PERFORMANCE BASED ANALYSIS OF WATERMIST PROTECTION SYSTEM IN A CONVEYOR BELT USING CFD

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OUTLINE

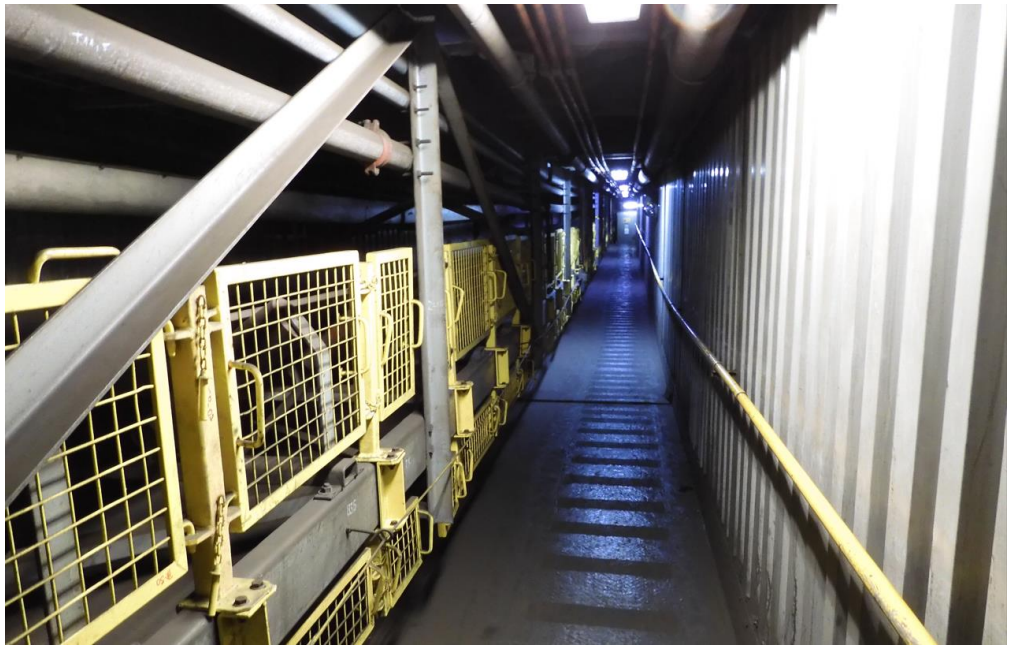
1. INTRODUCTION
2. METHODOLOGY
3. PERFORMANCE CRITERIA
4. FIRE SCENARIOS
5. TRIAL DESIGNS
6. RESULTS
7. CONCLUSIONS

1. INTRODUCTION

- Conveyor belts system crucial for copper concentrate transport in mining.
- Requirement of an automatic fire protection.

1. INTRODUCTION

- Fire protection goals of; life safety, operational continuity and minimize the **environmental impact** of water protection system discharged.



1. INTRODUCTION

- Fire protection goals of; life safety, operational continuity and minimize the **environmental impact** of water protection system discharged.

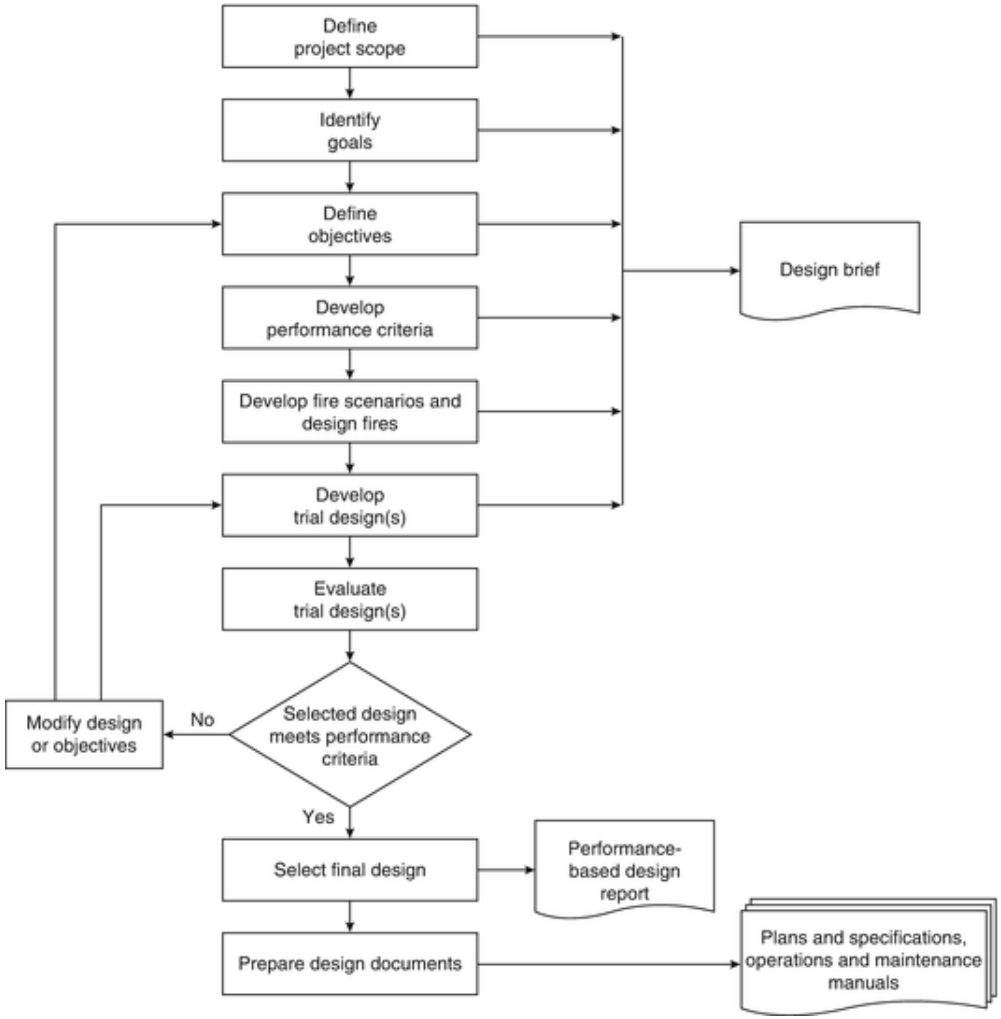
Contain the water discharge from the fire protection system.

A bigger water flow needed for fire control and extinguishment would need **a bigger drainage and accumulation system** installed in the structure of the conveyors belt above the sea.

Therefore, **performance base analysis** is developed to **minimize the water drainage system** and the potential contamination of the sea water.

2. METHODOLOGY

- General methodology for PBD according SFPE Handbook



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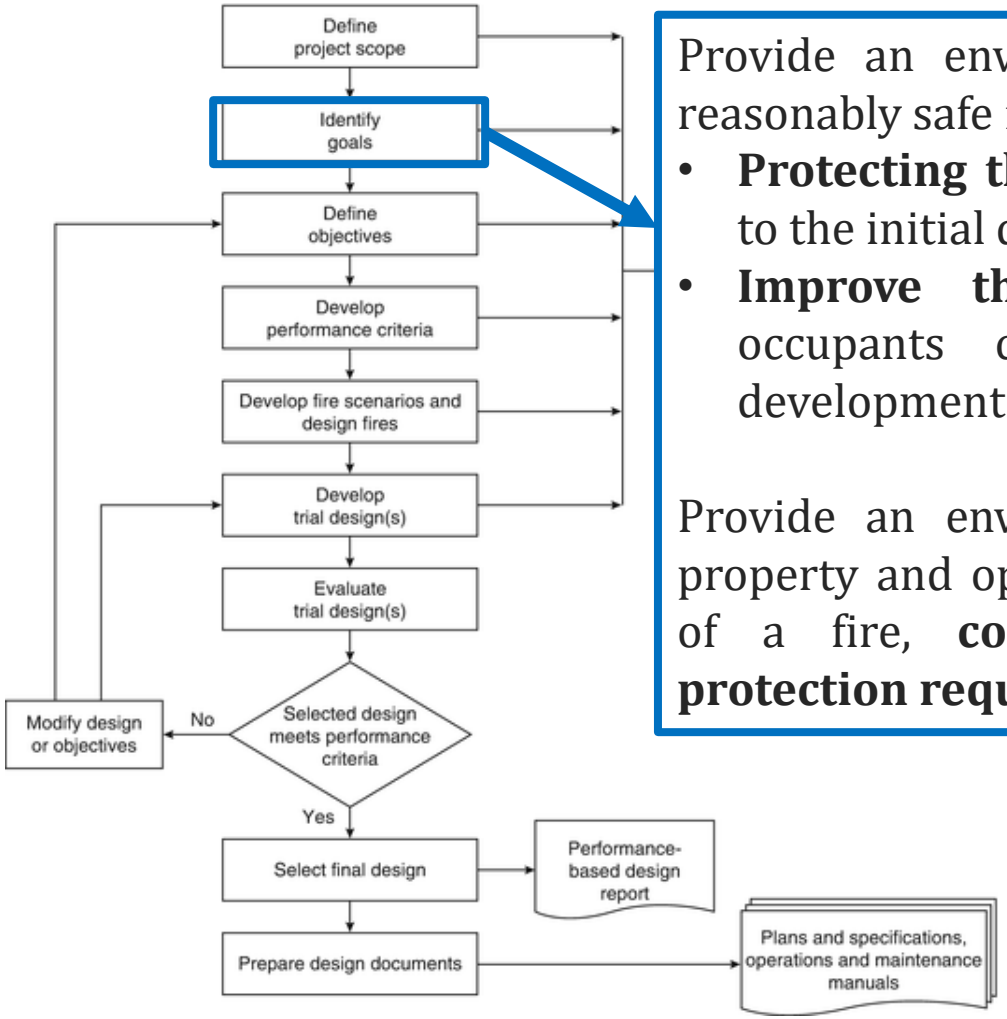

Provide an environment for occupants that is reasonably safe from fire by:

- **Protecting the occupants** not closely related to the initial development of the fire
- **Improve the survival capacity** of the occupants closely related to the initial development of the fire.

