

A stylized graphic in the background consists of several elements: a blue lattice tower on the left, two purple rectangular blocks in the center, a red dome-shaped structure, and a red silhouette of a fire hydrant on the right. The text 'FIRE PROTECTION CONGRESS' is overlaid on this graphic. 'FIRE PROTECTION' is in white text on a red rectangular background, and 'CONGRESS' is in white text on a blue rectangular background. Below these, the dates '16 Y 17' are in red, 'OCTUBRE' is in blue, and 'TIJUANA' is in red.

FIRE PROTECTION
CONGRESS
16 Y 17
OCTUBRE
TIJUANA

II Congreso Técnico de Discusión y Análisis de los Retos en la
Gestión de Riesgos de Incendio en la Industria

Análisis Comparativo y Selección de Criterio de Diseño en Almacenes por NFPA 13

Presentado por:
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HÉCTOR TREJO

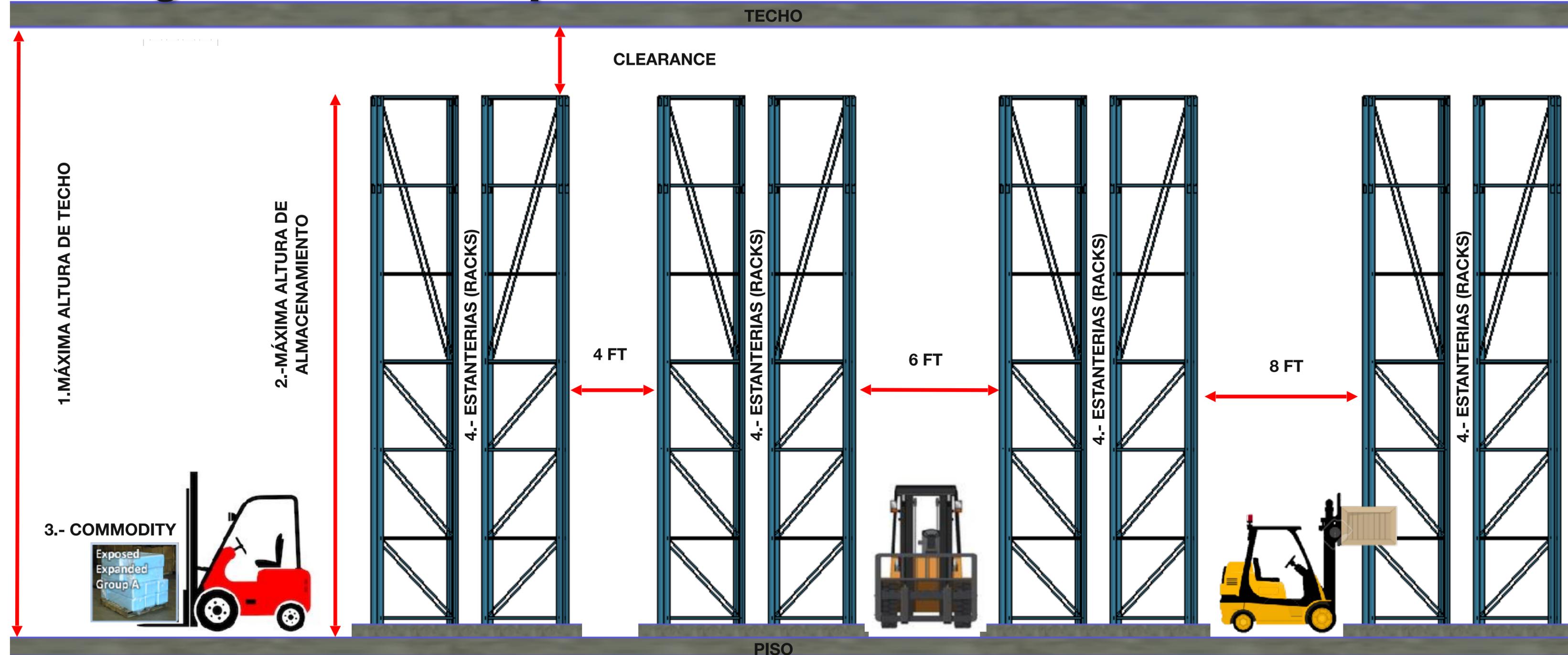
¿Por qué se incendian los almacenes?



Contaba con sistema de rociadores



4 Preguntas básicas para iniciar...



4 Preguntas básicas para continuar...

En general, las reglas de protección en los Capítulos 20 a 26 están diseñadas para responder a cuatro preguntas básicas, asumiendo que un incendio va a comenzar en el almacén:

1. ¿Cuál es una estimación razonable del flujo que será necesario para el sistema de rociadores? (Esto incluye consideración para el número de rociadores que podrían activarse en un incendio y el flujo que será utilizado para las operaciones del departamento de bomberos para extinguir el incendio a su llegada).
2. ¿A qué presión necesita estar disponible ese flujo?
3. ¿Cuánto tiempo necesitará durar el flujo?
4. Si el almacenamiento está en estanterías, ¿necesitan colocarse rociadores en las estanterías, o puede protegerse el almacenamiento con rociadores solo en el techo?

NFPA[®]

13

Standard for the
Installation of
Sprinkler Systems

2022



La edición 2022 de NFPA 13 continúa con los cambios de formato de la edición 2019. En esta nueva edición, la intención era simplificar aún más cada uno de los capítulos de almacenamiento y agregar nueva información sobre protección contra incendios basada en investigaciones y pruebas continuas.

Plásticos expuestos NO expandidos grupo A

Capítulo 23 – ESFR – Tabla 23.6.1

- **El Capítulo 23 “Requisitos ESFR para aplicaciones de almacenamiento” se actualizó con nuevos requisitos de diseño para la protección ESFR para algunas disposiciones de almacenamiento.**
- **Un ejemplo de esto es el almacenamiento en estantes (racks), de plásticos sin cartón (expuestos) NO expandidos (sin espuma-foam).**
- **El siguiente ejemplo compara los requisitos para la protección ESFR de un almacenamiento en estantes (racks) de 20 pies de altura, de plásticos sin cartón (expuestos) NO expandidos (sin espuma-foam), bajo un techo de 35 pies. Según la edición de 2019, este almacenamiento se puede proteger con rociadores K14 o K16.8 que funcionan a 75 psi y 52 psi respectivamente.**

2019 Edition – Rack Storage of Uncartoned (exposed) Unexpanded Plastics 20 ft. under a 35 ft. roof with ESFR sprinklers:

Table 23.6.1 Continued

Storage Arrangement	Commodity	Maximum Storage Height		Maximum Ceiling/ Roof Height		Nominal K-Factor	Orientation	Minimum Operating Pressure	
		ft	m	ft	m			psi	bar
		20	6.1	25	7.6	14 (200)	Pendent	50	3.4
						16.8 (240)	Pendent	35	2.4
				30	9.1	14 (200)	Pendent	50	3.4
						16.8 (240)	Pendent	35	2.4
				35	11	14 (200)	Pendent	75	5.2
						16.8 (240)	Pendent	52	3.6
				40	12	16.8 (240)	Pendent	52	3.6

Mangueras & Duración

Capítulo 20 – Requerimientos generales para almacenamiento – Tabla 20.12.2.6

Table 20.12.2.6 Hose Stream Allowance and Water Supply Duration

Commodity	Sprinkler Type	Sprinkler Spacing Type	Number of Ceiling Sprinklers in Design Area ^a	Size of Design Area at Ceiling	Hose Stream Allowance		Water Supply Duration (minutes)
					gpm	L/min	
Class I-IV Commodities, Group A plastics, idle wood pallets, idle plastic pallets and miscellaneous storage	Control mode density/area (CMDA)	Standard and extended-coverage	NA	Up to 1200 ft ² (112 m ²)	250	950	60
				Over 1200 ft ² (112 m ²) up to 1500 ft ² (140 m ²)	500	1900	90
				Over 1500 ft ² (140 m ²) up to 2600 ft ² (240 m ²)	500	1900	120
				Over 2600 ft ² (240 m ²)	500	1900	150
	Control mode specific application (CMSA)	Standard	Up to 12	NA	250	950	60
				Over 12 to 15	500	1900	90
				Over 15 to 25	500	1900	120
				Over 25	500	1900	150
		Extended-coverage	Up to 6	NA	250	950	60
				Up to 8 ^b	250	950	60
				Over 6 to 8	500	1900	90
				Over 8 to 12	500	1900	120
	Early suppression fast response (ESFR)	Standard	Up to 12	NA	250	950	60
				Over 12 to 15	500	1900	90
				Over 15 to 25	500	1900	120
				Over 25	500	1900	150

Plásticos expuestos NO expandidos grupo A

[NFPA 13 Ed. 2019 Capítulo 23 Tabla 23.6.1](#)

[K14@75psi](#) Máxima altura de techo 35 FT & Máxima altura de almacenamiento 20 FT

[K16.8@52psi](#) Máxima altura de techo 35 FT & Máxima altura de almacenamiento 20 FT

$$Q = k\sqrt{P}$$

$$Q = \text{Flujo (gpm)}$$

$$P = \text{Presión (psi)}$$

$$k = \text{Factor } k$$

$$Q = 14\sqrt{75} \text{ psi} = 121.24 \text{ gpm} \times 12 \text{ spks} = 1454.92 \text{ gpm} + 250\text{gpm} = \mathbf{1704.92 \text{ gpm}}$$

$$Q = 16.8\sqrt{52} \text{ psi} = 121.14 \text{ gpm} \times 12 \text{ spks} = 1453.75 \text{ gpm} + 250\text{gpm} = \mathbf{1703.75 \text{ gpm}}$$

Plásticos expuestos NO expandidos grupo A

Capítulo 23 – ESFR – Tabla 23.3.1

- Según la edición 2022, este mismo almacenamiento no puede protegerse ni con rociadores K14 ni con K16.8.
- También se notará que la tabla de 2022 no incluye la altura de almacenamiento, solo la altura del techo.
- Por lo tanto, para nuestro almacenamiento de 20 pies de altura bajo un techo de 35 pies, uno tendría que usar los criterios para un techo de 40 pies de altura y utilizar rociadores K22.4 o K25.2 que funcionen a 75 psi y 60 psi respectivamente.

2022 Edition – Rack Storage of Uncartoned (exposed) Unexpanded Plastics under a 35 ft. roof with ESFR sprinklers:

Table 23.3.1 ESFR Sprinkler Ceiling-Only Options for Solid Pile; Palletized; and Single-, Double-, and Multiple-Row Rack Storage

Commodity ^a	Maximum Ceiling/ Roof Height		ESFR Sprinklers — Pendent Orientation Minimum Operating Pressure psi (bar)				ESFR Sprinklers — Upright Orientation Minimum Operating Pressure psi (bar)	
			Nominal K-Factors				Nominal K-Factors	
			14 (200)	16.8 (240)	22.4 (320)	25.2 (360)	14 (200)	16.8 (240)
Class I through Class IV and cartoned nonexpanded Group A plastics	25	7.6	50 (3.4)	35 (2.4)	25 (1.7)	15 (1.0)	50 (3.4)	35 (2.4)
	30	9.1	50 (3.4)	35 (2.4)	25 (1.7)	15 (1.0)	50 (3.4)	35 (2.4)
	35	10.7	75 (5.2)	52 (3.6)	35 (2.4)	20 (1.4)	75 (5.2)	52 (3.6)
	40	12.2	—	52 (3.6)	—	25 (1.7)	—	—
	45	13.7	—	—	40 (2.8)	40 (2.8)	—	—
Cartoned expanded Group A plastics	25	7.6	50 (3.4)	35 (2.4)	—	—	50 (3.4)	35 (2.4)
	30	9.1	50 (3.4)	35 (2.4)	—	—	50 (3.4)	35 (2.4)
	35	10.7	—	—	—	—	—	—
	40	12.2	—	—	—	—	—	—
	45	13.7	—	—	—	—	—	—
Exposed nonexpanded, Group A plastics	25	7.6	50 (3.4)	35 (2.4)	—	—	—	—
	30	9.1	50 (3.4)	35 (2.4)	—	—	—	—
	35	10.7	—	—	—	—	—	—
	40	12.2	—	—	75 (5.2)	60 (4.1)	—	—
	45	13.7	In-rack sprinklers required. See Chapter 25.	—	—	—	—	—
Exposed expanded Group A plastics	25	7.6	—	—	—	—	—	—
	30	9.1	—	—	—	30 (2.0) ^b	—	—
	32	9.8	—	—	—	—	—	—
	35	10.7	—	—	—	—	—	—
	40	12.2	—	—	—	60 (4.1) ^{bc}	—	—
45	13.7	—	—	—	—	—	—	

Mangueras & Duración

• Capítulo 20 – Requerimientos generales para almacenamiento – Tabla 20.15.2.6

Pin Header ×

Table 20.15.2.6 Hose Stream Allowance and Water Supply Duration

Class I–IV commodities, Group A plastics, idle wood pallets, and idle plastic pallets	Control mode density/area (CMDA)	Standard and extended-coverage	NA	Over 1200 ft ² (112 m ²) up to 1500 ft ² (140 m ²)	500	1900	90	
				Over 1500 ft ² (140 m ²) up to 2600 ft ² (240 m ²)	500	1900	120	
				Over 2600 ft ² (240 m ²)	500	1900	150	
	Control mode specific application (CMSA)	Standard		Up to 12	NA	250	950	60
				Over 12 to 15	NA	500	1900	90
				Over 15 to 25	NA	500	1900	120
				Over 25	NA	500	1900	150
		Extended-coverage		Up to 6	NA	250	950	60
				Up to 8 ^b	NA	250	950	60
				Over 6 to 8	NA	500	1900	90
				Over 8 to 12	NA	500	1900	120
	Early suppression fast response (ESFR)	Standard		Over 12	NA	500	1900	150
Up to 12				NA	250	950	60	
Over 12 to 15				NA	500	1900	90	
Over 15 to 25				NA	500	1900	120	
			Over 25	NA	500	1900	150	

Plásticos expuestos NO expandidos grupo A

[NFPA 13 Ed. 2022 Capítulo 23 Tabla 23.3.1](#)

[K22.4@75psi](#) Máxima altura de techo 40 FT & Máxima altura de almacenamiento N/I

[K25.2@60psi](#) Máxima altura de techo 40 FT & Máxima altura de almacenamiento N/I

$$Q = k\sqrt{P}$$

$$Q = \text{Flujo (gpm)}$$

$$P = \text{Presión (psi)}$$

$$k = \text{Factor } k$$

$$Q = 22.4\sqrt{75\text{psi}} = 193.98 \text{ gpm} \times 12 \text{ spks} = 2327.87 \text{ gpm} + 250\text{gpm} = \mathbf{2577.87 \text{ gpm}}$$

$$Q = 25.2\sqrt{60\text{psi}} = 195.19 \text{ gpm} \times 12 \text{ spks} = 2342.38 \text{ gpm} + 250\text{gpm} = \mathbf{2592.38 \text{ gpm}}$$

Ejemplo: Análisis Comparativo de Criterios de Diseño para un almacén de Plásticos expuestos expandidos grupo A



4 Preguntas básicas para iniciar...

- 1.- Máxima altura de techo: 40 FT
- 2.- Máxima altura de almacenamiento: 35 FT
- 3.- Producto: Plásticos expuestos expandidos grupo A
- 4.- Método de almacenamiento: Estanterías (racks abiertos)

4 Preguntas básicas para continuar...

- 1.- Flujo Rociadores + Mangueras
- 2.- Flujo a que Presión
- 3.- Duración - Tiempo
- 4.- Rociadores en Techo o R. Techo + In racks

NFPA 13 2016 VS 2019 VS 2022

- En este capítulo es importante saber que se reestructuró la información para proteger almacenamiento de plásticos expuestos expandidos en racks, pero hay que poner atención a la información para almacenamiento con una altura de 35ft:

Chapter 17 Protection of Rack Storage of Plastic and Rubber Commodities

17.3.3.5* Protection of Exposed Expanded Group A Plastics.

