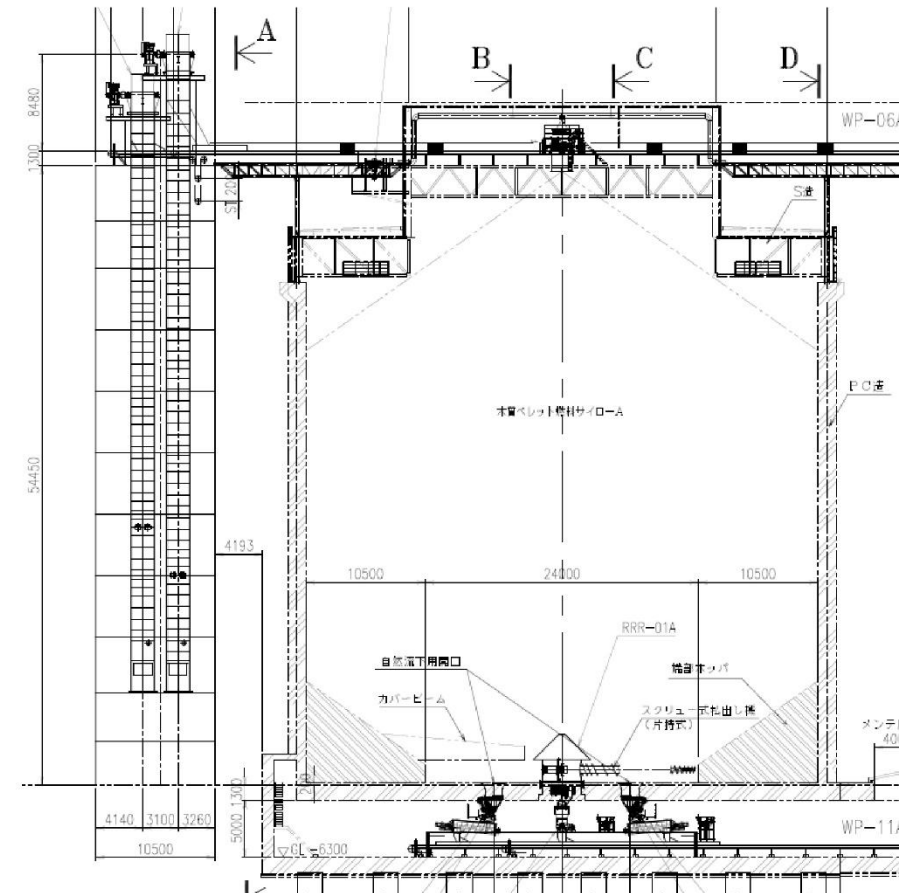
- Day 1–3: Microbial heating starts
- Day 4–10: Temperature rises to 80–100°C
- Day 10–20+: Chemical oxidation raises core temperature >150°C
- Beyond ~20 days: Pyrolysis gases form, risk of ignition becomes high.