Provide an environment for the protection of property and operational continuity in the event of a fire, **considering the environmental protection requirements.**

2. METHODOLOGY

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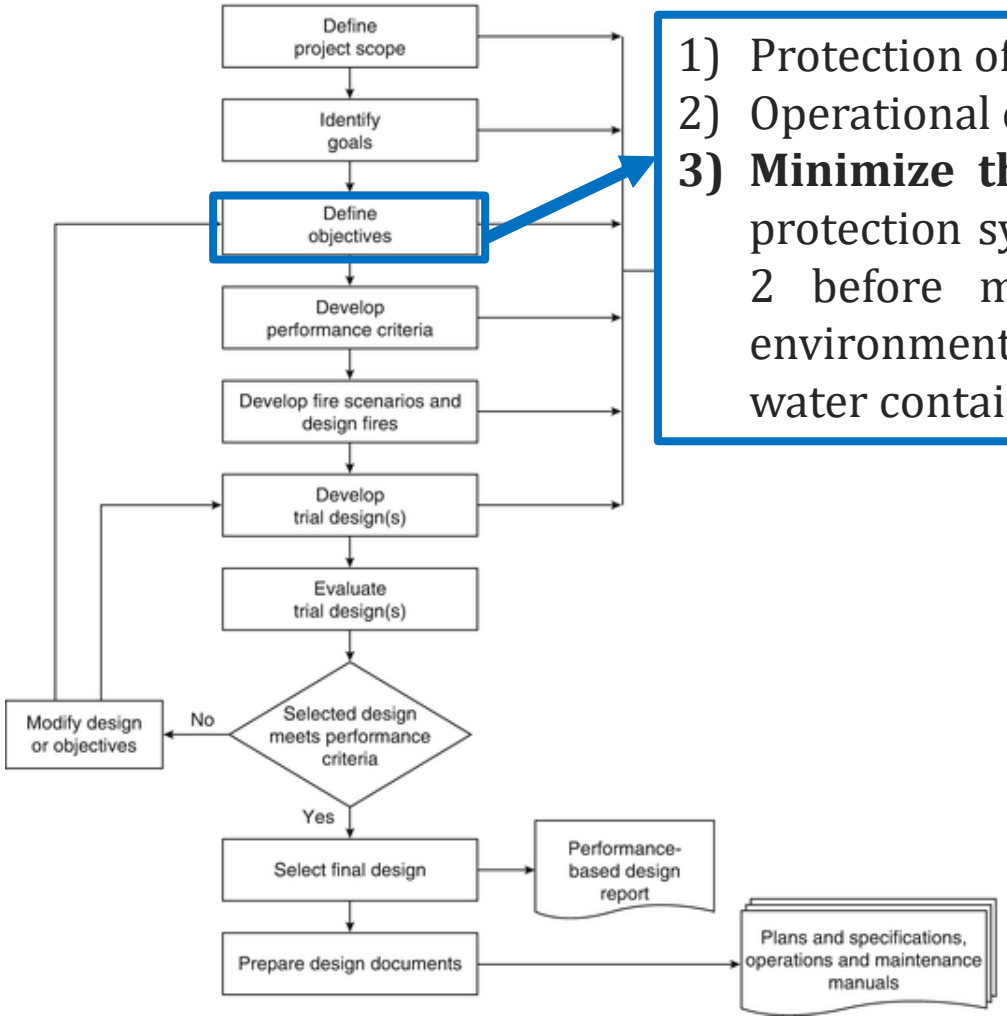
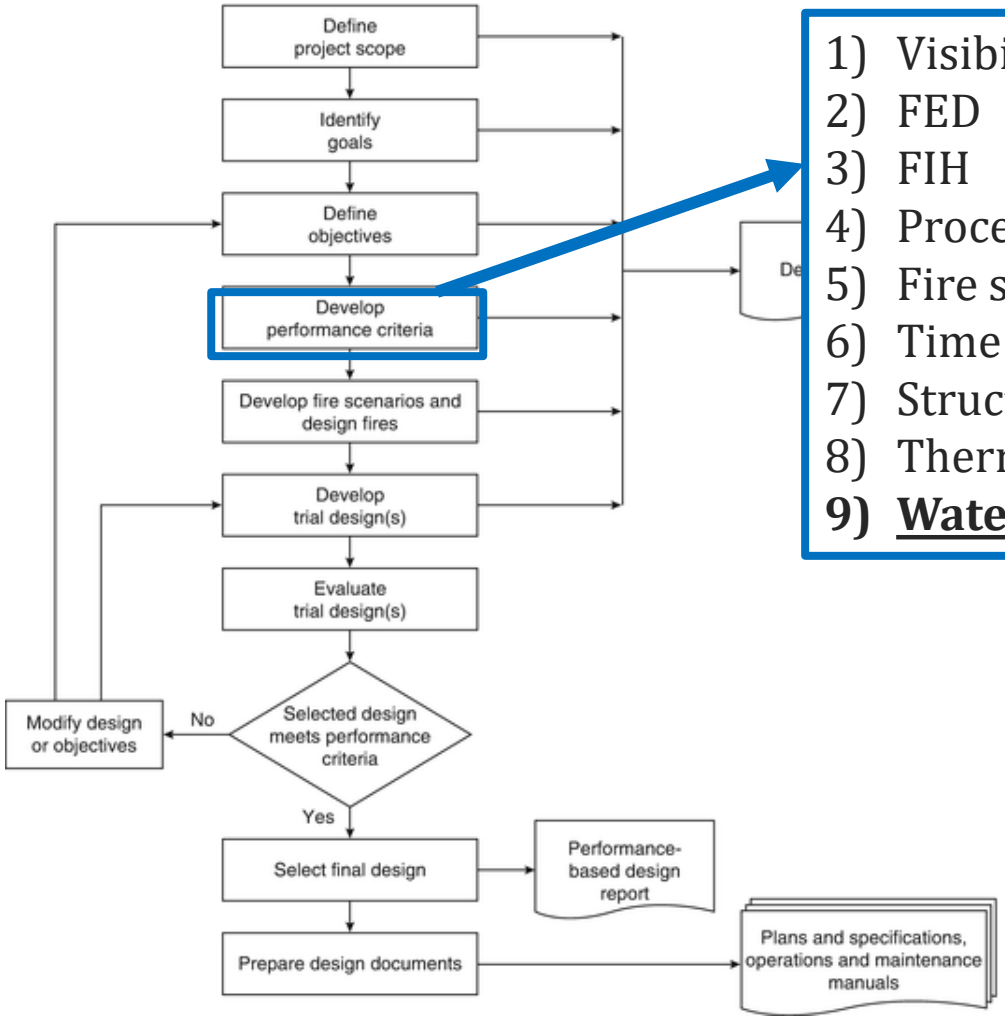


1) Protection of the occupants.
2) Operational continuity.
3) **Minimize the water discharge:** evaluate a fire protection system that fulfils the objectives 1 and 2 before mentioned and that also fulfil the environmental requirements of minimize the water containment.