17.3.3.5.1 Protection of single-, double-, and multiple-row rack storage of exposed expanded Group A plastics shall be permitted to be in accordance with 17.3.3.5.2 through 17.3.3.5.8.

17.3.3.5.2 The maximum storage height shall be 35 ft (11 m).

17.3.3.5.3 The maximum ceiling height shall be 40 ft (12 m).

17.3.3.5.4 Sprinklers shall be intermediate temperature-rated ESFR pendent sprinklers with a nominal K-factor of K-25.2 (360).

17.3.3.5.5 The design area shall consist of the most hydraulically demanding area of 12 sprinklers.

17.3.3.5.6 The minimum operating pressure shall be 60 psi (4.1 bar).

17.3.3.5.7 The minimum aisle width shall be 8 ft (2.4 m).

17.3.3.5.8 The rack shall have a solid vertical barrier of 3/8 in. (9.5 mm) plywood or particleboard, 22 gauge sheet metal, or equivalent, from face of rack to face of rack, spaced at a maximum 16.5 ft (5.0 m) interval.

17.3.3.5.8.1 The vertical barrier shall extend from a maximum of 4 in. (102 mm) above the floor to the maximum storage height.

17.3.3.5.8.2 The plan area of storage between vertical barriers and aisles shall not exceed 124 ft² (11.5 m²).

17.3.3.5.8.3 The vertical barrier shall extend across the longitudinal line.

17.3.3.5.8.4 Commodity shall be permitted to extend a nominal 4 in. (100 mm) beyond the vertical barrier at the aisle.

edición 2016

Chapter 23 ESFR Requirements for Storage Applications

23.7* Protection of Exposed Expanded Group A Plastics.

23.7.1 Protection of single-, double-, and multiple-row rack storage of exposed expanded Group A plastics shall be permitted to be in accordance with 23.7.2 through 23.7.8.

23.7.2 The maximum storage height shall be 35 ft (11 m).

23.7.3 The maximum ceiling height shall be 40 ft (12 m).

23.7.4 Sprinklers shall be intermediate temperature-rated ESFR pendent sprinklers with a nominal K-factor of K-25.2 (360).

23.7.4.1 The maximum sprinkler deflector distance below the ceiling shall be 14 in. (350 mm).

23.7.5 The design area shall consist of the most hydraulically demanding area of 12 sprinklers.

23.7.6 The minimum operating pressure shall be either 30 psi (2.0 bar) or 60 psi (4.1 bar) based upon the applicable storage and ceiling height for the installation as follows:

- (1) 30 psi (2.0 bar) for storage heights up to 25 ft (7.6 m) with a maximum ceiling height of 30 ft (9.1 m)
- (2) 60 psi (4.1 bar) for storage heights up to 25 ft (7.6 m) with a maximum ceiling height of 40 ft (12 m)

edición 2019

Frank,

Now I see what you are talking about. In the 2016 edition, section 17.3.3.5.6 gives the operating pressure of 60 psi. This is supposed to apply to the storage height of 35 ft (in section 17.3.3.5.2).

But when we reorganized the standard and moved this criteria to Chapter 23 in the 2019 edition, we made a mistake. Section 23.7.6(2) is supposed to say, "60 psi (4.1 bar) for storage heights up to 35 ft (10.7 m) with a maximum ceiling height of 40 ft (12 m)", but there is a typo and it only says 25 ft (7.6m).

I checked with Dave Hague at the NFPA and they are aware of the problem. They are taking steps to correct it.

Ken

Chapter 23 ESFR Requirements for Storage Applications

23.4*

edición
2022

Plásticos expuestos expandidos grupo A

Table 23.3.1 ESFR Sprinkler Ceiling-Only Options for Solid Pile; Palletized; and Single-, Double-, and Multiple-Row Rack Storage

Commodity ^a	Maximum Ceiling/ Roof Height		ESFR Sprinklers — Pendent Orientation Minimum Operating Pressure psi (bar)				ESFR Sprinklers — Upright Orientation Minimum Operating Pressure psi (bar)	
			Nominal K-Factors				Nominal K-Factors	
			14 (200)	16.8 (240)	22.4 (320)	25.2 (360)	14 (200)	16.8 (240)
Class I through Class IV and cartoned nonexpanded Group A plastics	25	7.6	50 (3.4)	35 (2.4)	25 (1.7)	15 (1.0)	50 (3.4)	35 (2.4)
	30	9.1	50 (3.4)	35 (2.4)	25 (1.7)	15 (1.0)	50 (3.4)	35 (2.4)
	35	10.7	75 (5.2)	52 (3.6)	35 (2.4)	20 (1.4)	75 (5.2)	52 (3.6)
	40	12.2	—	52 (3.6)	—	25 (1.7)	—	—
	45	13.7	—	—	40 (2.8)	40 (2.8)	—	—
Cartoned expanded Group A plastics	25	7.6	50 (3.4)	35 (2.4)	—	—	50 (3.4)	35 (2.4)
	30	9.1	50 (3.4)	35 (2.4)	—	—	50 (3.4)	35 (2.4)
	35	10.7	—	—	—	—	—	—
	40	12.2	—	—	—	—	—	—
	45	13.7	—	—	—	—	—	—
Exposed nonexpanded, Group A plastics	25	7.6	50 (3.4)	35 (2.4)	—	—	—	—
	30	9.1	50 (3.4)	35 (2.4)	—	—	—	—
	35	10.7	—	—	—	—	—	—
	40	12.2	—	—	75 (5.2)	60 (4.1)	—	—
	45	13.7	In-rack sprinklers required. See Chapter 25.	—	—	—	—	—
Exposed expanded Group A plastics	25	7.6	—	—	—	—	—	—
	30	9.1	—	—	—	30 (2.0) ^b	—	—
	32	9.8	—	—	—	—	—	—
	35	10.7	—	—	—	—	—	—
	40	12.2	—	—	—	60 (4.1) ^{b,c}	—	—
45	13.7	—	—	—	—	—	—	

Plásticos expuestos expandidos grupo A

NFPA 13 Ed. 2022 Capítulo 23 Tabla 23.3.1 (2016 & 2019 ya existía)

K25.2@30psi Máxima altura de techo 30 FT & Máxima altura de almacenamiento 25 FT

K25.2@60psi Máxima altura de techo 40 FT Máxima altura de almacenamiento 35 FT

$$Q = k\sqrt{P}$$

$$Q = \text{Flujo (gpm)}$$

$$P = \text{Presión (psi)}$$

$$k = \text{Factor } k$$

$$Q = 25.2\sqrt{30\text{psi}} = 138.02 \text{ gpm} \times 12 \text{ spks} = 1656.31 \text{ gpm} + 250\text{gpm} = 1906.31 \text{ gpm}$$

$$Q = 25.2\sqrt{60\text{psi}} = 195.19 \text{ gpm} \times 12 \text{ spks} = 2342.38 \text{ gpm} + 250\text{gpm} = \underline{2592.38 \text{ gpm}}$$

$$\underline{V = 2592.38 \text{ gpm} \times 60 \text{ min} = 155,543 \text{ Galones}}$$

¿Mismos criterios de diseño = Mismos requerimientos del Sistema de rociadores y equipo de bombeo?

- ¿Por qué los requerimientos del sistema de rociadores (diámetros de ramales, cabezales, accesorios, risers, etc.) y/o las bombas pueden variar de un proyecto a otro, aún teniendo el mismo criterio de diseño y en teoría las mismas condiciones?
- Desde el punto de vista del cliente, usualmente surgen algunas preguntas como:
- ¿Por qué NO puedo usar el mismo sistema de rociadores, diámetro de ramales, cabezales, accesorios, risers, bomba etc., si tengo el mismo criterio de diseño que en mi otra planta?
- Si tengo el mismo almacén en todas mis plantas ¿porqué necesito una bomba de capacidad diferente?
- Aún cuando pareciera que son diseños “similares”, hay muchos factores que se tienen que revisar antes de poder asegurar que se pueden utilizar los mismos diámetros de ramales, cabezales, accesorios, risers, bomba etc.,

Puntos por considerar al seleccionar una bomba para un sistema de rociadores.

¿Flujo a que Presión?

1. ¿El diseño es NFPA o FM?
2. El criterio de diseño (revisar el commodity)
3. La altura del edificio
4. Tipo de arreglo de tuberías anillo (loop o línea)
5. Ramales calculados (cantidad, longitud y diámetro)
6. Longitud del alimentador principal
7. Tipo de arreglo del rociador (montante, colgante o garzas)
8. Puntos de la curva de la bomba teóricos vs reales

Estos son los factores más importantes que se tienen que tomar en cuenta y son estos mismos los que nos darán la pauta de saber cuándo podremos utilizar un equipo de bombeo u otro.

1.- ¿El diseño es NFPA o FM?

2022 Edition – Rack Storage of Uncartoned (exposed) Unexpanded Plastics under a 35 ft. roof with ESFR sprinklers:

Table 23.3.1 ESFR Sprinkler Ceiling-Only Options for Solid Pile; Palletized; and Single-, Double-, and Multiple-Row Rack Storage

Commodity ^a	Maximum Ceiling/ Roof Height		ESFR Sprinklers — Pendent Orientation Minimum Operating Pressure psi (bar)				ESFR Sprinklers — Upright Orientation Minimum Operating Pressure psi (bar)	
			Nominal K-Factors				Nominal K-Factors	
			14 (200)	16.8 (240)	22.4 (320)	25.2 (360)	14 (200)	16.8 (240)
Class I through Class IV and cartoned nonexpanded Group A plastics	25	7.6	50 (3.4)	35 (2.4)	25 (1.7)	15 (1.0)	50 (3.4)	35 (2.4)
	30	9.1	50 (3.4)	35 (2.4)	25 (1.7)	15 (1.0)	50 (3.4)	35 (2.4)
	35	10.7	75 (5.2)	52 (3.6)	35 (2.4)	20 (1.4)	75 (5.2)	52 (3.6)
	40	12.2	—	52 (3.6)	—	25 (1.7)	—	—
	45	13.7	—	—	40 (2.8)	40 (2.8)	—	—
Cartoned expanded Group A plastics	25	7.6	50 (3.4)	35 (2.4)	—	—	50 (3.4)	35 (2.4)
	30	9.1	50 (3.4)	35 (2.4)	—	—	50 (3.4)	35 (2.4)
	35	10.7	—	—	—	—	—	—
	40	12.2	—	—	—	—	—	—
	45	13.7	—	—	—	—	—	—
Exposed nonexpanded, Group A plastics	25	7.6	50 (3.4)	35 (2.4)	—	—	—	—
	30	9.1	50 (3.4)	35 (2.4)	—	—	—	—
	35	10.7	—	—	—	—	—	—
	40	12.2	—	—	75 (5.2)	60 (4.1)	—	—
	45	13.7	—	—	—	—	—	—
			In-rack sprinklers required. See Chapter 25.					
Exposed expanded Group A plastics	25	7.6	—	—	—	—	—	—
	30	9.1	—	—	—	30 (2.0) ^b	—	—
	32	9.8	—	—	—	—	—	—
	35	10.7	—	—	—	—	—	—
	40	12.2	—	—	—	60 (4.1) ^{bc}	—	—
	45	13.7	—	—	—	—	—	—

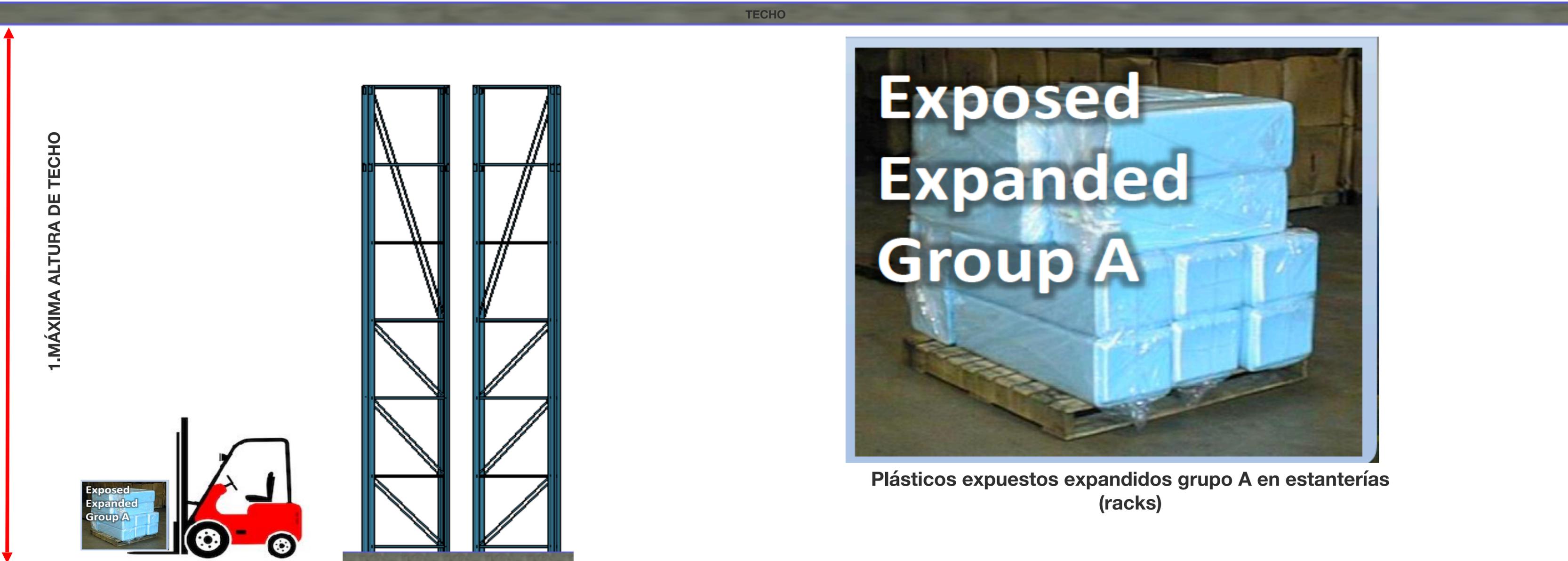
FM Global (DS 8-9) – Rack Storage of Uncartoned (exposed) Unexpanded Plastics under a 35 ft. roof with ESFR sprinklers:

Table 10. Ceiling-Level Protection Guidelines for Uncartoned Unexpanded Plastic Commodities in Open-Frame Rack Storage Arrangements