NOTE: This is just an example, normally it takes longer time

The Solution

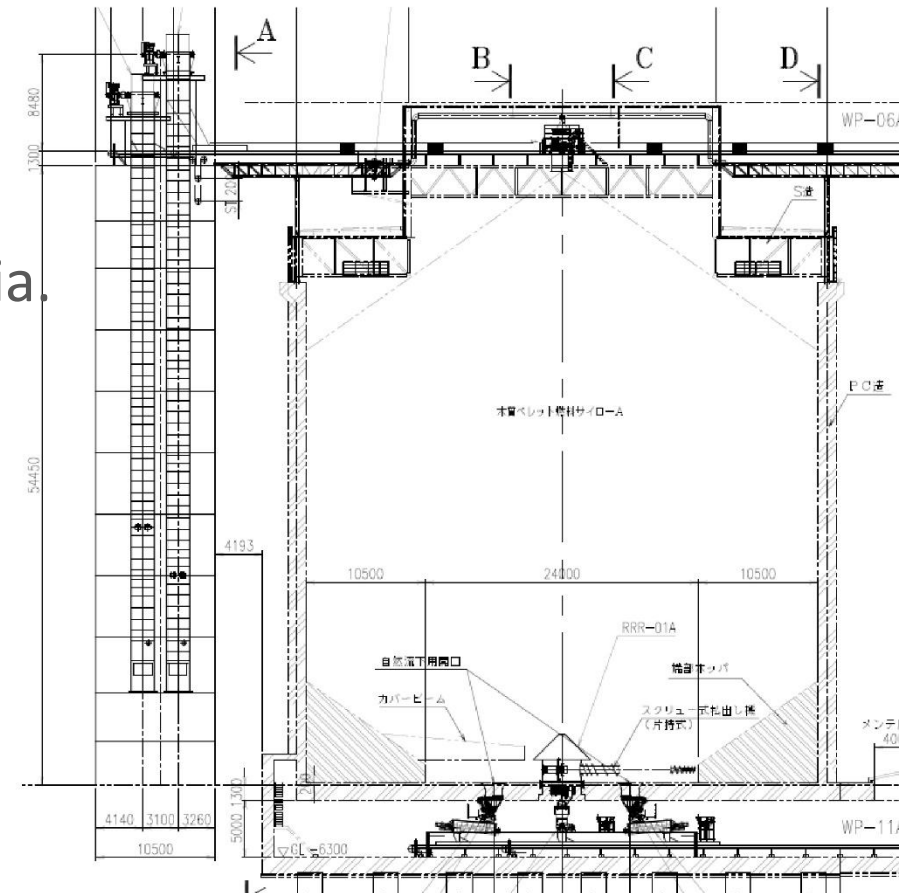
- Reliable Gas Detection System
- N₂ injection system in bottom of the Silo
- Redundance
- Inline 3D scanner



The Solution

N₂ injection system in bottom of the Silo

- Based on research, experience and full scale test N₂ is the most sufficient suppression media.
- Can also be use to “push” the released combustion gases in the silo to the top of the Silo where the measuring equipment is installed. (earlier detection of an on-going smoldering fire)
- Never use water suppression in a wood pellet silo the consequences can be catastrophic.