3. PERFORMANCE CRITERIA

- General methodology for PBD according SFPE Handbook



1) Visibility
2) FED
3) FIH
4) Process Equipment Temperature
5) Fire spread and Combustion Control
6) Time to Control and Extinguish the Fire
7) Structural Stability
8) Thermal radiation
9) **Water discharged**

3. PERFORMANCE CRITERIA

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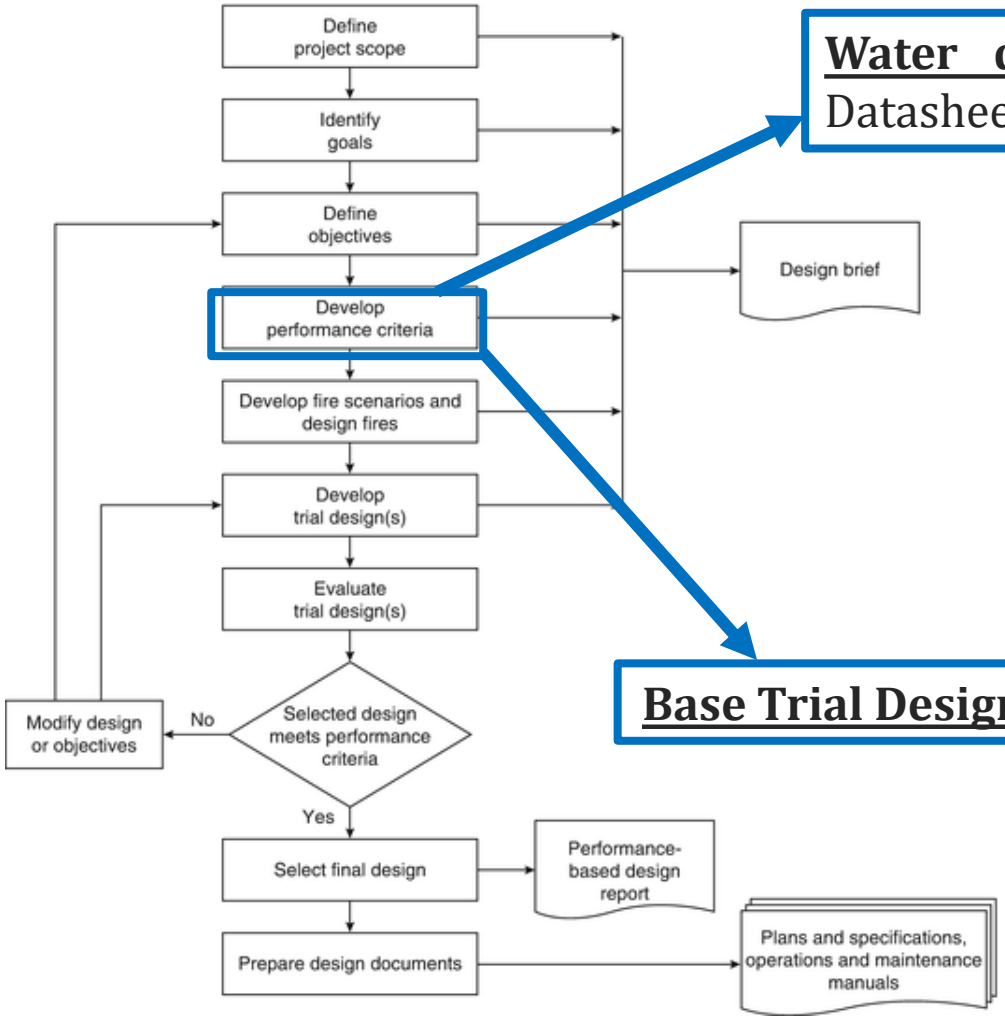


Water discharged: Based in FM Global Datasheet 7-11. Art 2.3.3.

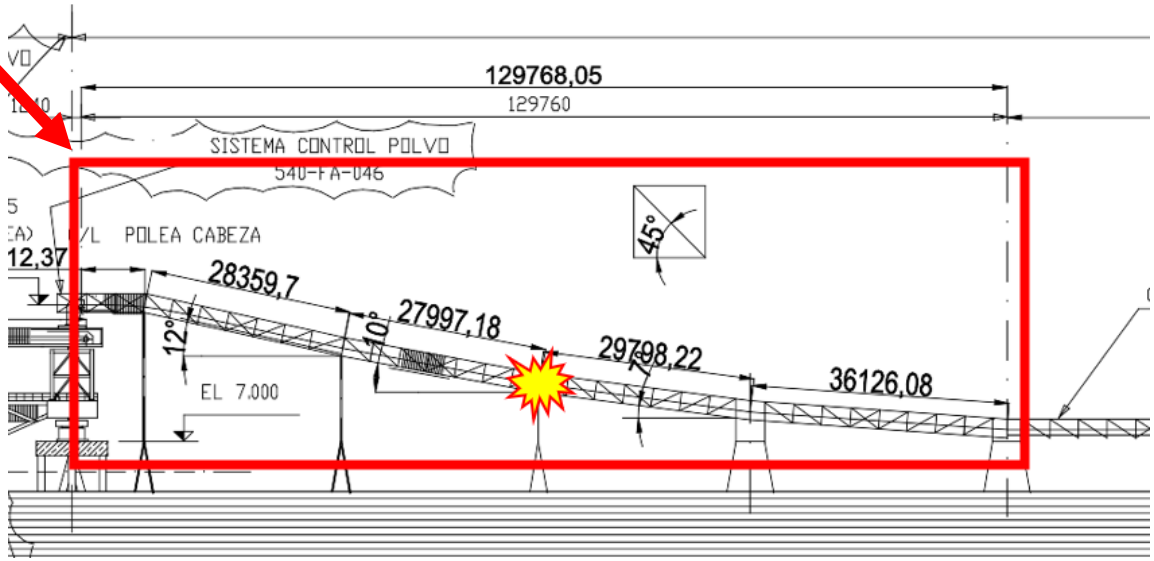
K Factor	8	US
Pressure	15	PSI
Flow per Sprinkler	31	gpm
Flow per 10 Sprinklers	310	gpm
	1171	lpm

Base Trial Design

Opened Sprinklers	5	Un
Total Flow	155	gpm
	586	lpm
Average Activation Time	22.3	sec

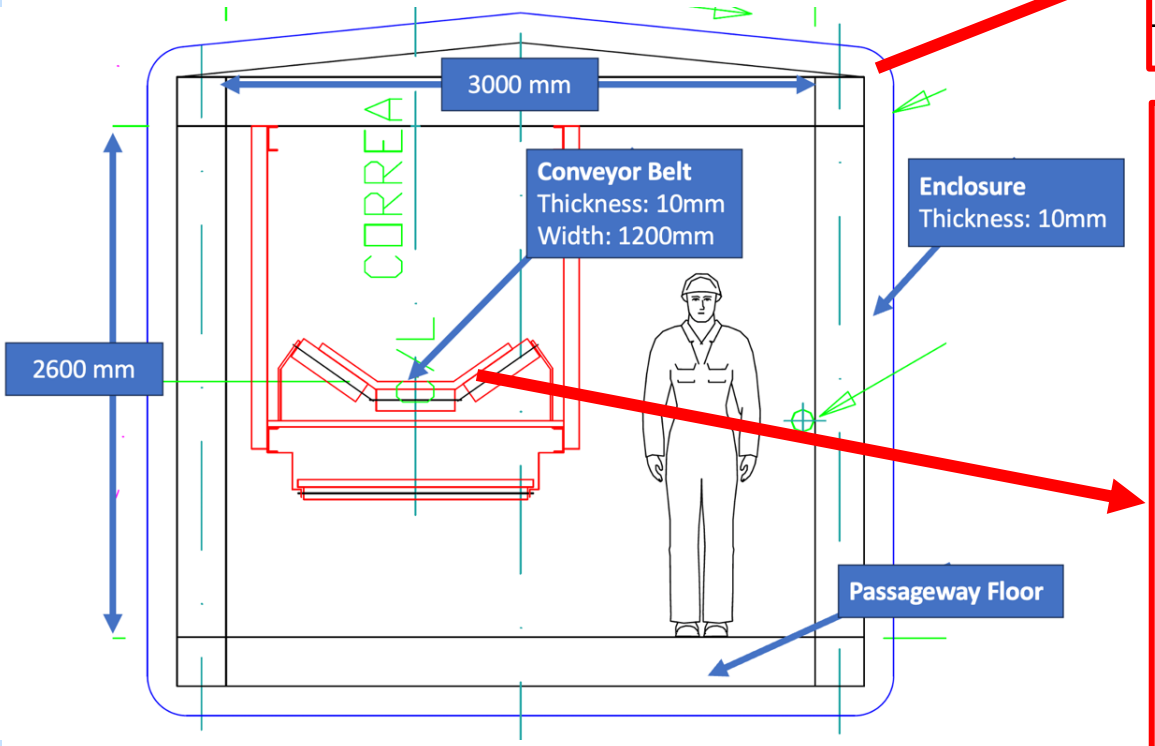
4. FIRE SCENARIOS

- Average 10° of slope
- 130m section
- 2 Scenarios;
- **ES-01 -> Fire in the actual conditions of the facilities**
- **ES-02 -> Fire considering the trial designs**

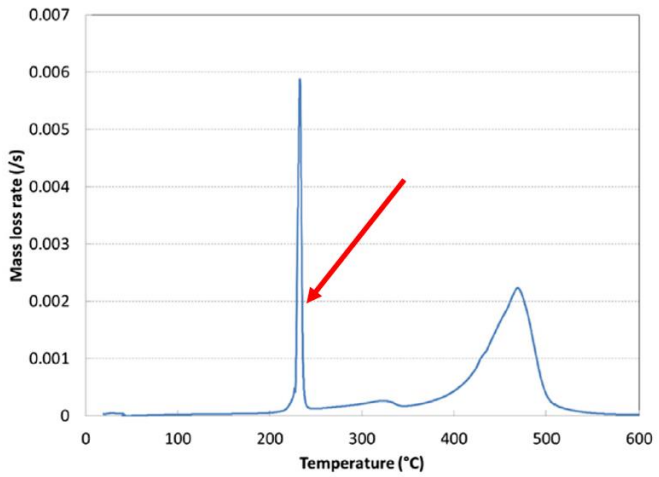


4. FIRE SCENARIOS

- Geometry and Materials



Specific Heat	0.46	kJ/(kg°K)
Conductivity	45.8	W/(m°K)
Density	7850	kg/m3
Emissivity	0.95	Dimensionless
Thickness	0.01	Meters