Max. Ceiling Height, ft (m)	Protection of Uncartoned Unexpanded Plastic Commodities in Open-Frame Storage Racks; No. of AS @ psi (bar)																			
	Wet System, 160°F (70°C) Nominally Rated, Pendent Sprinklers										Wet System, 160°F (70°C) Nominally Rated, Upright Sprinklers						Dry System, 280°F (140°C) Nominally Rated, Upright Sprinklers			
	Quick Response					Standard Response					Quick Response			Standard Response			Standard Response			
	K11.2 (K160)	K14.0 (K200)	K16.8 (K240)	K22.4 (K320)	K25.2 (K360)	K25.2EC (K360EC)	K11.2 (K160)	K14.0 (K200)	K19.6 (K280)	K25.2 (K360)	K11.2 (K160)	K14.0 (K200)	K16.8 (K240)	K25.2EC (K360EC)	K11.2 (K160)	K16.8 (K240)	K25.2 (K360)	K11.2 (K160)	K16.8 (K240)	K25.2 (K360)
10 (3.0)	15 @ 10 (0.7)	15 @ 7 (0.5)	15 @ 7 (0.5)	9 @ 20 (1.4)	9 @ 20 (1.4)	6 @ 20 (1.4)	15 @ 10 (0.7)	15 @ 7 (0.5)	12 @ 16 (1.1)	15 @ 7 (0.5)	15 @ 10 (0.7)	15 @ 7 (0.5)	6 @ 20 (1.4)	15 @ 10 (0.7)	15 @ 7 (0.5)	15 @ 7 (0.5)	20 @ 10 (0.7)	20 @ 7 (0.5)	20 @ 7 (0.5)	
15 (4.5)	15 @ 50 (3.5)	12 @ 32 (2.2)	12 @ 22 (1.5)	9 @ 25 (1.7)	9 @ 20 (1.4)	6 @ 60 (4.1)	15 @ 50 (3.5)	12 @ 50 (3.5)	12 @ 25 (1.7)	12 @ 15 (1.0)	15 @ 50 (3.5)	15 @ 32 (2.2)	15 @ 22 (1.5)	8 @ 35 (2.4)	15 @ 50 (3.5)	15 @ 22 (1.5)	15 @ 10 (0.7)	20 @ 50 (3.5)	20 @ 22 (1.5)	20 @ 10 (0.7)
20 (6.0)		9 @ 50 (3.5)	9 @ 35 (2.4)	9 @ 25 (1.7)	9 @ 20 (1.4)	6 @ 60 (4.1)		12 @ 50 (3.5)	12 @ 25 (1.7)	12 @ 15 (1.0)										
25 (7.5)		10 @ 50 (3.5)	10 @ 35 (2.4)	10 @ 25 (1.7)	10 @ 20 (1.4)															
30 (9.0)		15 @ 50 (3.5)	15 @ 35 (2.4)	10 @ 50 (3.5)	10 @ 40 (2.8)															
40 (12.0)				12 @ 75 (5.2)	12 @ 60 (4.1)															

VS

- 2.- El criterio de diseño (revisar el commodity)
- 3.- Altura del edificio



1. MÁXIMA ALTURA DE TECHO

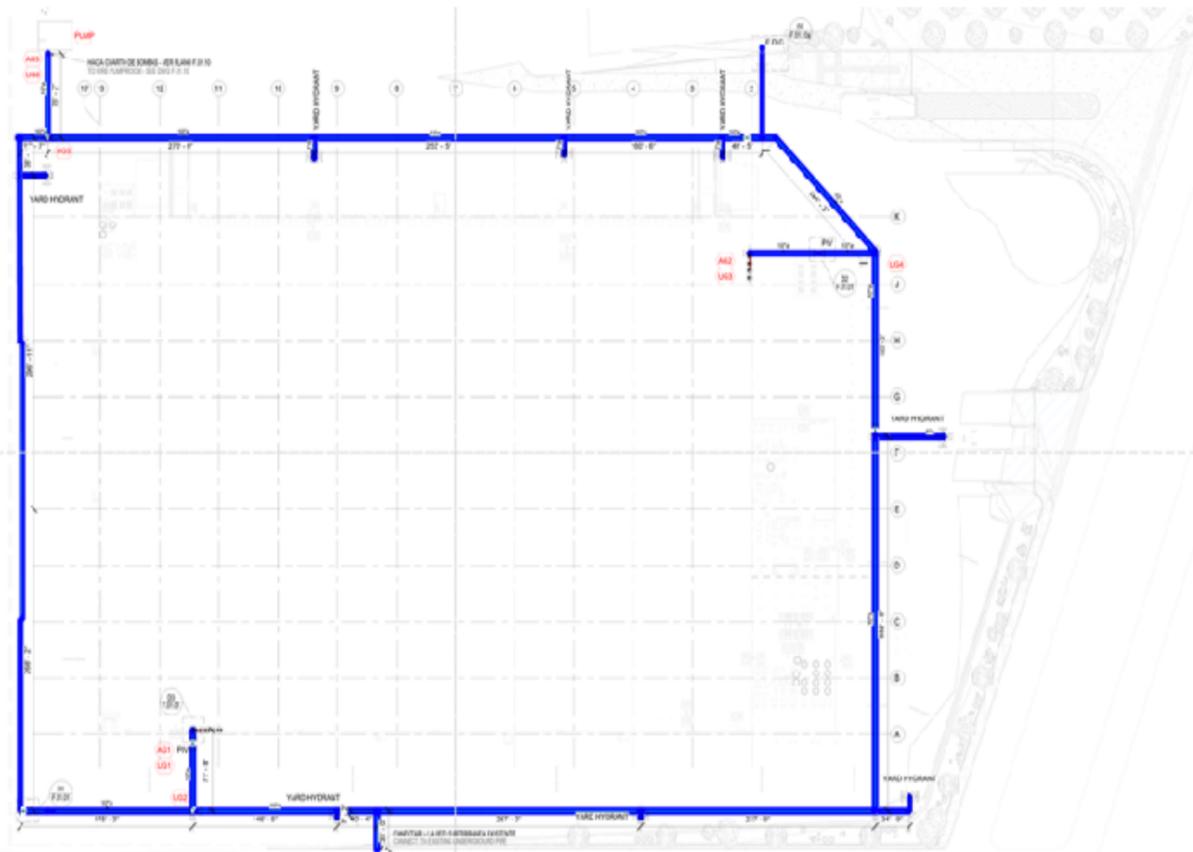
TECHO

PISO

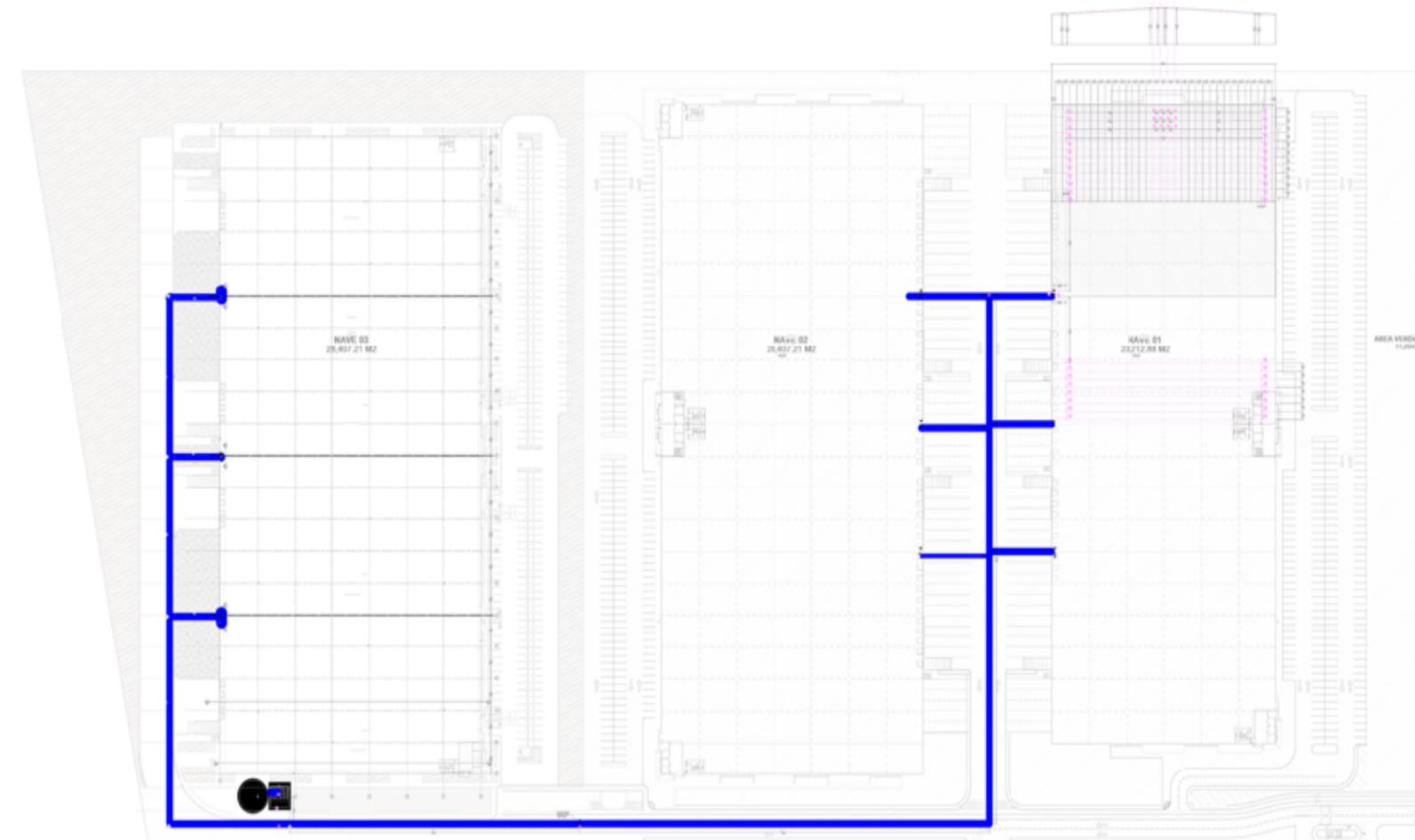


Plásticos expuestos expandidos grupo A en estanterías (racks)

4.- Tipo de arreglo de tuberías anillo (loop o línea)

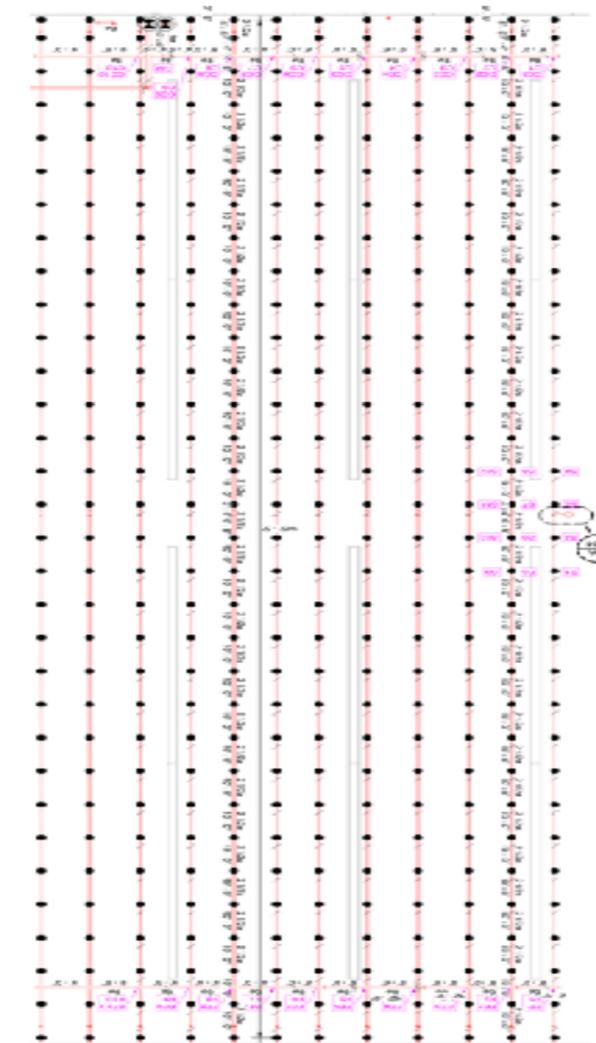
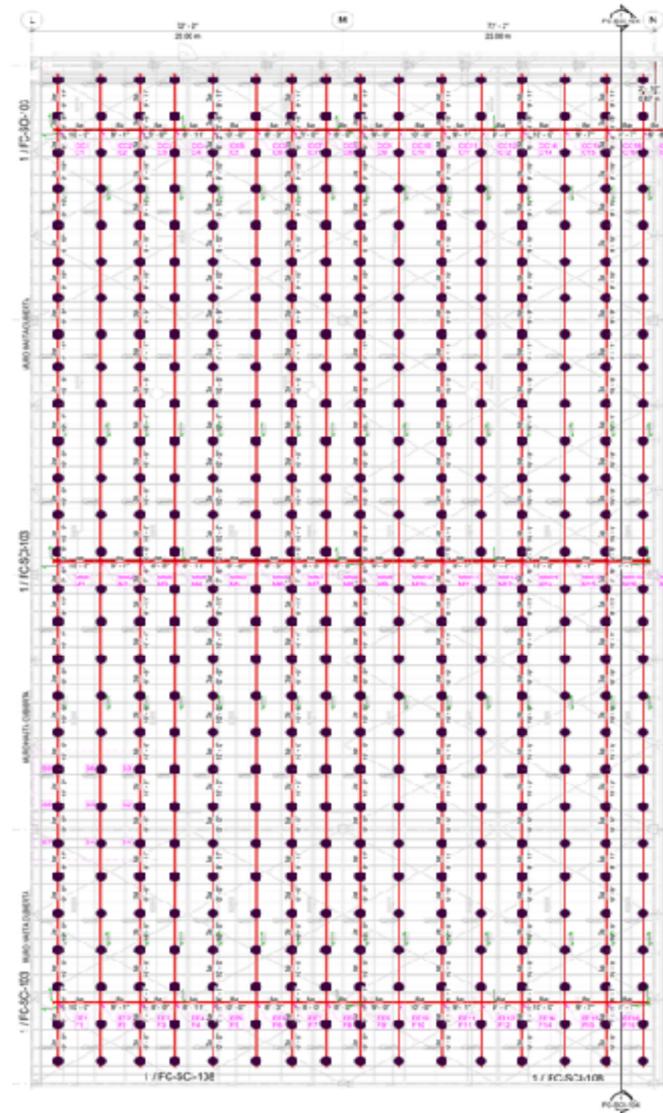
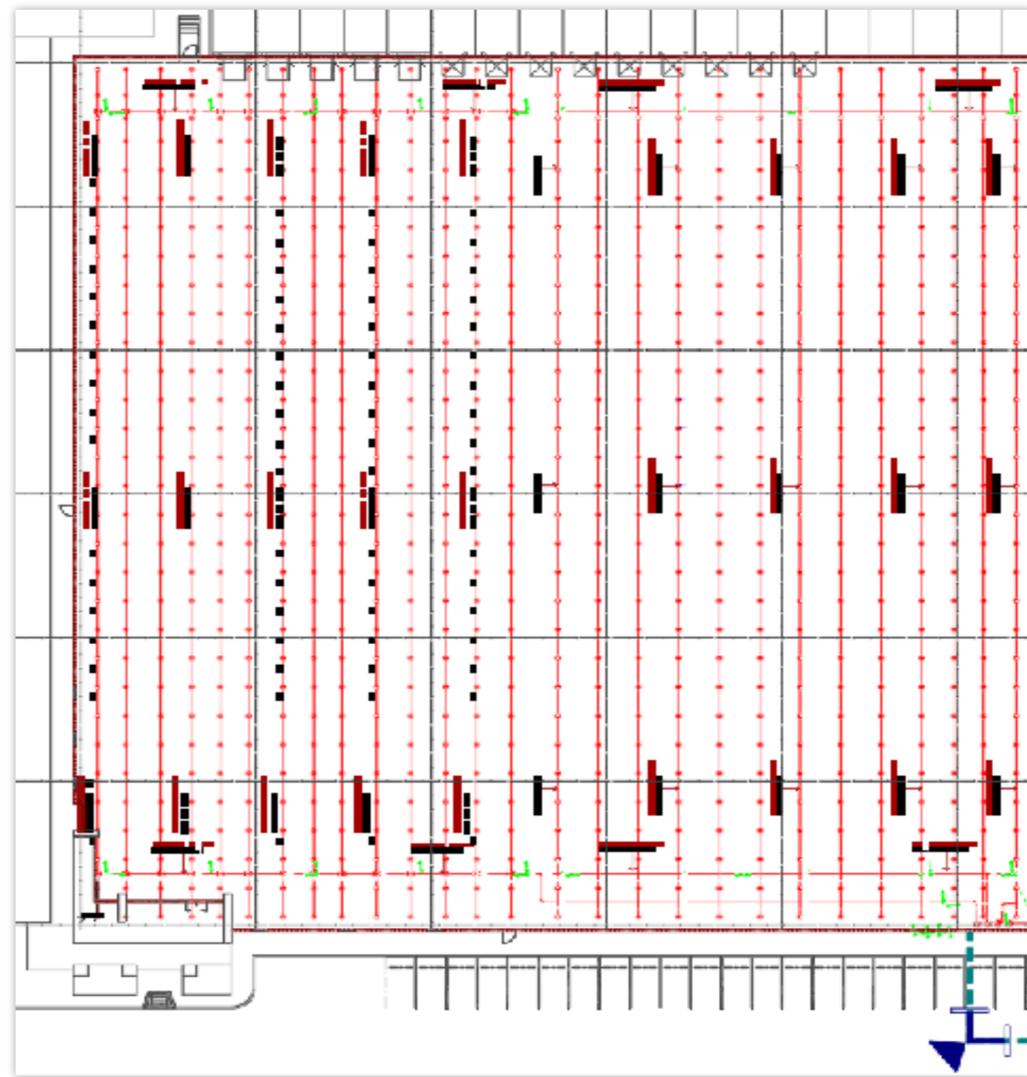