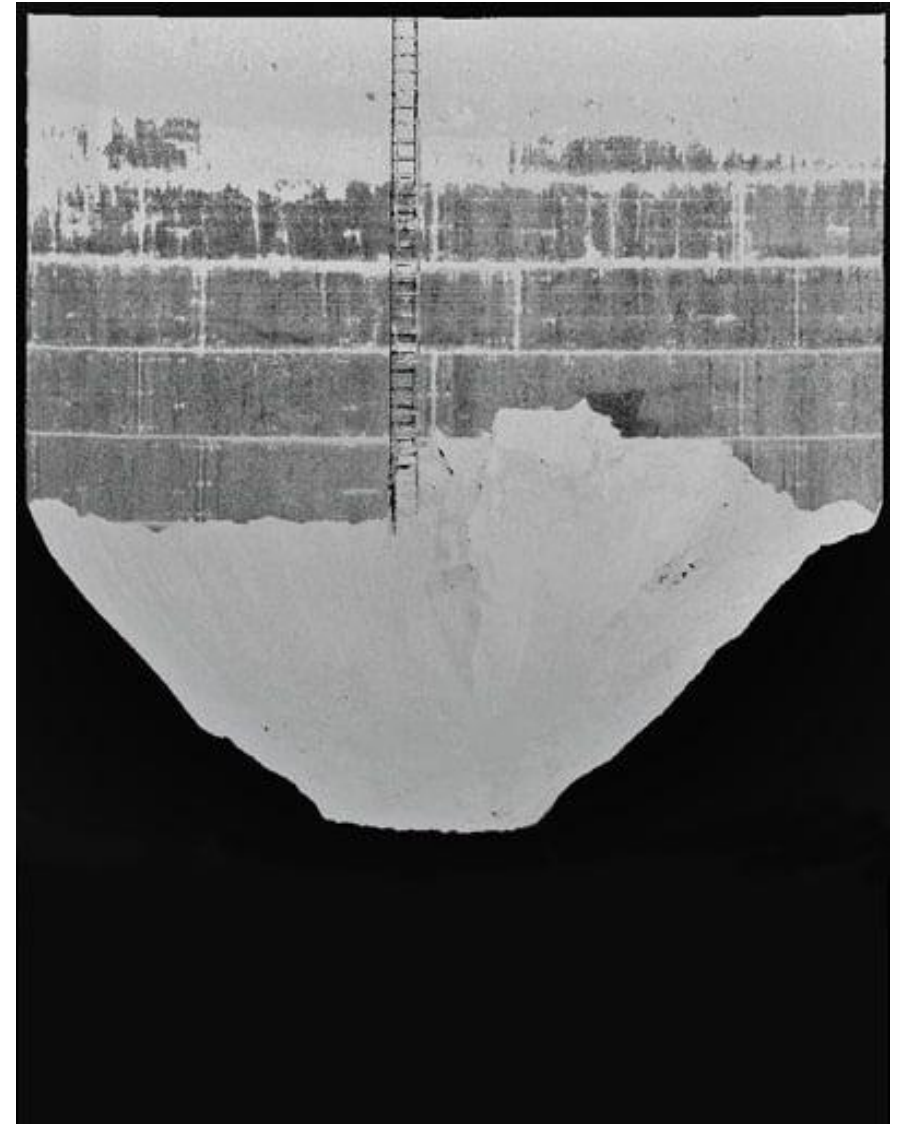


The Solution

Inline 3D Scanner

- Install a 3D Scanner in top of the silo to ensure the Silo is emptied evenly.
- Prevent “bridging”, know your Silo inside.
- A smoldering fire will force the pellets/flakes to release moisture which can create bridging
- Bridging can generate a “block” of dissolve wood pellet with a weight of several 100 tons, if this drops down at some point, it can create a catastrophic event.

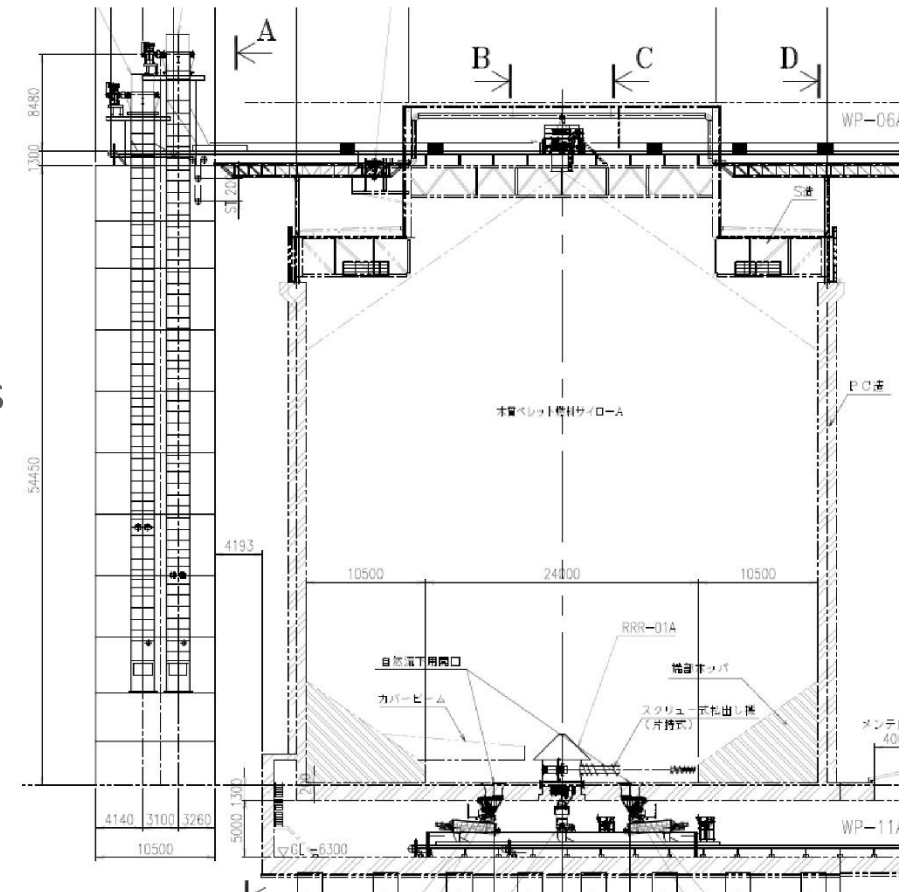
NOTE: A small volume can cause self-ignition, 1-2m³ can be enough