Property	Virgin material
Density (kg/m^3)	1300
Specific heat (kJ/kg/K)	1.3
Conductivity (W/m/K)	0.19
Heat of combustion (kJ/kg)	2.85×10^4
Heat of gasification (kJ/kg)	1500

4. FIRE SCENARIOS

- Statistical Data

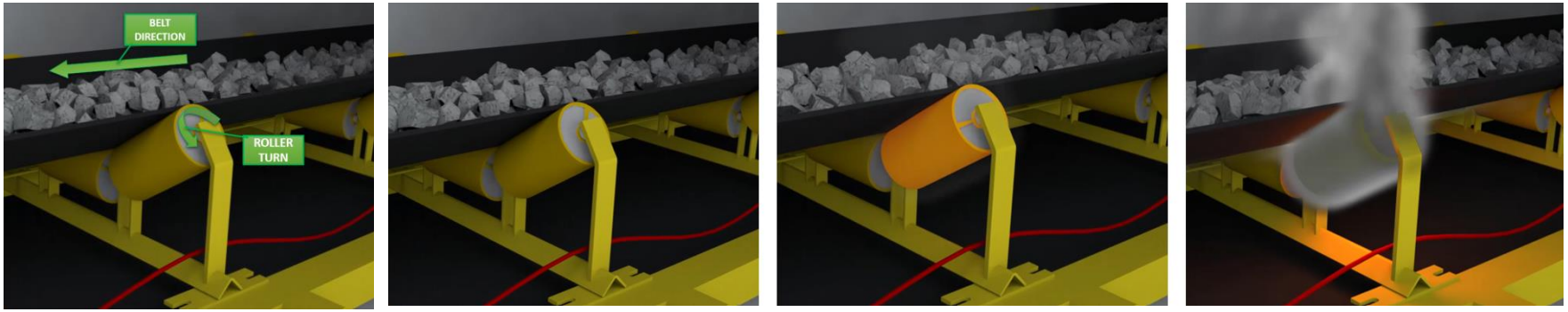
Most fires were caused by friction in the belt drive along the length of the belt, where the most common causes of conveyor belt fires were:

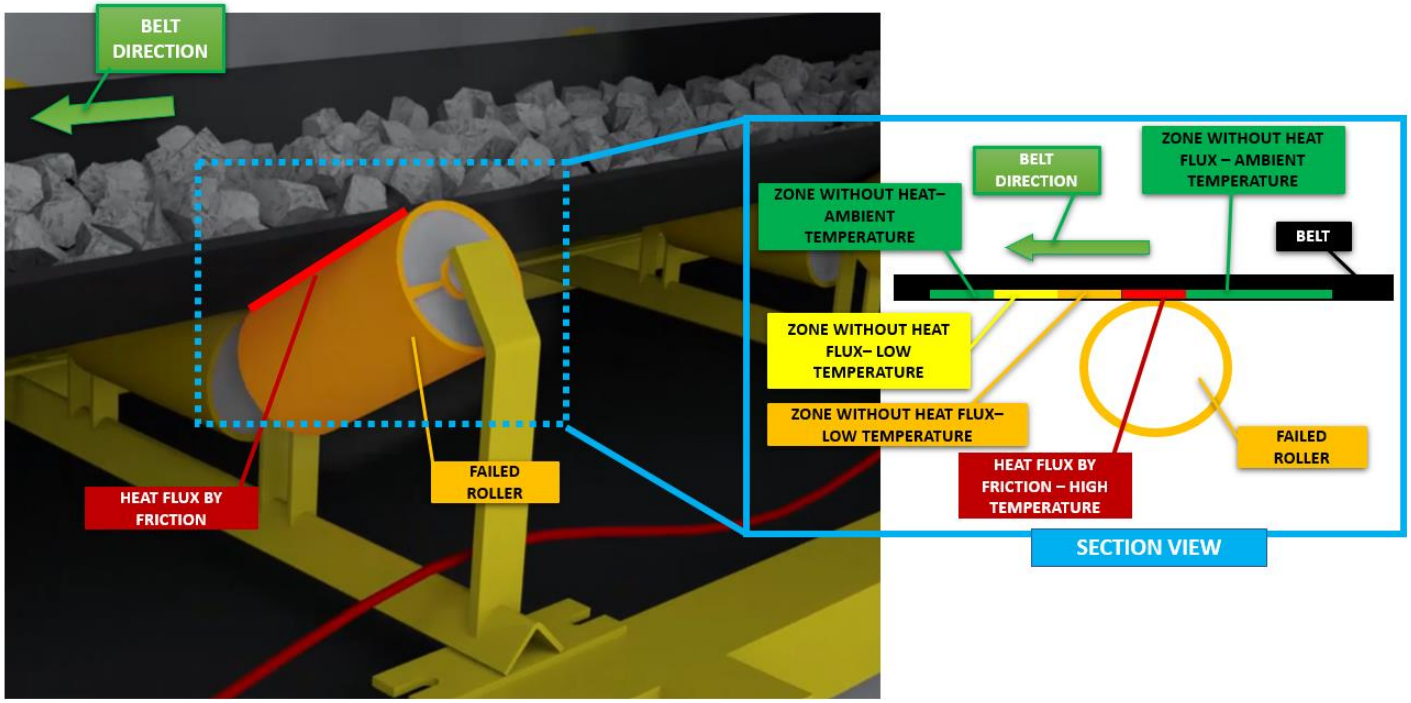
- Faulty bearing causes the excess of grease to ignite.
- Defective roller or roller causing friction and igniting the roller.
- Friction between the conveyor and a roller or pulley.
- Metal in contact with the belt.
- Rocks stuck against a roller/conveyor causing friction.

The **most common places** for fire starting are the **conveyor belt**, belt roller, return roller, impact roller, idler pulley, bending pulley and head pulley.

4. FIRE SCENARIOS

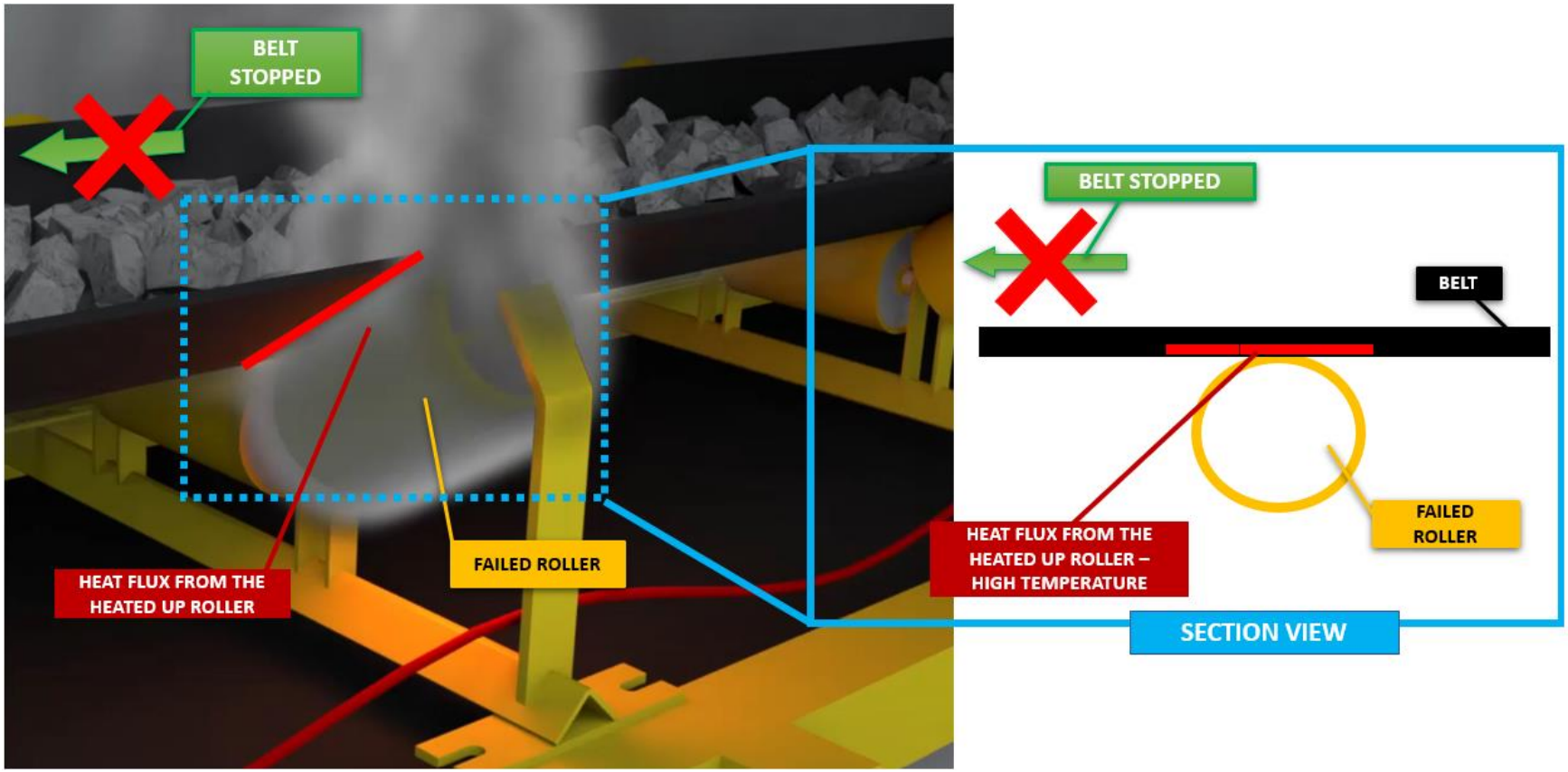
- Ignition Mode





4. FIRE SCENARIOS

- The fire scenario considers that the conveyor belt will ignite when stops, developing a fire under no influence of the air velocity of the moving of the conveyor belt.