Loop de tubería enterrada

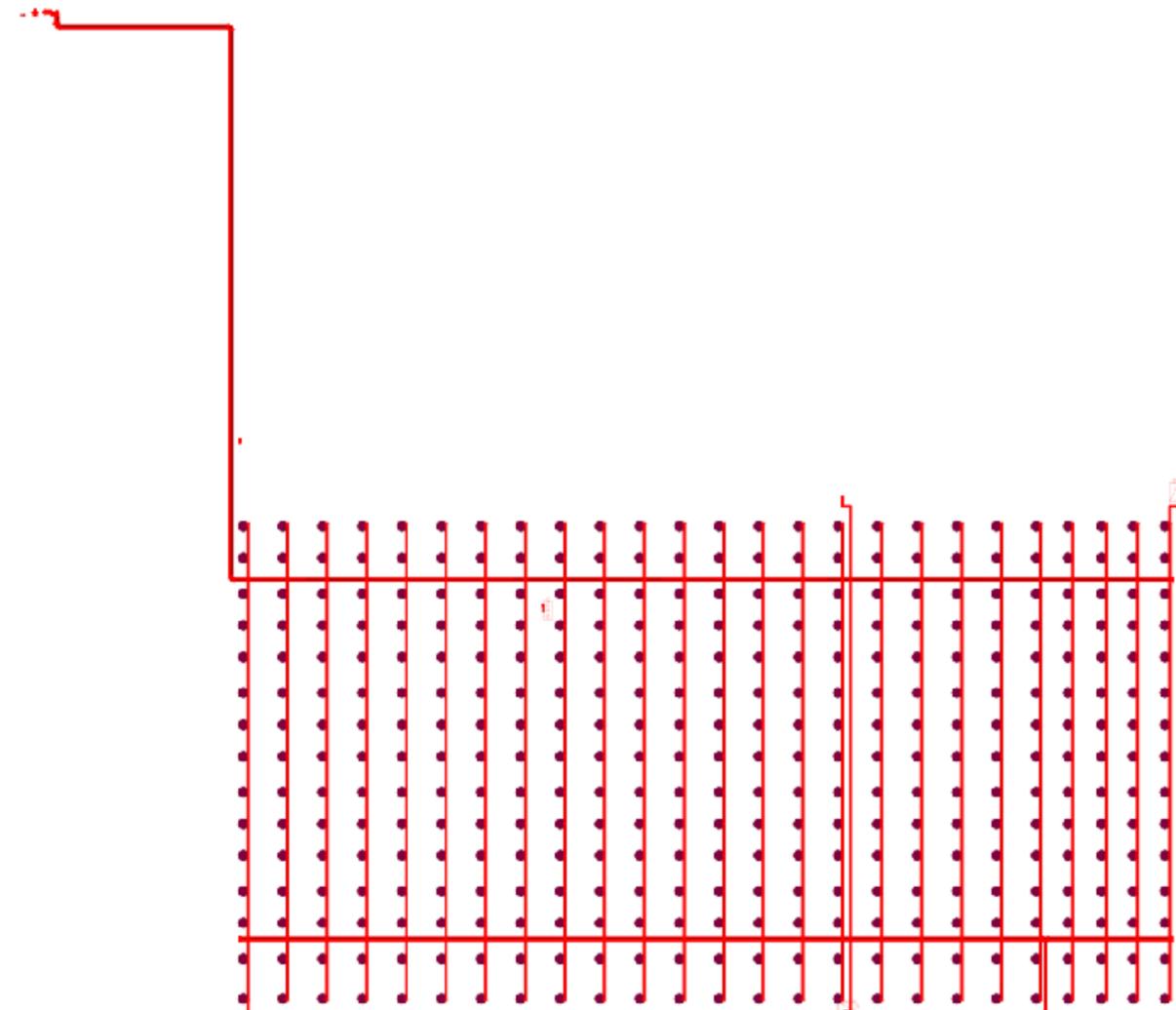
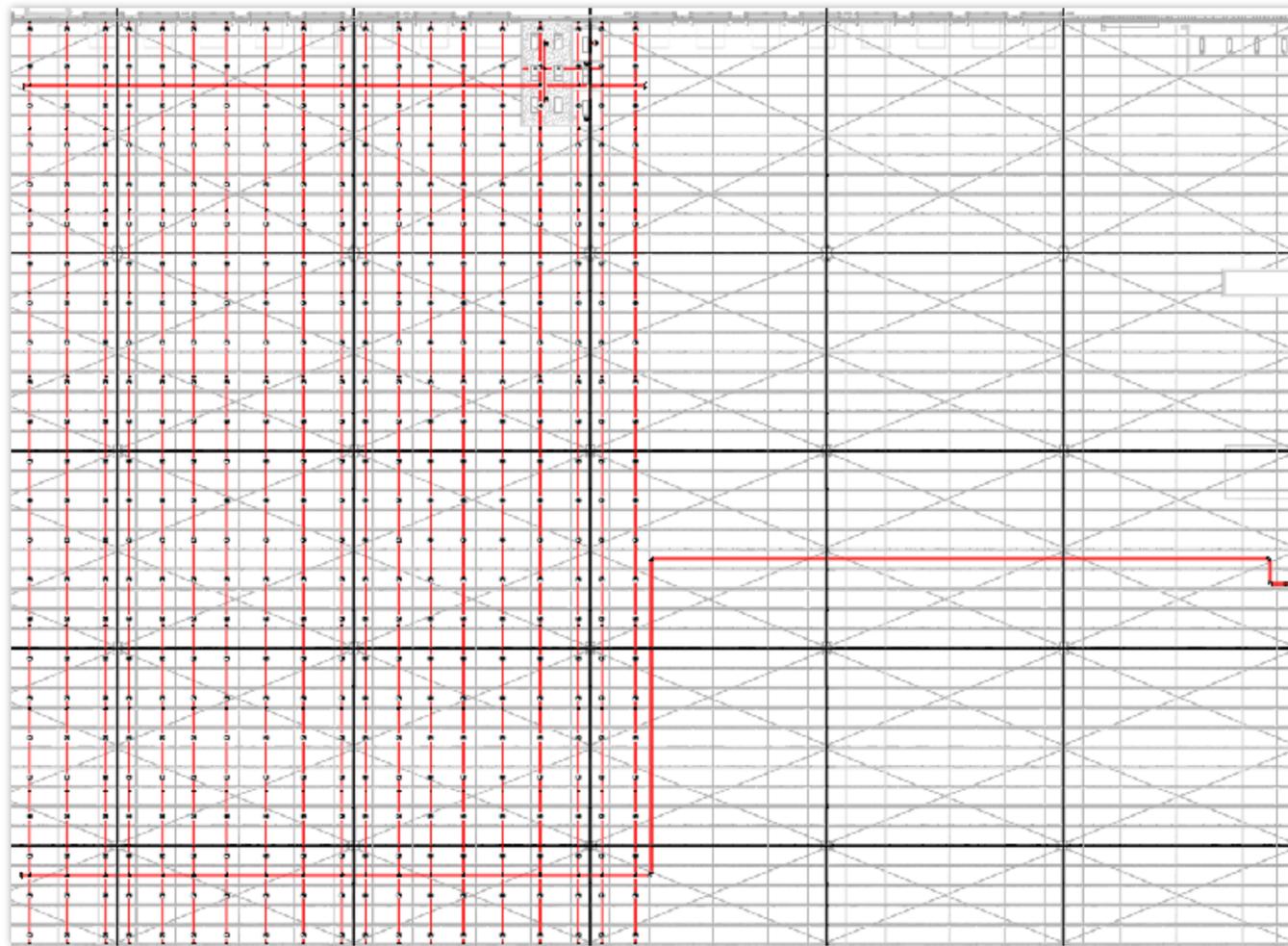


Línea de tubería enterrada

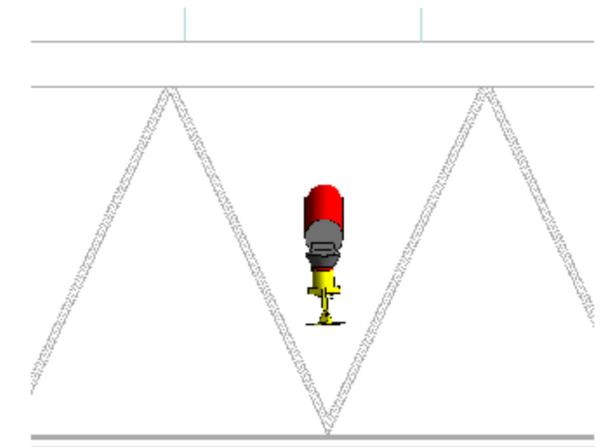
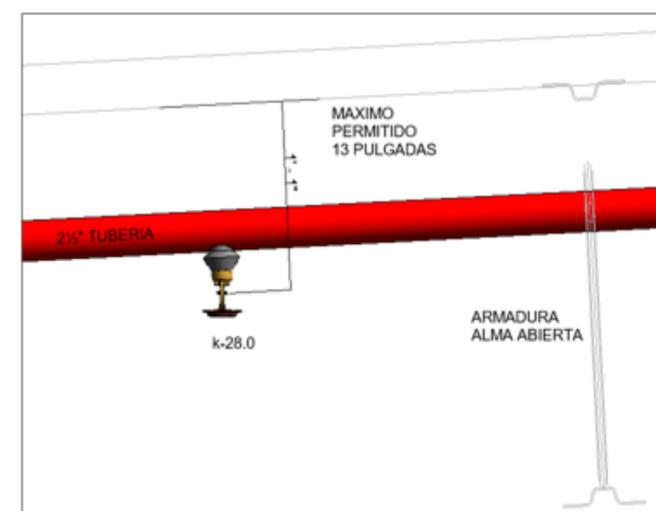
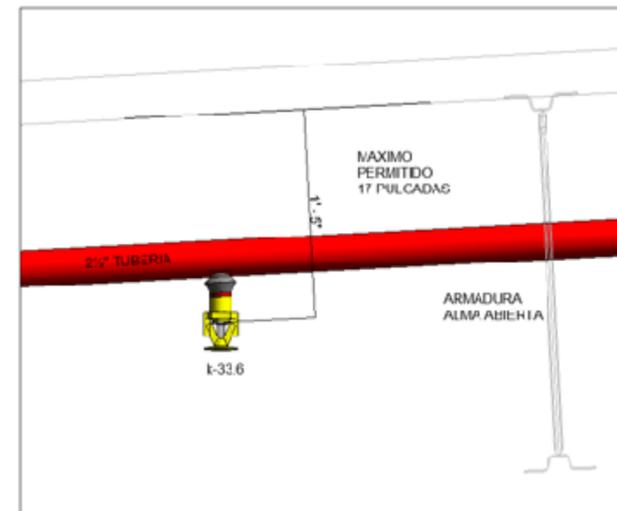
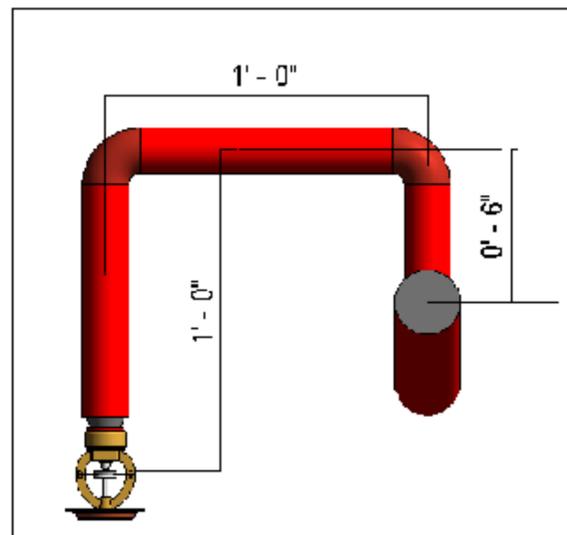
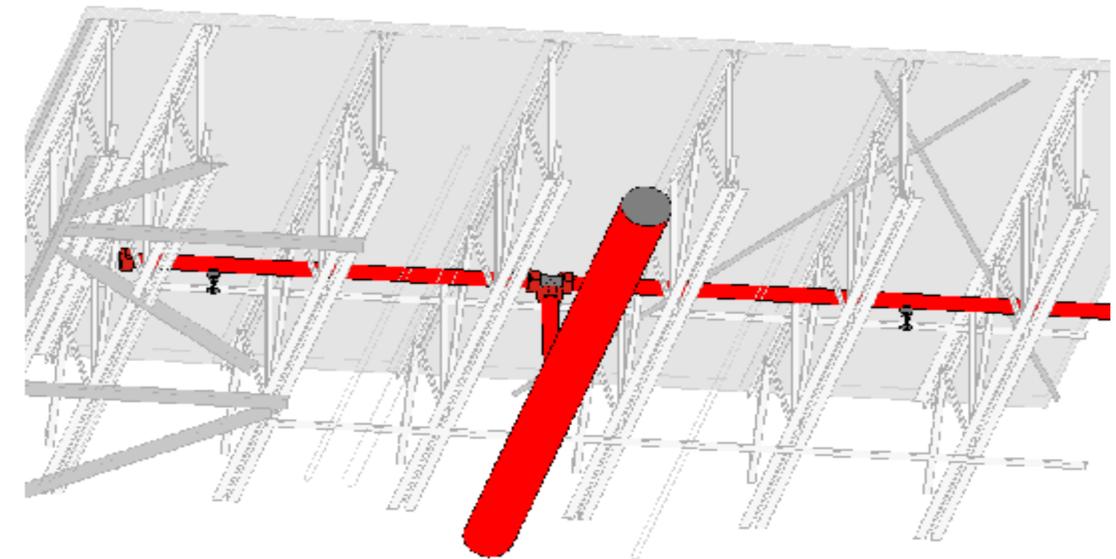
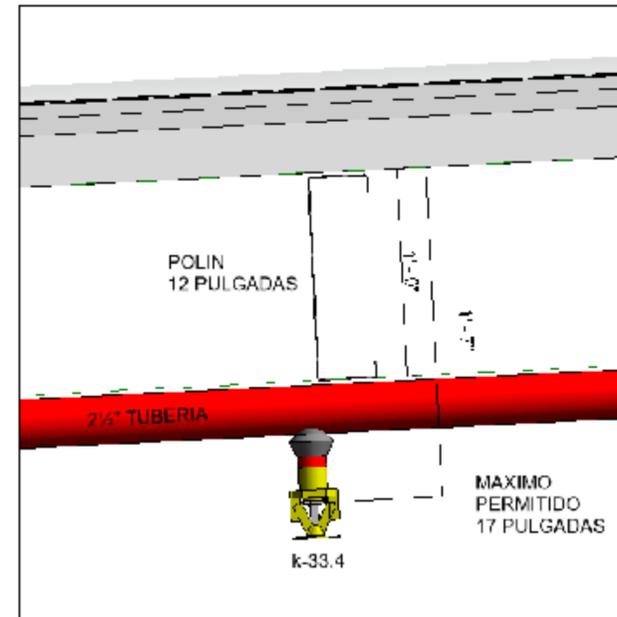
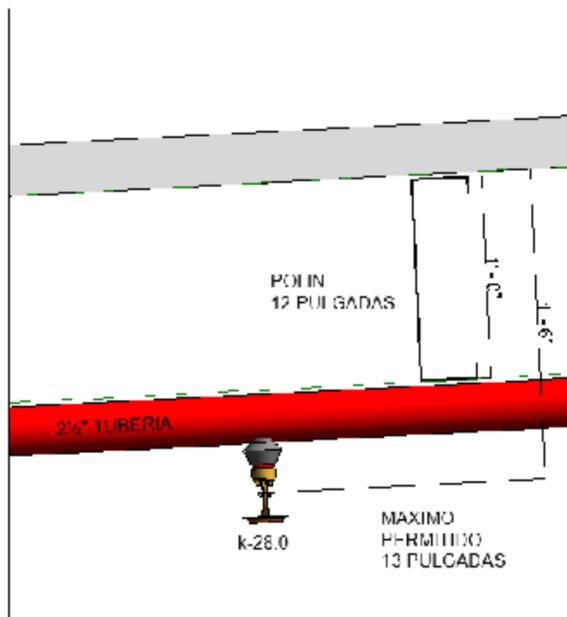
5.- Ramales calculados (cantidad, longitud y diámetro)