The Solution

Reliable Gas Detection System

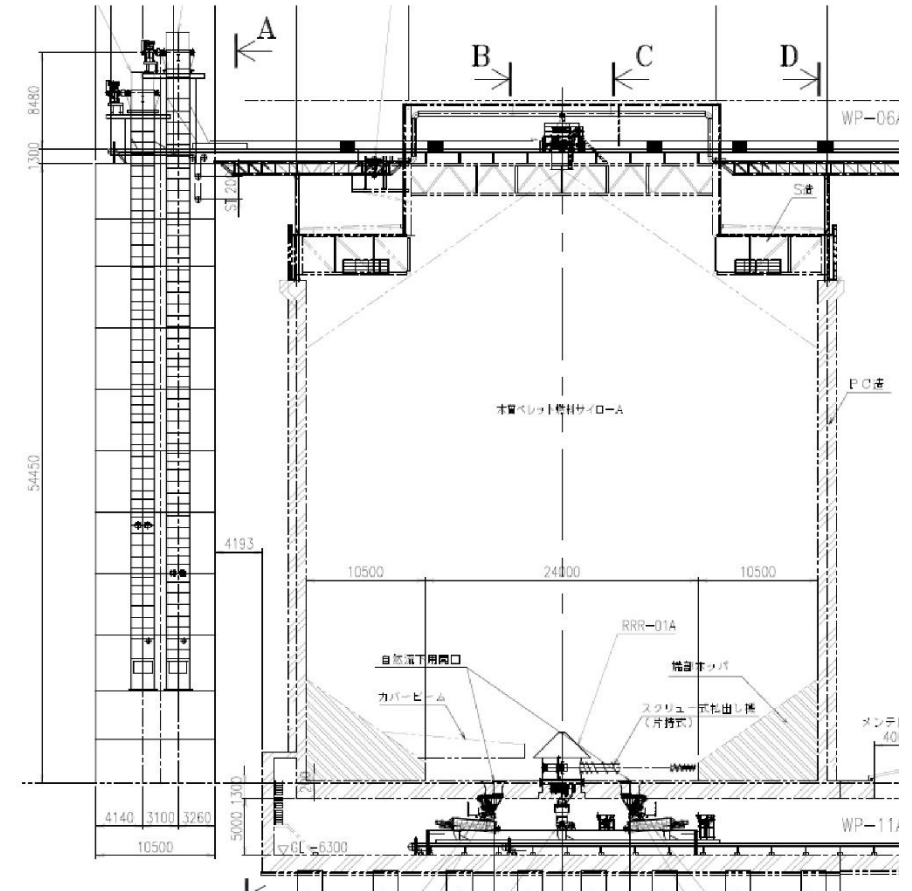
- Recommended to install a redundant system, i.e. two pcs of every sensor this to ensure that the value is correct.
- MGD is the fastest detector to detect combustion gases
 - The MGD does not detect a specific level of each gas, the MGD searching for specific pattern between different combustion gases.
 - The MGD require 5-10 less volume of each gas to be able to confirm if there is n on-going smoldering fire
- Installed the correct sensors with the correct range.
 - Especially the CO sensor, it is common that the range is 0-3000ppm. 3000ppm can appear in a silo if the silo is filled with virgin wood and the surrounding condition is optimal.



The Solution

Recommended Sensors

- O₂ - Oxygen, 0-25%
- CO - Carbon monoxide, 0-100 000ppm
- CO₂ - Carbon dioxide, 0-5%
- CH₄ – Methane, 0-100% LEL
- H₂ – Hydrogen, 0-100% LEL
- RH – Moisture level, 0-100%
- Temperature



Summary

- Make sure you install correct Spark Detection Sensors that can detect below LIT
- Never suppress a Wood Pellet Silo Fire with Water
- Always install Nitrogen injection system in the bottom of the Silo
- Redundance of Gas Sensors
- Choose the correct Gas Sensors
- Know your Silo, Inline 3D Scanner

Q & A

THANK YOU!



PROTECTION SYSTEMS FROM

firefly