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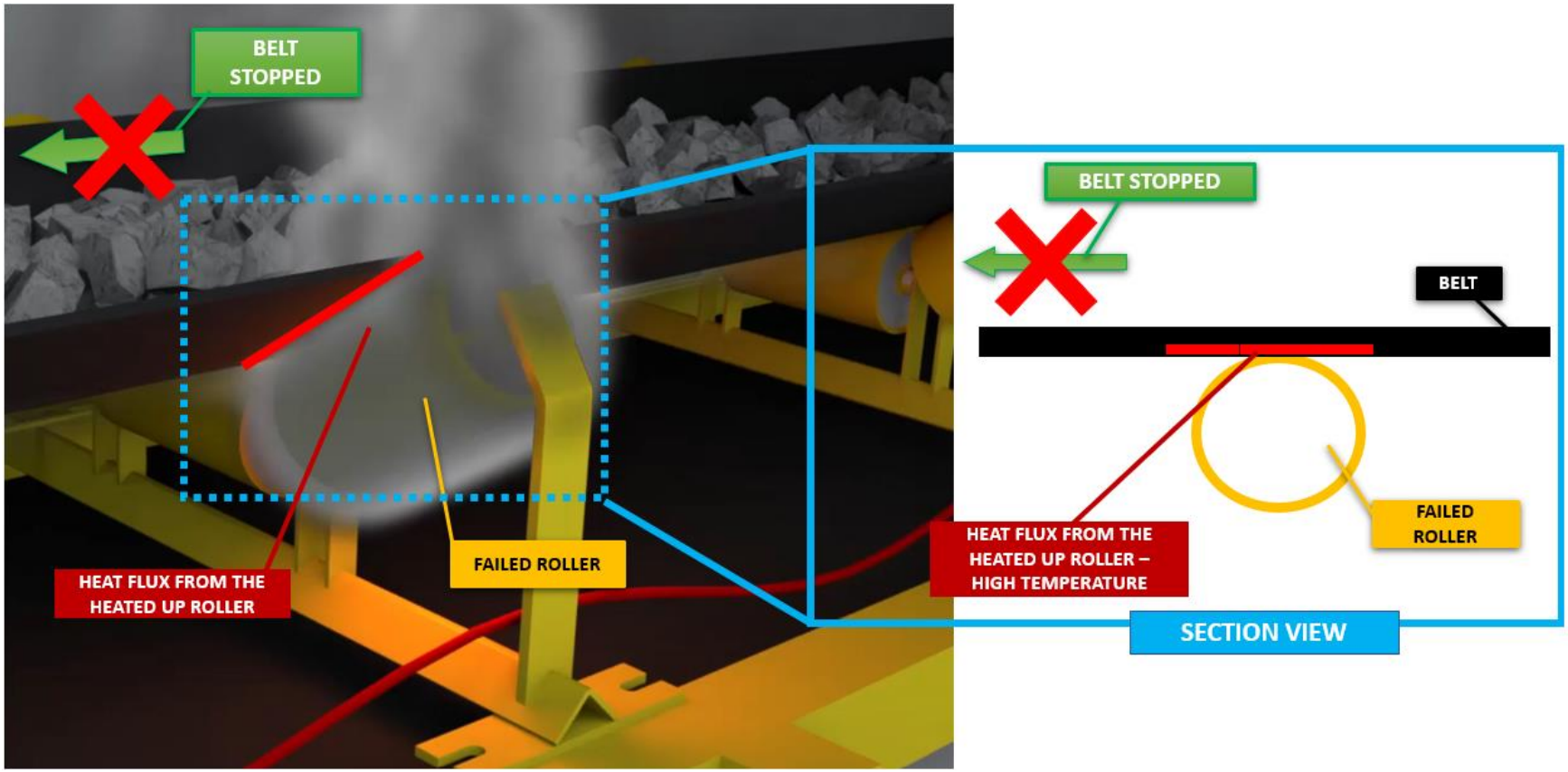


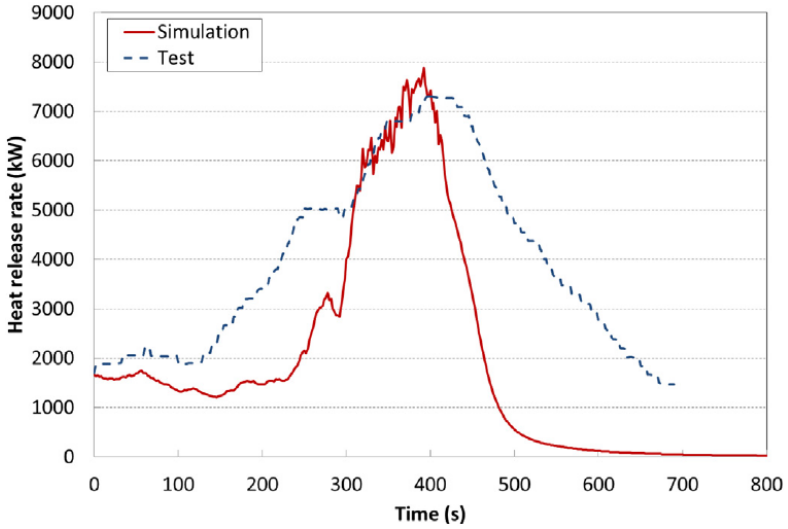
4. FIRE SCENARIOS

- Mesh and Cell size

$$\dot{Q} = \chi \dot{m}'' A_f \Delta H_c = \chi \dot{m} \Delta H_c = \dot{m} \Delta H_{c,eff}$$

$$\frac{D^*}{\delta x} \rightarrow D^* = \left(\frac{\dot{Q}}{\rho_\infty C_p T_\infty \sqrt{g}} \right)^{\frac{2}{5}}$$

$$4 < \frac{D^*}{\delta x} < 16$$



Scenario	HRR		D*	Cellsize (m)	D*/Cellsize
Scenario 01	2000	kW	0.8041	0.05	16
Scenario 02-05-A	2000	kW	0.8041	0.05	16
Scenario 02-05-B	2000	kW	0.8041	0.05	16
Scenario 02-05-C	2000	kW	0.8041	0.05	16
Scenario 02-05-D	2000	kW	0.8041	0.05	16

Scenario	HRR		D*	Cellsize (m)	D*/Cellsize
Scenario 01	2000	kW	0.8041	0.1	8
Scenario 02-05-A	2000	kW	0.8041	0.1	8
Scenario 02-05-B	2000	kW	0.8041	0.1	8
Scenario 02-05-C	2000	kW	0.8041	0.1	8
Scenario 02-05-D	2000	kW	0.8041	0.1	8