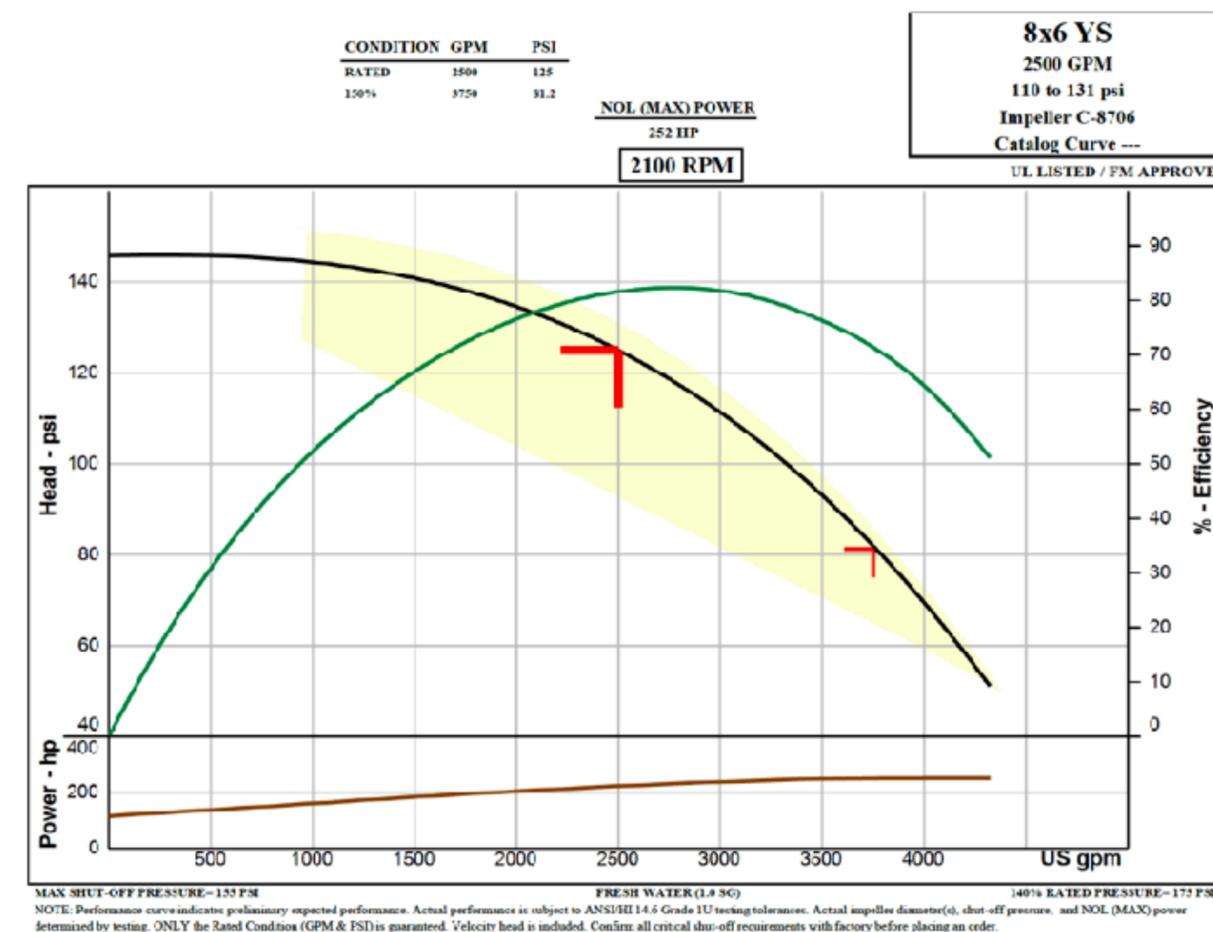
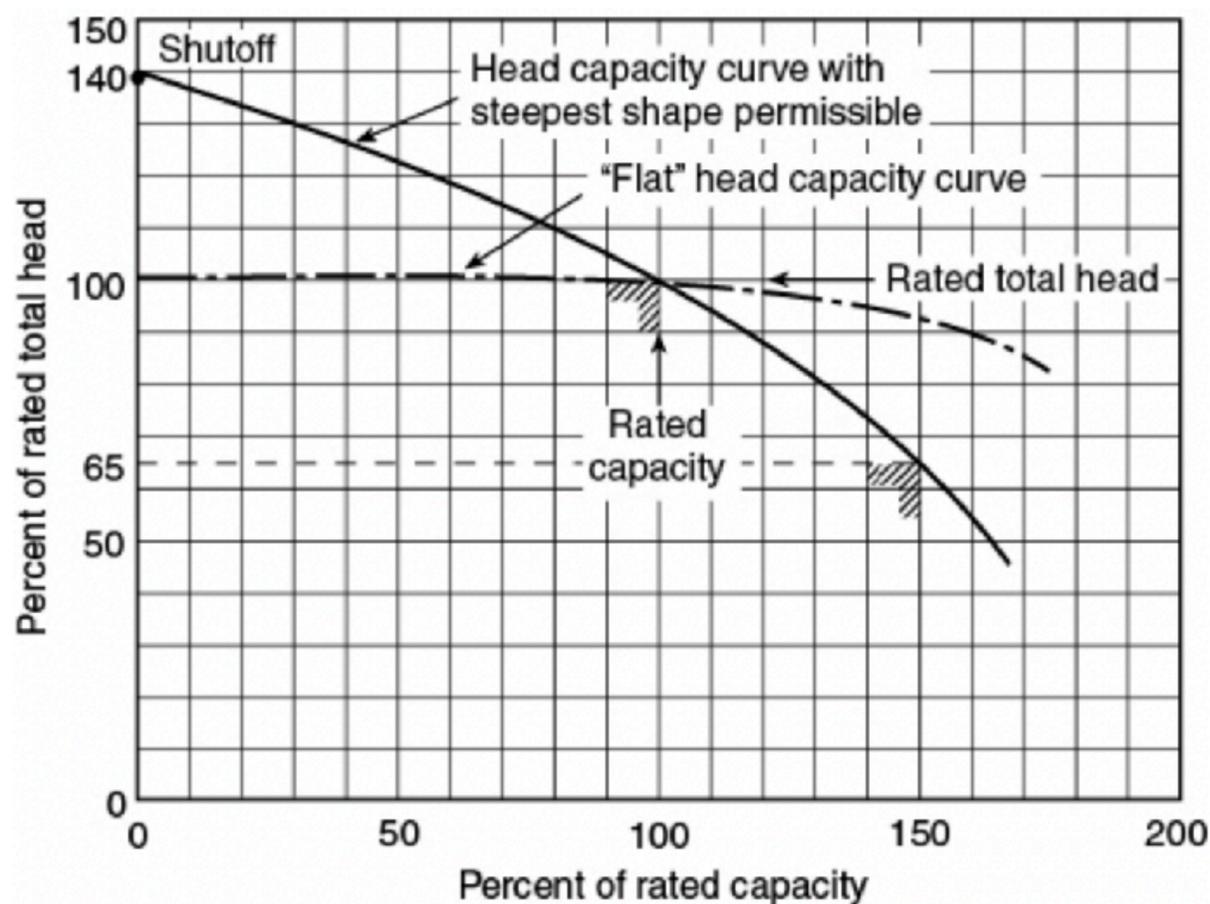
6.- Longitud del alimentador principal



7.- Tipo de arreglo del rociador (montante, colgante o garzas)



8.- Puntos de la curva de la bomba teóricos vs reales



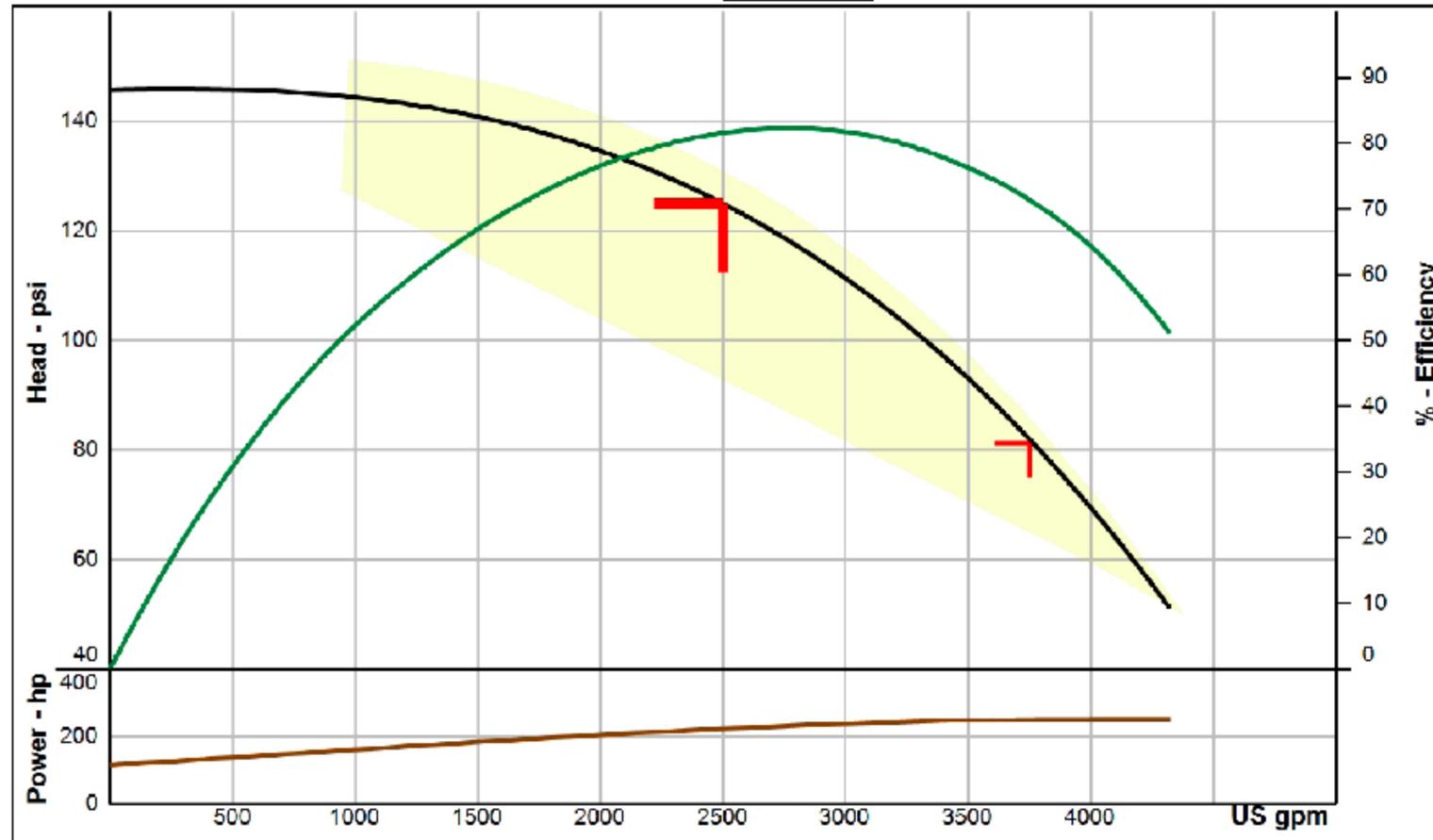
VS

2500 GPM @ 125 PSI OP1

CONDITION	GPM	PSI
RATED	2500	125
150%	3750	81.2

NOI (MAX) POWER
 252 HP
2100 RPM

8x6 YS
 2500 GPM
 110 to 131 psi
 Impeller C-8706
 Catalog Curve ---
 UL LISTED / FM APPROVED



MAX SHUT-OFF PRESSURE - 155 PSI
 FRESH WATER (1.0 SG)
 140% RATED PRESSURE - 175 PSI
 NOTE: Performance curve indicates preliminary expected performance. Actual performance is subject to ANSIMIT 14.6 Grade IU testing tolerances. Actual impeller diameter(s), shut-off pressure, and NOI (MAX) power determined by testing. ONLY the Rated Condition (GPM & PSI) is guaranteed. Velocity head is included. Confirm all critical shut-off requirements with factory before placing an order.