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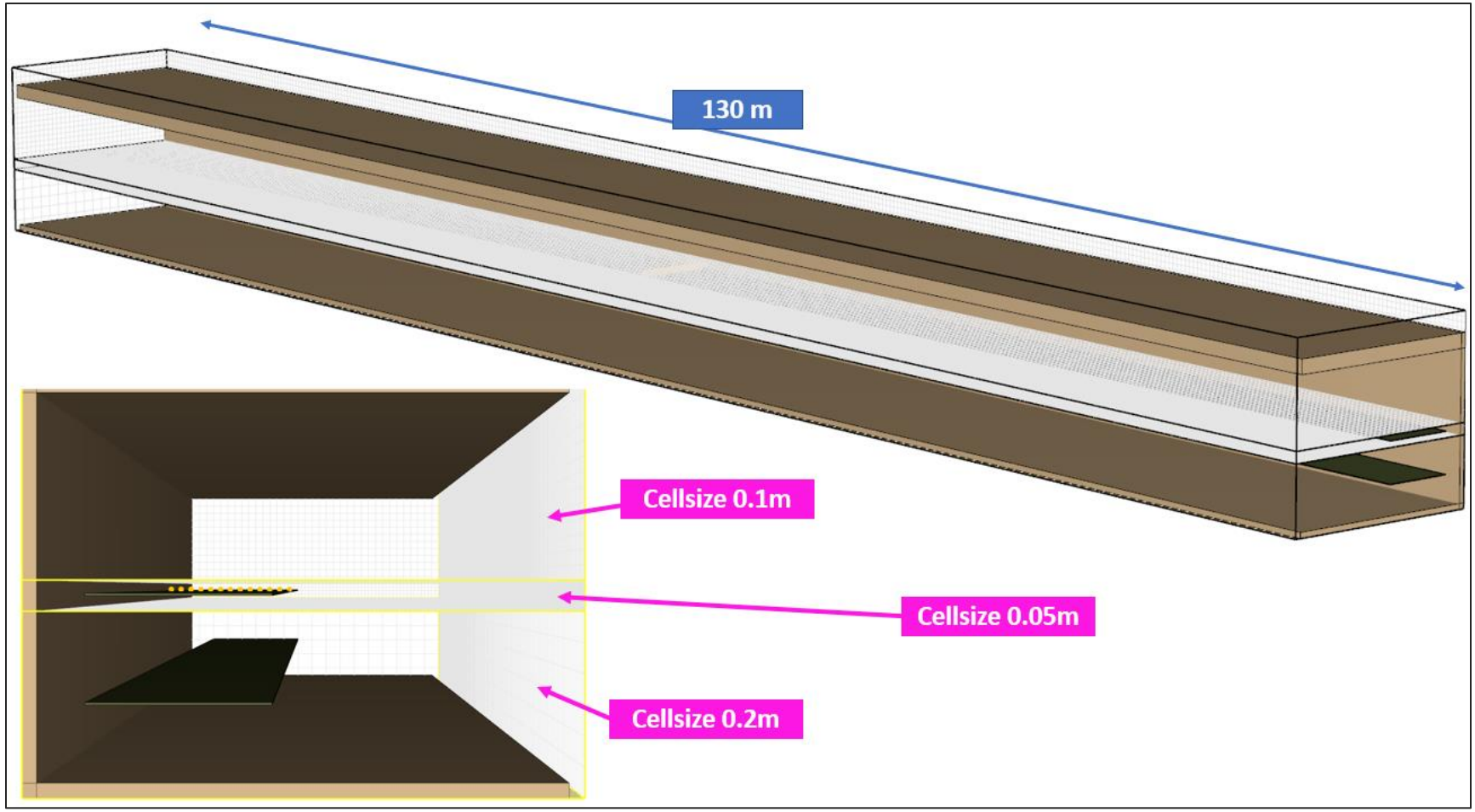
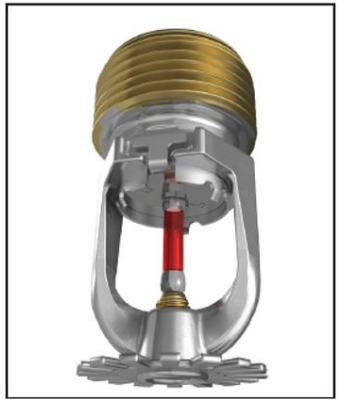
- Mesh and Cell size



5. TRIAL DESIGNS



ES-02-05-A

- Belt with Viking sprinklers quick response
- K=8.0 (115)
- Operating pressure = 15 PSI
- Temperature rating of 165ºF (74ºC)
- Dv50=2274.8 um
- N° of Droplets=5000

ES-02-05-B

- Belt with Viking sprinklers quick response
- K=5.6 (80.6)
- Operating pressure = 15 PSI
- Temperature rating of 165ºF (74ºC)
- Dv50=1623.12 um
- N° of Droplets=5000

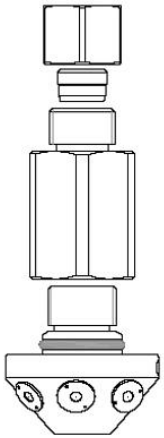
ES-02-05-C

- Belt with Viking sprinklers standard response
- K=5.6 (80.6)
- Operating pressure = 15 PSI
- Temperature rating of 165ºF (74ºC)
- Dv50=1623.12 um
- N° of Droplets=5000

5. TRIAL DESIGNS

ES-02-05-C

- Open water mist system (RG Systems)
- K=2.04 lpm/bar1/2
- Operating pressure = 100 Bar
- Dv50 = 120 um
- N° Droplets = 100.000



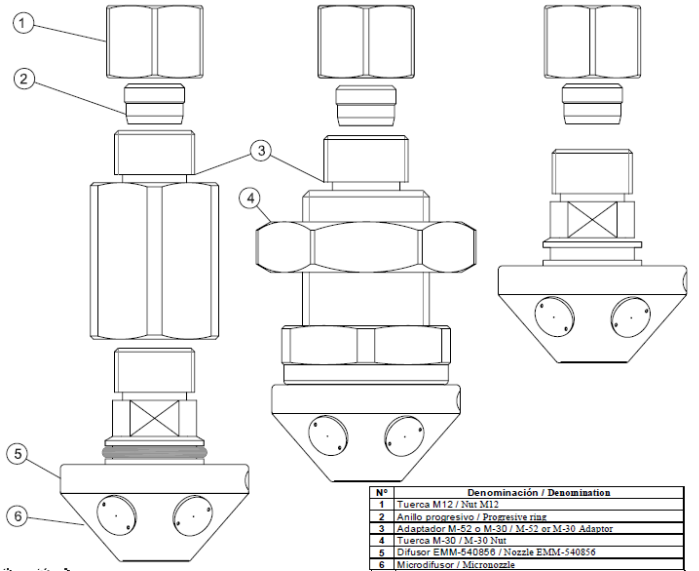
Revisión: Review: 01	FICHA TECNICA / DATA SHEET	Codigo: Code:
Fecha: Date: 29-01-13	DIFUSOR ABIERTO APLI. LOCAL EMM-540856	Nº F.Técnica/Fichero: Data Sheet No./File: fa008cs1.dwg
Hoja: Sheet: 1/1	OPEN NOZZLE LOCAL APPLICATION EMM-540856	Sistema de Extinción: Extinguish System: RG W-FOG Agua Nebulizada

Descripción Description

Difusor abierto de agua nebulizada para riesgos protegidos por aplicación local. Descargan el agente extintor dentro de la zona protegida asegurandose una correcta distribución del flujo. El cabezal esta formado por dos cuerpos que facilitan la instalación y el mantenimiento. Cada difusor está compuesto por un nº determinado de microdifusores en función de las características de la aplicación.

Water Mist open nozzle for local application protected risks. They discharge extinguishing agent into protected zone, assuring the correct flow distribution. Head is compounded of two bodies that makes easier the installation and maintenace operations. Each nozzle is compounded of a determinated number of micronozzles, according to the application characteristics.

Esquema Scheme



Nº	Denominación / Denomination
1	Tuerca M12 / Nut M12
2	Anillo progresivo / Progresive ring
3	Adaptador M-52 o M-30 / M-52 or M-30 Adaptor
4	Tuerca M-30 / M-30 Nut
5	Difusor EMM-540860 / Nozzle EMM-540856
6	Microdifusor / Micronozzle

Características técnicas Characteristics technical

Medio operativo / Operating medium	Agua nebulizada alta presión / High pressure water mist
Material del difusor / Nozzle material	Acero INOX / INOX Steel
Material del microdifusor / Micronozzle material	Acero INOX / INOX Steel
Material del adaptador M-52 / M-52 Adaptor material	Acero INOX / INOX Steel
Unión a tubería / Pipe union	Mediante anillo progresivo en bicono. Tubería de 12x1.5mm / With progresive ring bi-cone. Pipe 12x1.5mm
Máxima presión de trabajo / Max. working pressure	200 bar
Presión de prueba / Test pressure	620 bar
Temperatura de trabajo / Working temperature	-20º C to +600º C
Temperatura de ensayo de resistencia a la presión y al calor / Heat and pressure proof temperature	600º C
Factor K / K Factor	2.04 l.p.m. / bar $^{1/2}$
Instalación / Instalation	Horizontal o pendiente / Horizontal or slope
Aplicación / Aplication	Aplicación local / Local aplication

Aviso Warning

Este tipo de difusores, están fabricados y aprobados para ser usados en instalaciones fijas de proteccion contra incendios con Agua Nebulizada a alta presión. Estos productos no están diseñados para otro uso o propósito. Si el usuario del producto tiene alguna duda respecto a la aplicación o fin del producto, debe llamar al teléfono +34 947 28 11 08. Todo uso o aplicación no aprobado y / o cualquier no-aprobada modificación del producto o su funcionamiento puede provocar serios accidentes y / o daños personales. **RG Systems S.L.** no es responsable de ningún no-aprobado uso o aplicación.