2500 GPM @ 125 PSI OP2

CONDITION	GPM	PSI
RATED	2500	125
150%	3750	81.2

NOL (MAX) POWER
267 HP

1780 RPM

10x8 M

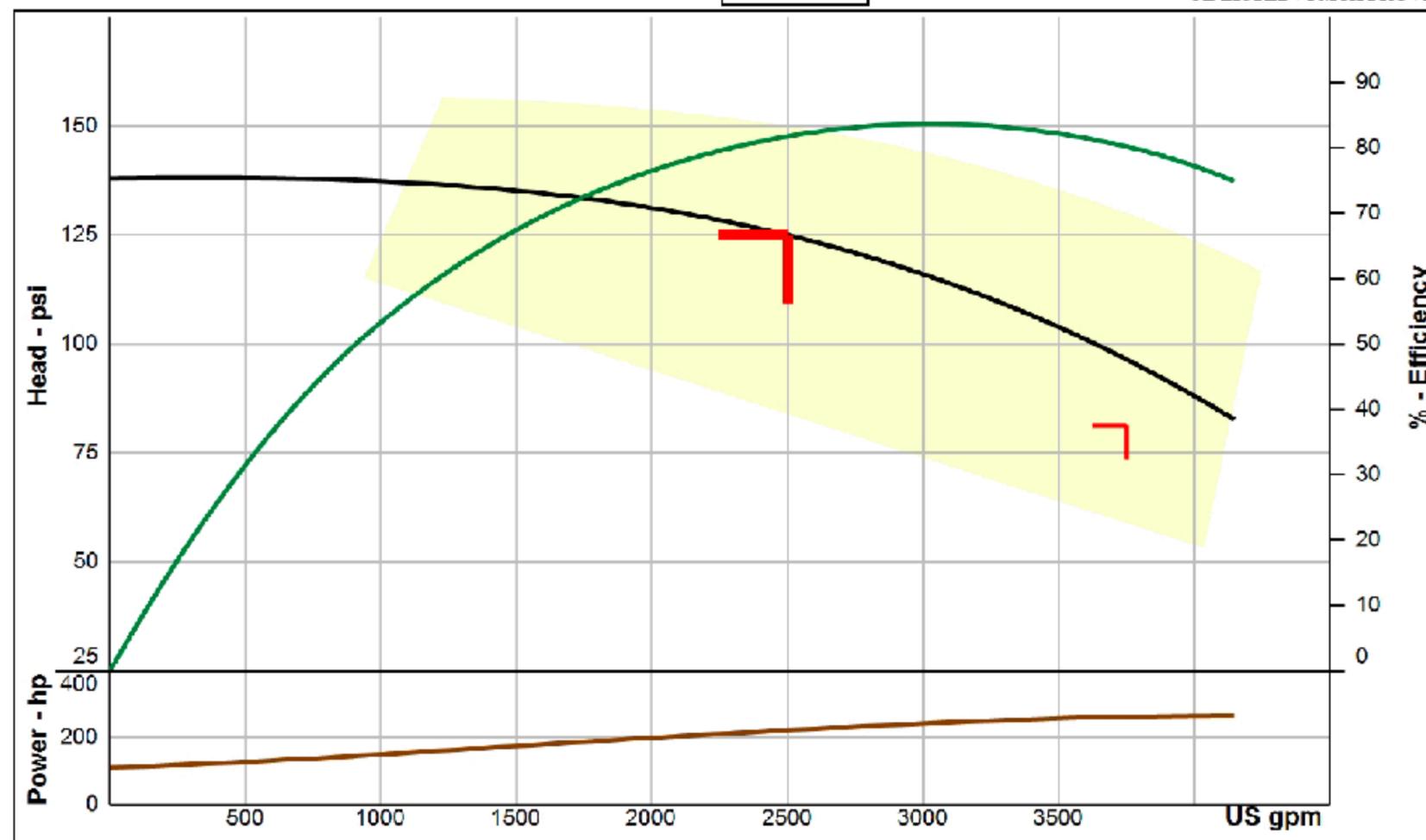
2500 GPM

100 to 150 psi

Impeller C-4070

Catalog Curve ---

UL LISTED / FM APPROVED



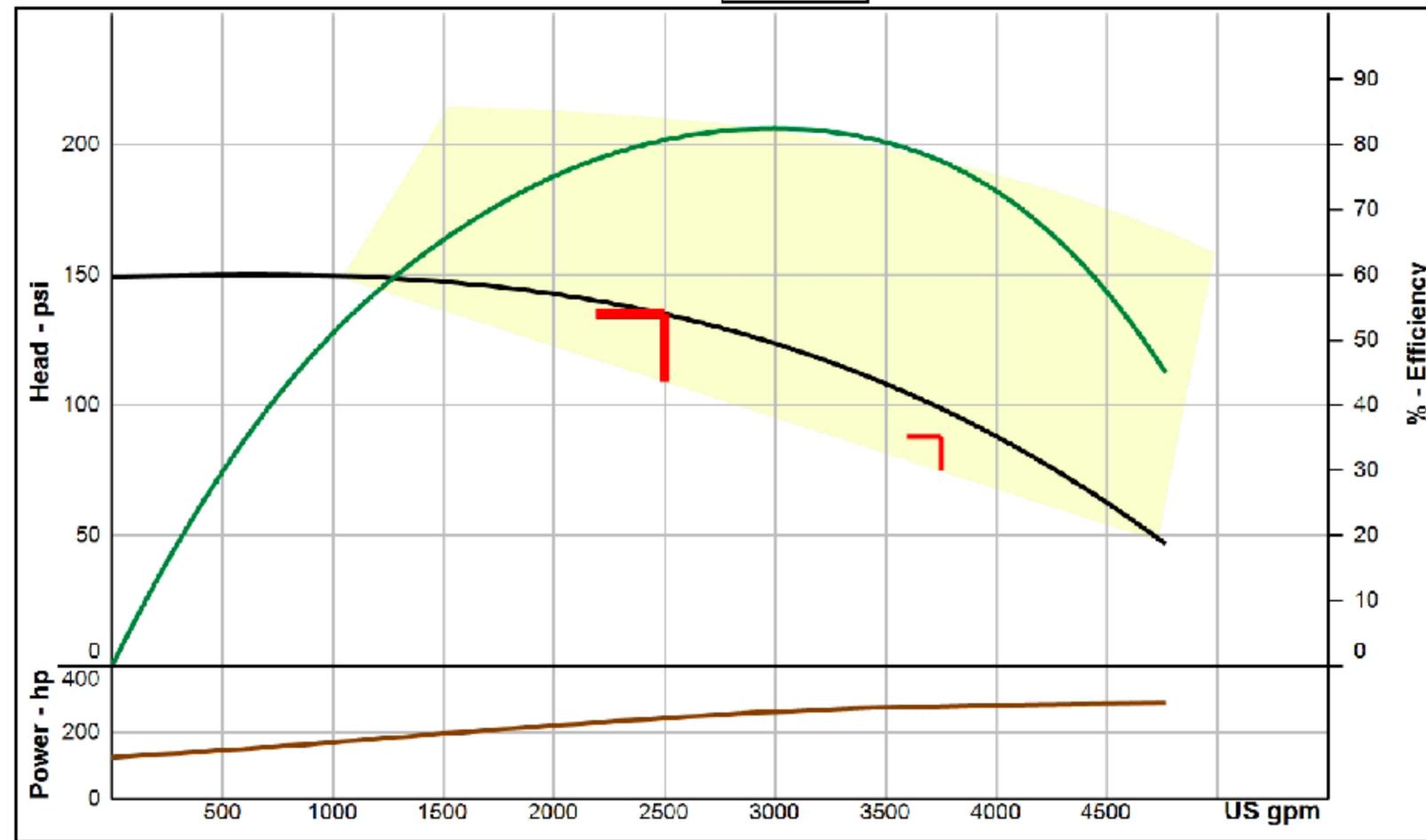
MAX SHUT-OFF PRESSURE- 146 PSI FRESH WATER (1.0 SG) 140% RATED PRESSURE- 175 PSI
 NOTE: Performance curve indicates preliminary expected performance. Actual performance is subject to ANSI/III 14.6 Grade IIU testing tolerances. Actual impeller diameter(s), shut-off pressure, and NOL (MAX) power determined by testing. ONLY the Rated Condition (GPM & PSI) is guaranteed. Velocity head is included. Confirm all critical shut off requirements with factory before placing an order.

2500 GPM @ 135 PSI OP1

CONDITION	GPM	PSI
RATED	2500	135
150%	3750	87.8

NOL (MAX) POWER
 289 HP
2100 RPM

10x8 M
 2500 GPM
 135 to 210 psi
 Impeller C-4070
 Catalog Curve ---
 UL LISTED / FM APPROVED



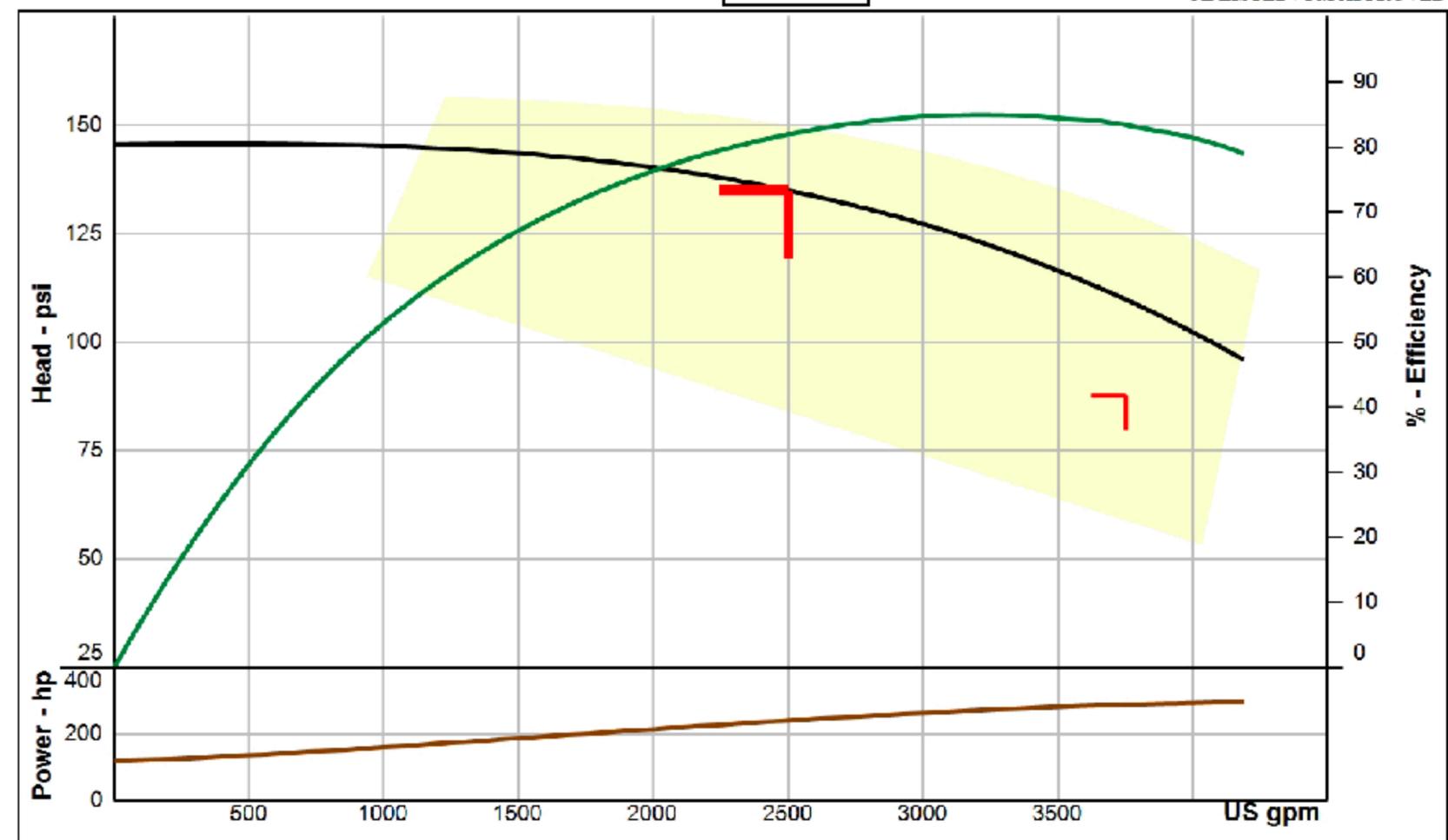
MAX SHUT OFF PRESSURE: 158 PSI
 FRESH WATER (1.0 SG)
 140% RATED PRESSURE: 189 PSI
 NOTE: Performance curve indicates preliminary expected performance. Actual performance is subject to ANSI/HT 11.6 Grade IJ testing tolerances. Actual impeller diameter(s), shut off pressure, and NOL (MAX) power determined by testing. ONLY the Rated Condition (GPM & PSI) is guaranteed. Velocity head is included. Confirm all crucial shut-off requirements with factory before placing an order.

2500 GPM @ 135 PSI OP2

CONDITION	GPM	PSI
RATED	2500	135
150%	3750	87.8

NOL (MAX) POWER
 297 HP
1780 RPM

10x8 M
 2500 GPM
 100 to 150 psi
 Impeller C-4070
 Catalog Curve ---
 UL LISTED / FM APPROVED



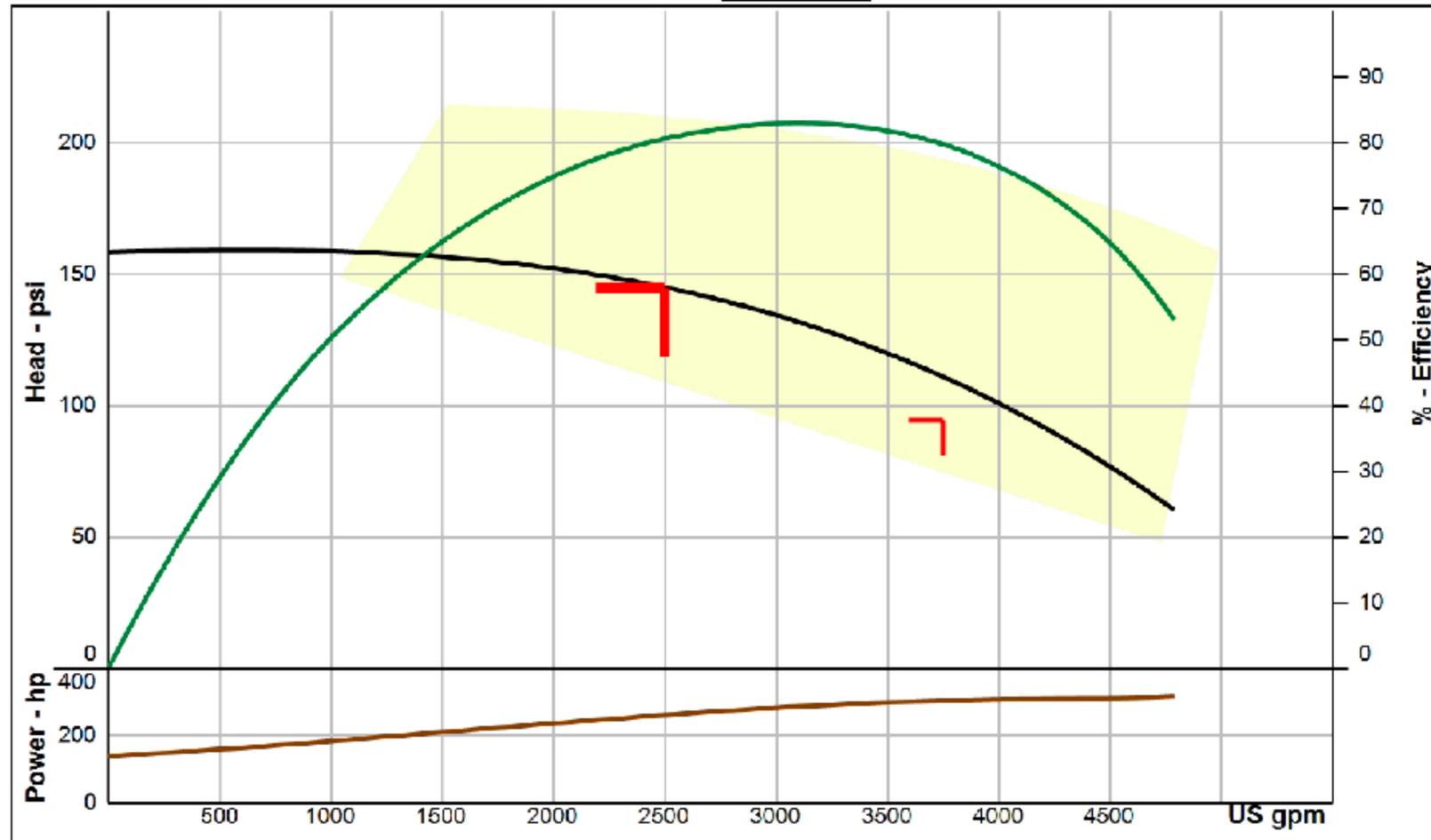
MAX SHUT-OFF PRESSURE= 155 PSI
 FRESH WATER (1.0 SG)
 140% RATED PRESSURE= 189 PSI
 NOTE: Performance curve indicates preliminary expected performance. Actual performance is subject to ANSI/III 14.6 Grade 1U testing tolerances. Actual impeller diameter(s), shut-off pressure, and NOL (MAX) power determined by testing. ONLY the Rated Condition (GPM & PSI) is guaranteed. Velocity head is included. Confirm all critical shut-off requirements with factory before placing an order.