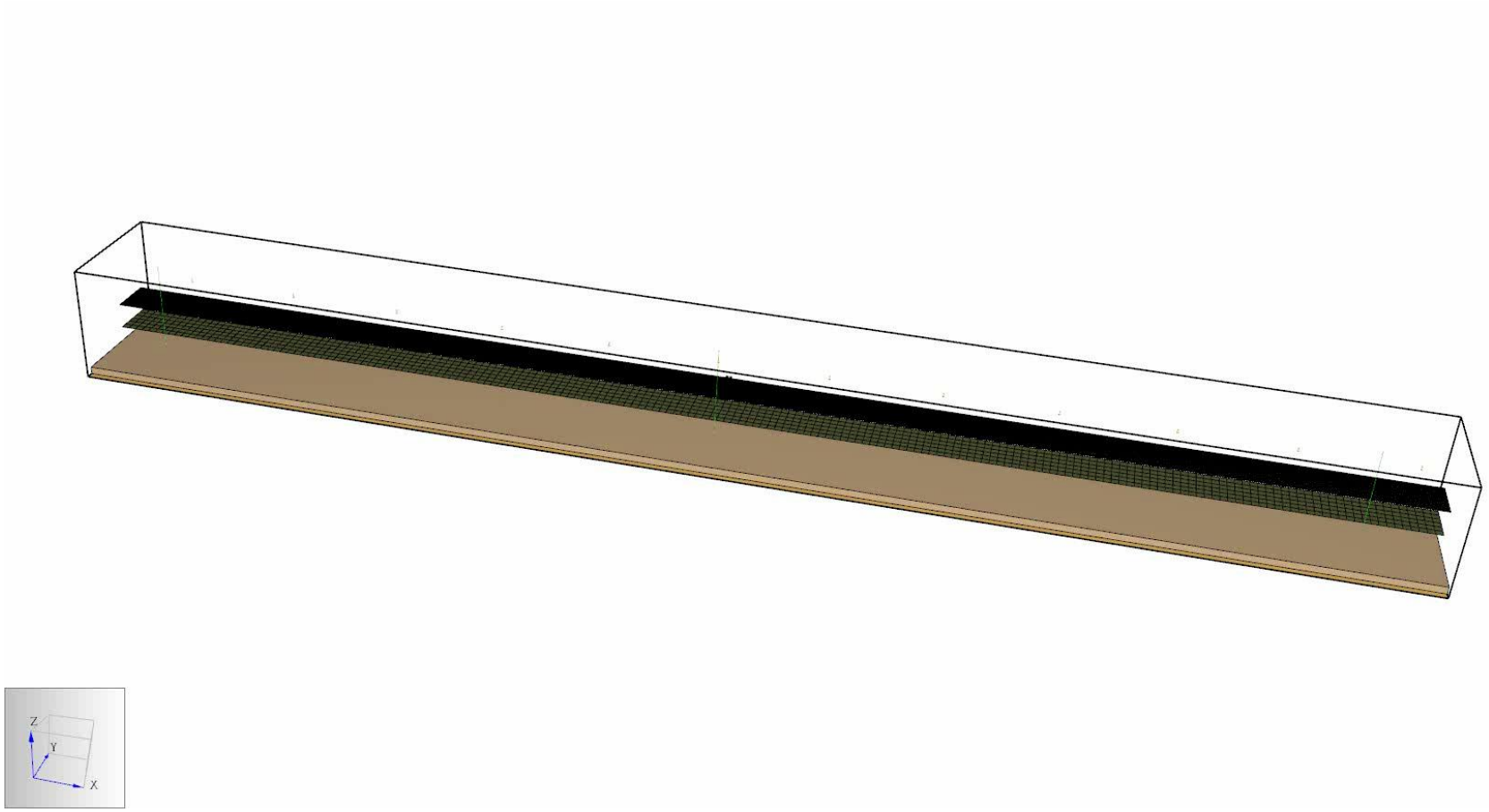
This type of nozzles, are manufactured and approved to be used in fixed protected against fire installations with high pressure Water Mist. These products are not designed for other use or purpose. If product user has any doubt regarding the application or product use, please contact +34 947 28 11 08. Every not approved use or application or / and any other not approved modification of the product or its function may cause serious accidents or / and personal damages. **RG Systems S.L.** is not responsable for any non-approved use of the application.

IMPORTANT: RG Systems S.L. reserves the right to change or modify without previous notice any data or specification due to changes or modification in order to improve the products presented.

Dibujado: Draw by: C. Francés	Firma / Signed by	Sustituye a: Substitution to: 06-08-07	RG SYSTEMS Pol. Ind. Villalonquejar C/Meninidad de Monhya Nº6 (09001) Burgos - España Tel.- 947281108 Fax.-947281112
Comprobado: Check by: J.I.Melgosa		Sustituido por: Sustituyed by:	

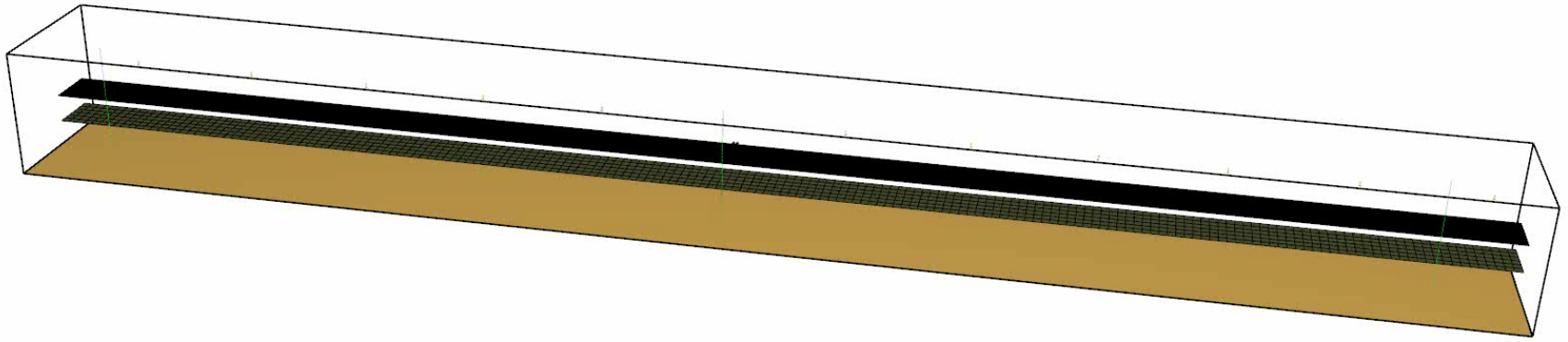
6. RESULTS

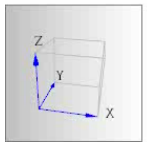
ES-02-05-A



6. RESULTS

ES-02-05-B





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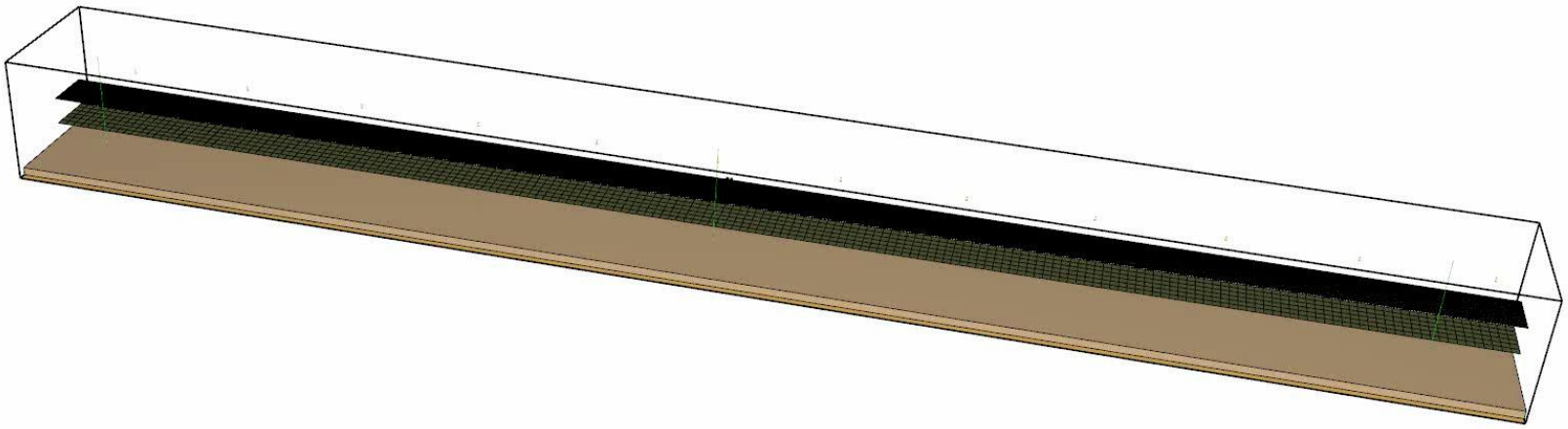
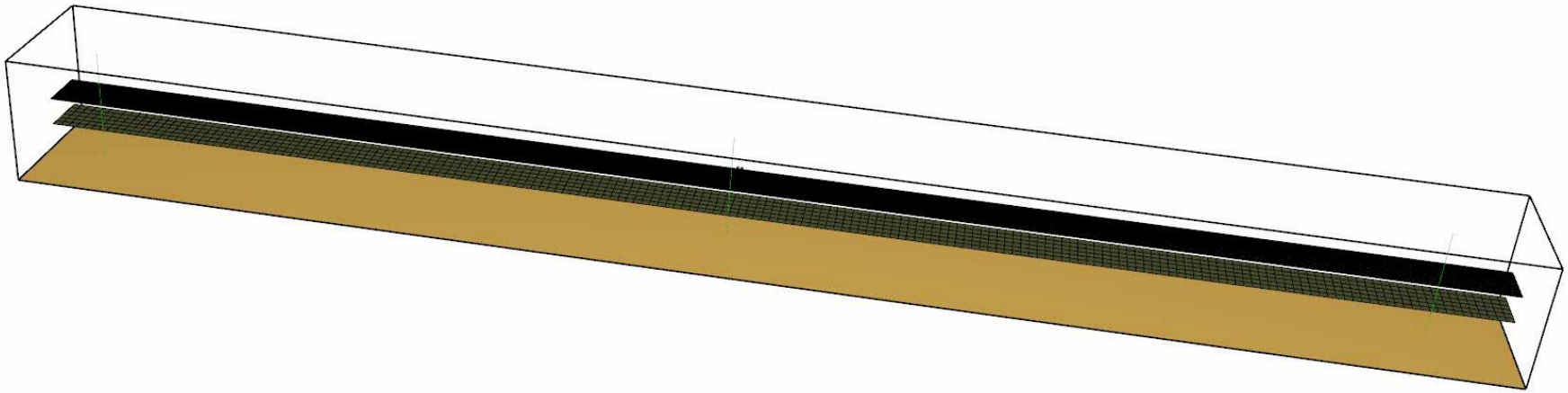
6. RESULTS