2500 GPM @ 145 PSI OP1

CONDITION	GPM	PSI
RATED	2500	145
150%	3750	94.2

NOL (MAX) POWER
 314 HP
2100 RPM

10x8 M
 2500 GPM
 135 to 210 psi
 Impeller C-4070
 Catalog Curve ---
 UL LISTED / FM APPROVED



MAX SHUT-OFF PRESSURE- 169 PSI
 FRESH WATER (1.0 SG)
 140% RATED PRESSURE- 203 PSI
 NOTE: Performance curve indicates preliminary expected performance. Actual performance is subject to ANSI/HI 14.6 Grade IU testing tolerances. Actual impeller diameter(s), shut-off pressure, and NOL (MAX) power determined by testing. ONLY the Rated Condition (GPM & PSI) is guaranteed. Velocity head is included. Confirm all critical shut-off requirements with factory before placing an order.

2500 GPM @ 145 PSI OP2

CONDITION	GPM	PSI
RATED	2500	145
150%	3750	94.2

NOI (MAX) POWER
326 HP

1780 RPM

10x8 M

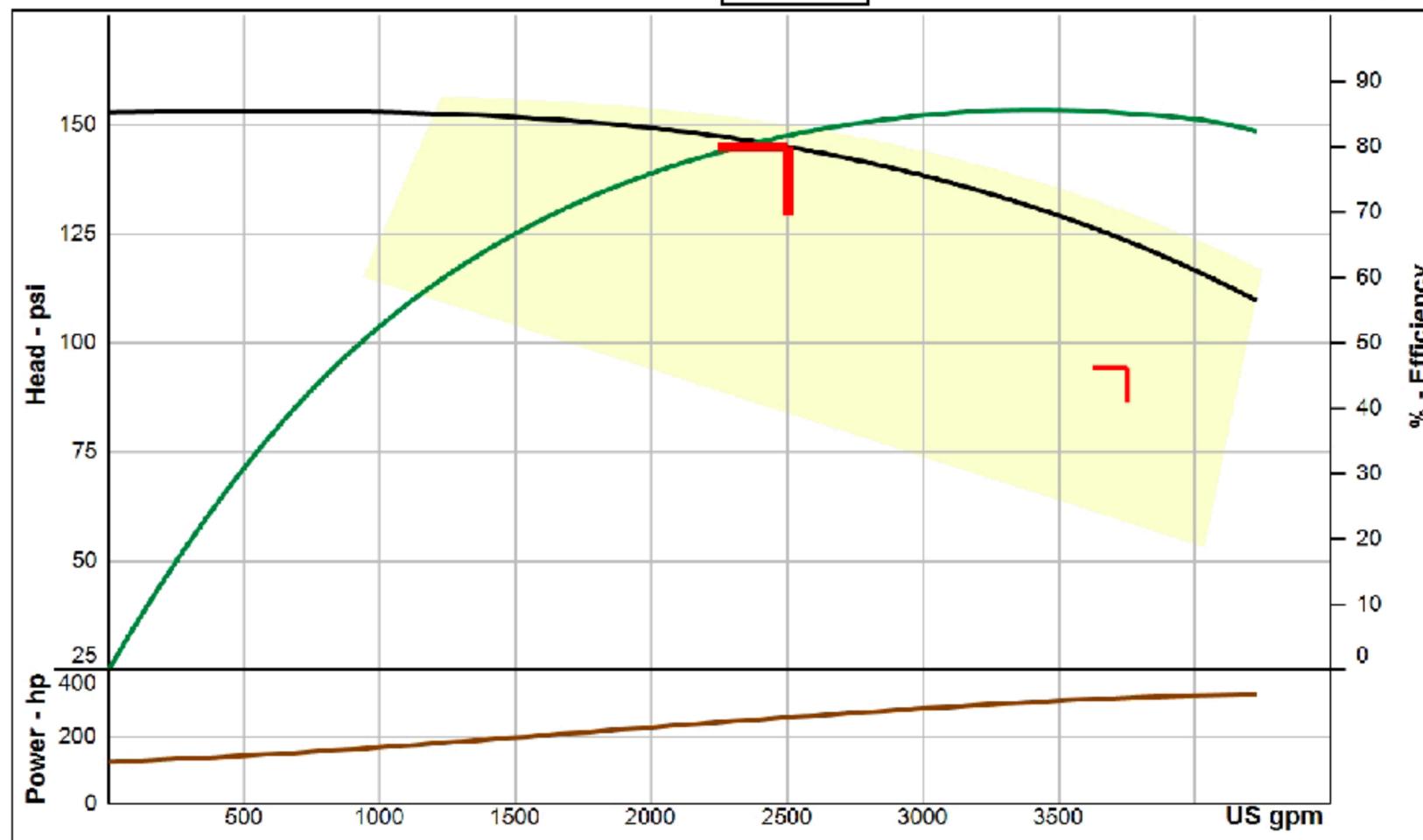
2500 GPM

100 to 150 psi

Impeller C-4070

Catalog Curve ---

UL LISTED / FM APPROVED



MAX SHUT OFF PRESSURE: 162 PSI FRESH WATER (1.0 SG) 140% RATED PRESSURE: 203 PSI

NOTE: Performance curve indicates preliminary expected performance. Actual performance is subject to ANSI/HI 14.6 Grade 1U testing tolerances. Actual impeller diameter(s), shut-off pressure, and NOI (MAX) power determined by testing. ONLY the Rated Condition (GPM & PSI) is guaranteed. Velocity head is included. Confirm all critical shut-off requirements with factory before placing an order.

3000 GPM @ 125 PSI OP1

CONDITION	GPM	PSI
RATED	3000	125
150%	4500	81.2

NOL (MAX) POWER

318 HP

1750 RPM

12x8 MAA

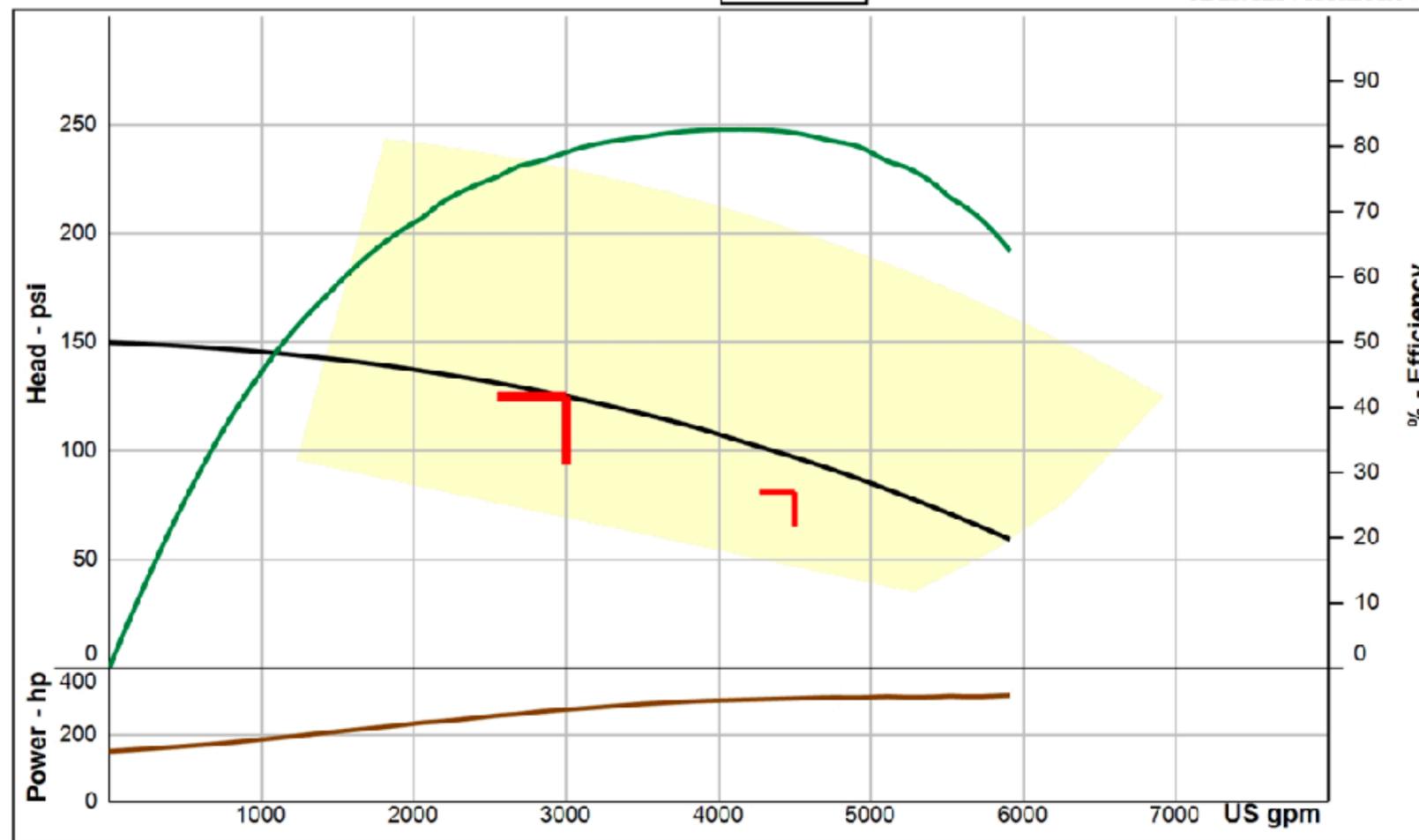
3000 GPM

80 to 230 psi

Impeller D-5530

Catalog Curve ---

UL LISTED / FM APPROVED



MAX SHUT-OFF PRESSURE= 159 PSI
FRESH WATER (1.0 SG)
140% RATED PRESSURE= 175 PSI
NOTE: Performance curve indicates preliminary expected performance. Actual performance is subject to ANSI/HI 14.5 Grade 1U testing tolerances. Actual impeller diameter(s), shut-off pressure, and NOL (MAX) power determined by testing. ONLY the Rated Condition (GPM & PSI) is guaranteed. Velocity head is included. Confirm all critical shut-off requirements with factory before placing an order.

3000 GPM @ 135 PSI OP2

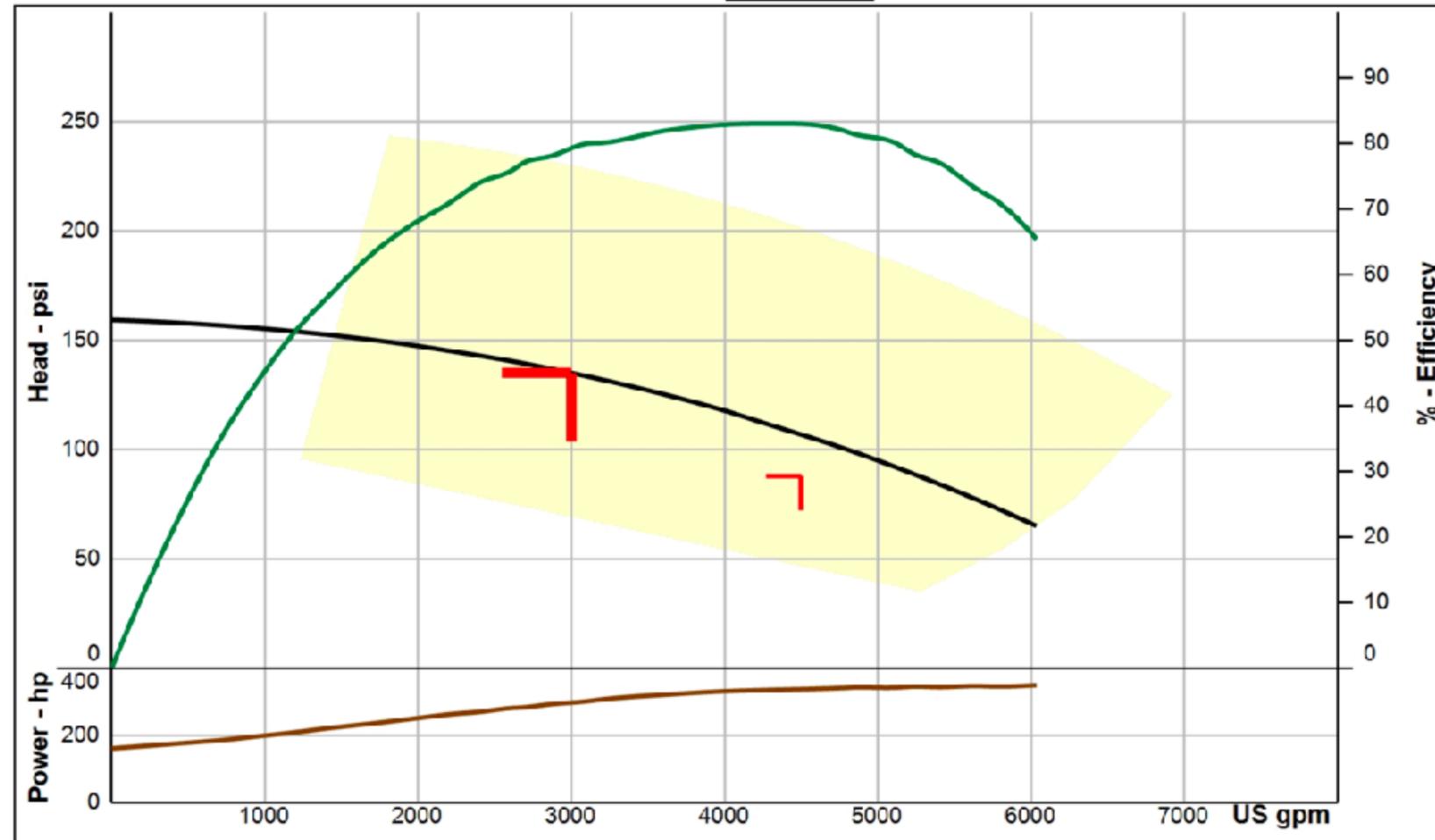
CONDITION	GPM	PSI
RATED	3000	135
150%	4500	87.3

NOL (MAX) POWER
 348 HP

1750 RPM

12x8 MAA
 3000 GPM
 80 to 230 psi
 Impeller D-5530
 Catalog Curve ---

UL LISTED / FM APPROVED



MAX SHUT-OFF PRESSURE= 169 PSI
 FRESH WATER (1.0 SG)
 140% RATED PRESSURE= 189 PSI
 NOTE: Performance curve indicates preliminary expected performance. Actual performance is subject to ANSI/HI 14.6 Grade 1U testing tolerances. Actual impeller diameter(s), shut-off pressure, and NOL (MAX) power determined by testing. ONLY the Rated Condition (GPM & PSI) is guaranteed. Velocity head is included. Confirm all critical shut-off requirements with factory before placing an order.