ES-02-05-C



6. RESULTS

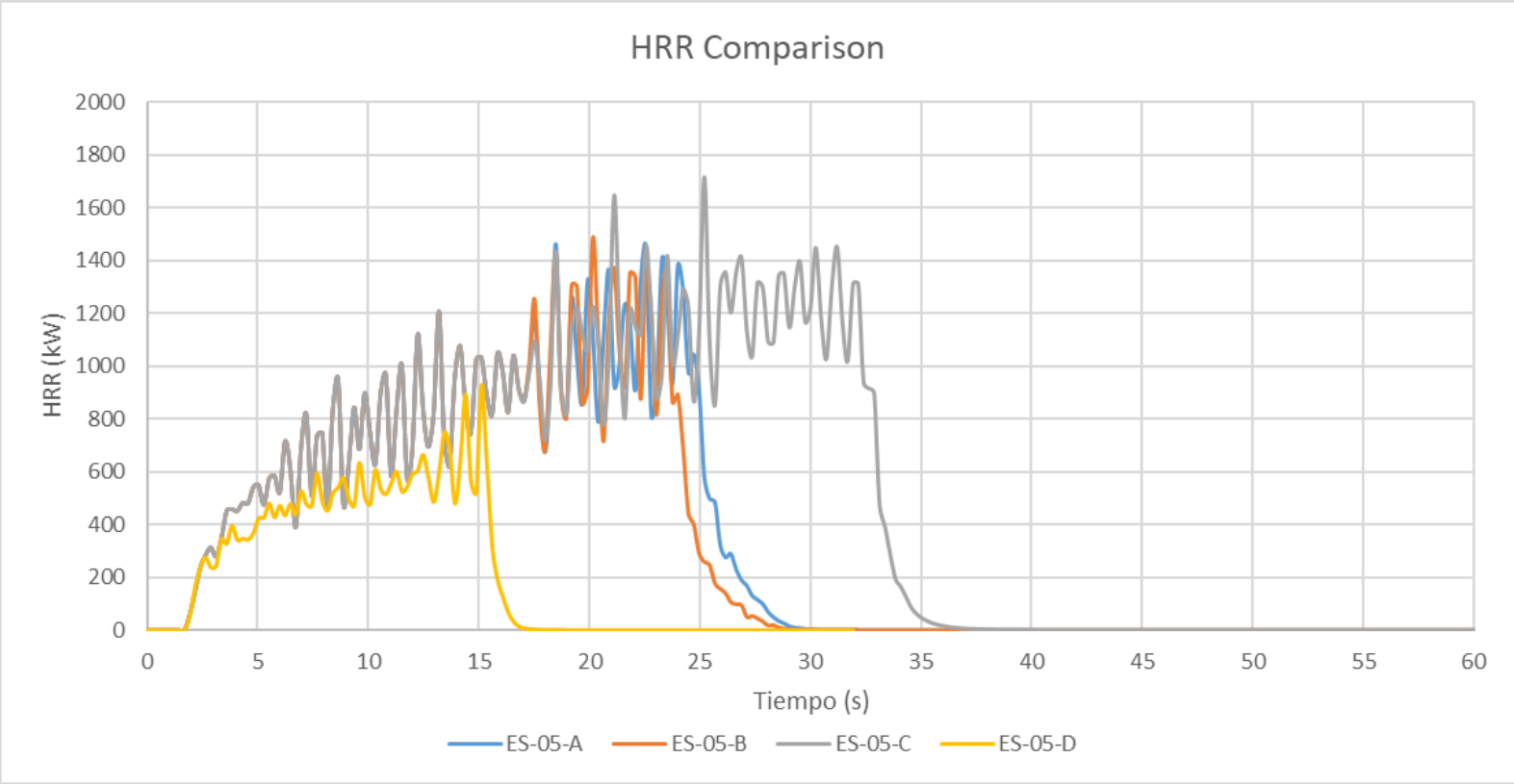
ES-02-05-D



6. RESULTS

- Comparison

	Trial Design			
	ES-05-A	ES-05-B	ES-05-C	ES-05-D
Average kW	584.67	565.77	607.03	338.18
	96.32%	93.20%	100%	55.71%



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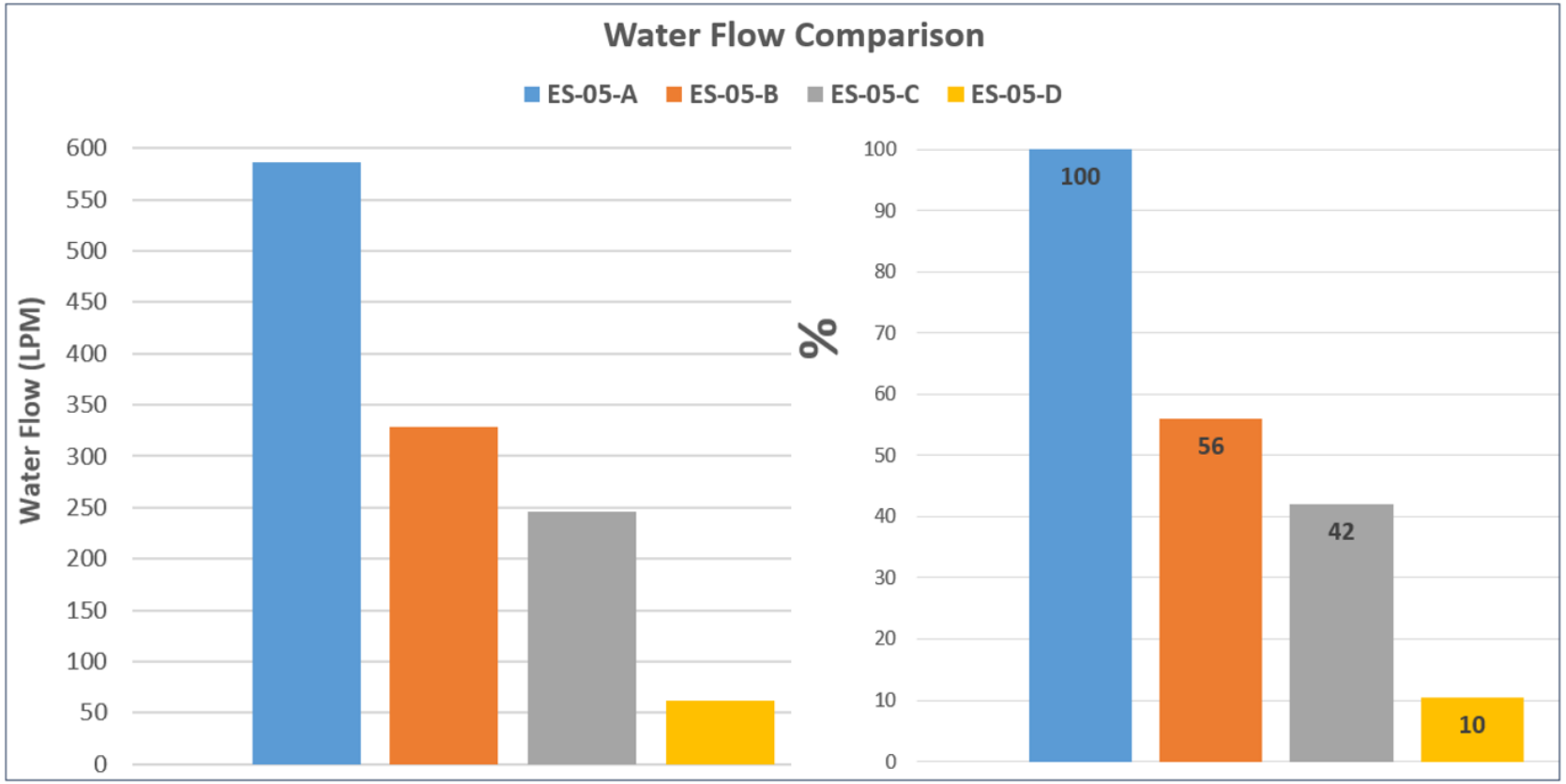

7. CONCLUSIONS

- Sprinklers systems can control and extinguish the fire.
- Sprinkler permit to increase the HRR but use less water than the FM Global design expects.
- Water mist system can control and extinguish the fire.
- The water mist system use just 10% of the water that FM-Global expects that controls and extinguish a fire.
- Watermist - Decrease size of a drainage system.
- Watermist - Smaller water collector tank.
- Sprinklers - HRR present average values.
- Watermist – lower HRR values.
- Watermist - HRR dependent on the activation time of the detection system

Thank you!
Questions?

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