3000 GPM @ 145 PSI OP3

CONDITION	GPM	PSI
RATED	3000	145
150%	4500	94.2

NOL (MAX) POWER
 379 HP

1750 RPM

12x8 MAA

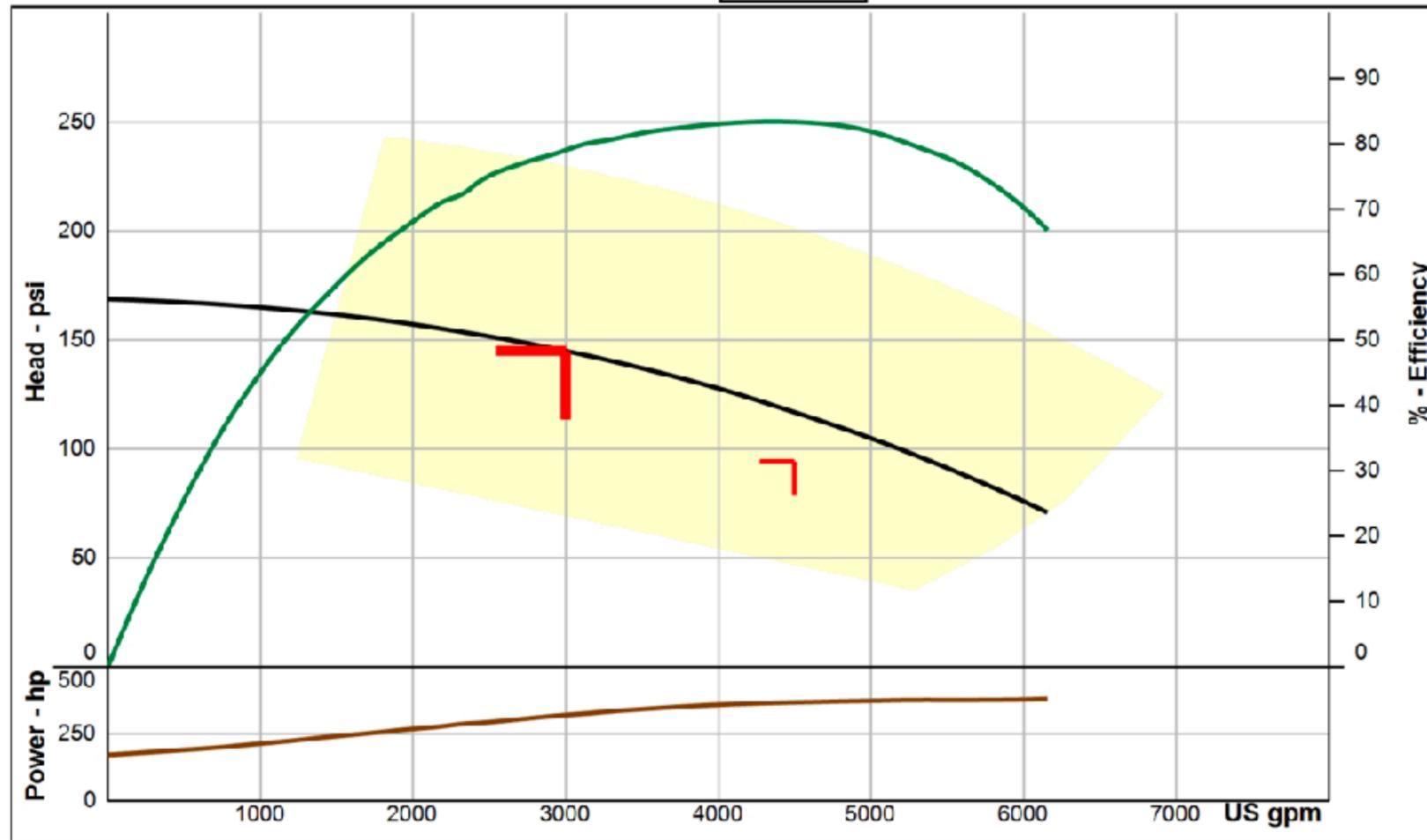
3000 GPM

80 to 230 psi

Impeller D-5530

Catalog Curve ---

UL LISTED / FM APPROVED



MAX SHUT-OFF PRESSURE= 179 PSI
 FRESH WATER (1.0 SG)
 140% RATED PRESSURE= 203 PSI
 NOTE: Performance curve indicates preliminary expected performance. Actual performance is subject to ANSI/HI 14.6 Grade IJ testing tolerances. Actual impeller diameter(s), shut-off pressure, and NOL (MAX) power determined by testing. ONLY the Rated Condition (GPM & PSI) is guaranteed. Velocity head is included. Confirm all critical shut-off requirements with factory before placing an order.

Ejemplo: Análisis Comparativo de Criterios de Diseño para un almacén de Plásticos expuestos expandidos grupo A

Commodity	EEP - PROYECTO 1								
Max. Bldg Height	40 FT								
Criterio	12 ESFR K25.2 @ 60 PSI + 250 GPM								
Bomba	OP1 2500@125	OP2 2500@125	OP1 2500@135	OP2 2500@135	OP1 2500@145	OP2 2500@145	OP1 3000@125	OP2 3000@135	OP3 3000@145
Tipo U.G.	Loop	Loop	Loop	Loop	Loop	Loop	Loop	Loop	Loop
U.G.	12"	12"	12"	12"	10"	10"	10"	10"	10"
Lead in	12"	12"	12"	12"	10"	10"	10"	10"	10"
Manifold	10"	10"	10"	10"	10"	10"	10"	10"	10"
Riser	8"	8"	8"	8"	8"	8"	8"	8"	8"
Feeder	10"	10"	10"	10"	10"	8"	10"	8"	8"
Crossmain	8"	8"	8"	8"	8"	8"	8"	8"	8"
Farmain	8"	8"	8"	8"	8"	8"	8"	6"	6"
Riser Niple	3"	3"	3"	3"	3"	3"	3"	3"	3"
No. Branchlines	19	19	19	19	19	19	19	19	19
Long. Branchlines	200 ft	200 ft	200 ft	200 ft	200 ft	200 ft	200 ft	200 ft	200 ft
Long. Feeder	245 ft	245 ft	245 ft	245 ft	245 ft	245 ft	245 ft	245 ft	245 ft
Long. UG	2,500 ft	2,500 ft	2,500 ft	2,500 ft	2,500 ft	2,500 ft	2,500 ft	2,500 ft	2,500 ft
Branchline	3"	3"	3"	3"	3"	3"	3"	3"	3"
Colchón	- 3.3 psi	- 7 psi	10.2 psi	12.5 psi	13.6 psi	11.5 psi	10.9 psi	11.5 psi	11.1psi

Ejemplo: Análisis Comparativo de Criterios de Diseño para un almacén de Plásticos expuestos expandidos grupo A

Commodity	EEP - PROYECTO 2								
Max. Bldg Height	40 FT								
Criterio	12 ESFR K25.2 @ 60 PSI + 250 GPM								
Bomba	OP1 2500@125	OP2 2500@125	OP1 2500@135	OP2 2500@135	OP1 2500@145	OP2 2500@145	OP1 3000@125	OP2 3000@135	OP3 3000@145
Tipo U.G.	Linea	Linea	Linea	Linea	Linea	Linea	Linea	Linea	Linea
U.G.	12"	12"	12"	12"	12"	10"	12"	12"	12"
Lead in	12"	12"	12"	12"	12"	10"	12"	12"	12"
Manifold	10"	10"	10"	10"	10"	10"	10"	10"	10"
Riser	8"	8"	8"	8"	8"	8"	8"	8"	8"
Feeder	10"	10"	10"	10"	8"	8"	8"	8"	8"
Crossmain	8"	8"	8"	8"	8"	8"	8"	6"	6"
Farmain	8"	8"	8"	8"	8"	8"	8"	6"	6"
Riser Niple	3"	3"	3"	3"	3"	3"	3"	3"	3"
No. Branchlines	14	14	14	14	14	14	14	14	14
Long. Branchlines	256 ft	256 ft	256 ft	256 ft	256 ft	256 ft	256 ft	200 ft	256 ft
Long. Feeder	140 ft	141 ft	142 ft	143 ft	144 ft	145 ft	144 ft	245 ft	144 ft
Long. UG	1,200 ft	1,200 ft	1,200 ft	1,200 ft	1,200 ft	1,200 ft	1,200 ft	2,500 ft	1,200 ft
Branchline	3"	3"	3"	3"	3"	3"	3"	3"	3"
Colchón	- 2.3 psi	- 6.0 psi	8.9 psi	12.4psi	14.6 psi	5.4 psi	11.9 psi	15.5 psi	14 psi

Ejemplo: Análisis Comparativo de Criterios de Diseño para un almacén de Plásticos expuestos expandidos grupo A

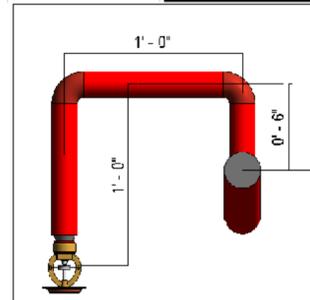
640,000 FT2
16 SISTEMAS

320,000 FT2
8 SISTEMAS

Commodity	EEP - PROYECTO 1									
Max. Bldg Height	40 FT									
Criterio	12 ESRF K25.2 @ 60 PSI + 250 GPM									
Bomba	OP1 2500@125	OP2 2500@125	OP1 2500@135	OP2 2500@135	OP1 2500@145	OP2 2500@145	OP1 3000@125	OP2 3000@135	OP3 3000@145	
Tipo U.G.	Loop	Loop	Loop	Loop	Loop	Loop	Loop	Loop	Loop	Loop
U.G.	12"	12"	12"	12"	10"	10"	10"	10"	10"	10"
Lead in	12"	12"	12"	12"	10"	10"	10"	10"	10"	10"
Manifold	10"	10"	10"	10"	10"	10"	10"	10"	10"	10"
Riser	8"	8"	8"	8"	8"	8"	8"	8"	8"	8"
Feeder	10"	10"	10"	10"	10"	8"	10"	8"	8"	8"
Crossmain	8"	8"	8"	8"	8"	8"	8"	8"	8"	8"
Farmain	8"	8"	8"	8"	8"	8"	8"	6"	6"	6"
Riser Niple	3"	3"	3"	3"	3"	3"	3"	3"	3"	3"
No. Branchlines	19	19	19	19	19	19	19	19	19	19
Long. Branchlines	200 ft	200 ft	200 ft	200 ft	200 ft	200 ft	200 ft	200 ft	200 ft	200 ft
Long. Feeder	245 ft	245 ft	245 ft	245 ft	245 ft	245 ft	245 ft	245 ft	245 ft	245 ft
Long. UG	2,500 ft	2,500 ft	2,500 ft	2,500 ft	2,500 ft	2,500 ft	2,500 ft	2,500 ft	2,500 ft	2,500 ft
Branchline	3"	3"	3"	3"	3"	3"	3"	3"	3"	3"
Colchón	- 3.3 psi	- 7 psi	10.2 psi	12.5 psi	13.6 psi	11.5 psi	10.9 psi	11.5 psi	11.1psi	

Commodity	EEP - PROYECTO 2									
Max. Bldg Height	40 FT									
Criterio	12 ESRF K25.2 @ 60 PSI + 250 GPM									
Bomba	OP1 2500@125	OP2 2500@125	OP1 2500@135	OP2 2500@135	OP1 2500@145	OP2 2500@145	OP1 3000@125	OP2 3000@135	OP3 3000@145	
Tipo U.G.	Linea	Linea	Linea	Linea	Linea	Linea	Linea	Linea	Linea	Linea
U.G.	12"	12"	12"	12"	12"	10"	12"	12"	12"	12"
Lead in	12"	12"	12"	12"	12"	10"	12"	12"	12"	12"
Manifold	10"	10"	10"	10"	10"	10"	10"	10"	10"	10"
Riser	8"	8"	8"	8"	8"	8"	8"	8"	8"	8"
Feeder	10"	10"	10"	10"	8"	8"	8"	8"	8"	8"
Crossmain	8"	8"	8"	8"	8"	8"	8"	6"	6"	6"
Farmain	8"	8"	8"	8"	8"	8"	8"	6"	6"	6"
Riser Niple	3"	3"	3"	3"	3"	3"	3"	3"	3"	3"
No. Branchlines	14	14	14	14	14	14	14	14	14	14
Long. Branchlines	256 ft	256 ft	256 ft	256 ft	256 ft	256 ft	256 ft	200 ft	256 ft	256 ft
Long. Feeder	140 ft	141 ft	142 ft	143 ft	144 ft	145 ft	144 ft	245 ft	144 ft	144 ft
Long. UG	1,200 ft	1,200 ft	1,200 ft	1,200 ft	1,200 ft	1,200 ft	1,200 ft	2,500 ft	1,200 ft	1,200 ft
Branchline	3"	3"	3"	3"	3"	3"	3"	3"	3"	3"
Colchón	- 2.3 psi	- 6.0 psi	8.9 psi	12.4psi	14.6 psi	5.4 psi	11.9 psi	15.5 psi	14 psi	

Importante: NO se consideraron Garzas o armovers.



**2500 GPM @ ? vs 3000 GPM @ ?
 125 PSI vs 135 vs 145?**

PROYECTO	GPM	PSI	MODELO	HP MOTOR	RPM	COSTO
ORLANDO 125 OP1	2500	125	8x6 YS	252	2100	70,174 USD
ORLANDO 125 OP2	2500	125	10x8 M	267	1780	81,978 USD
						11,804 USD
ORLANDO 135 OP1	2500	135	10x8 M	289	2100	81,088 USD
ORLANDO 135 OP2	2500	135	10x8 M	297	1780	94,155 USD
						13,067 USD
ORLANDO 145 OP1	2500	145	10x8 M	314	2100	93,455 USD
ORLANDO 145 OP2	2500	145	10x8 M	326	1780	94,231 USD
						776 USD
ORLANDO 125 OP1	3000	125	12x8	318	1750	109,058 USD
ORLANDO 135 OP2	3000	135	12x8	348	1750	109,761 USD
						703 USD
ORLANDO 145 OP3	3000	145	12x8	379	1750	112,115 USD
						3,057 USD

2500 GPM @ ? vs 3000 GPM @ ? 125 PSI vs 135 vs 145?

Pump Room	Price			Water Tank		Price	
2500 @ 125	218,000.00	100%		150,000 Gall		230,000.00	100%
2500 @ 135	225,000.00	103%		200,000 Gall		243,000.00	106%
2500 @ 145	232,000.00	106%					
3000 @ 125	240,000.00	110%					
3000 @ 135	248,000.00	114%					
3000 @ 145	260,000.00	119%					
One Diesel Engine Driven. Located @ 1000 Mts ASL @ 90F				One Steel Bolted Water Tank			
Include Jockey Pump, Flowmeter, Waste Cone to Outdoor				Include all Appurtenances & Valving			
All Piping, Valves, Bracings, Etc In Compliance with NFPA20				Include Tank Foundation & Civil Works			
Include Pump Room & Civil Works							
Loop	Price						
10" diam	178,000.00	100%					
12" diam	191,000.00	107%					
1,000 Ft PVC C900 Calse 200							
Include Valves, Lead Ins, Fittings, Flanges, Yard Hydrants							
Include Pipe Trench, Thrust Blocks & Civil Works							

**2500 GPM @ ? vs 3000 GPM @ ?
 125 PSI vs 135 vs 145?**

	Example:	40,000.00		
	BASE 40,000 SQFT	TOTAL COST	PRICE	SAVING
Base Quote	Option 1	182,000.00	4.55	0
	Option 2	189,000.00	4.73	7,000.00
	Option 3	207,000.00	5.18	25,000.00
	Option 4	212,000.00	5.30	30,000.00
	Option 5	191,000.00	4.78	9,000.00
	Option 6	198,000.00	4.95	16,000.00
	Option 7	216,000.00	5.40	34,000.00
	Option 8	221,000.00	5.53	39,000.00

2500 GPM @ ? vs 3000 GPM @ ? 125 PSI vs 135 vs 145?

	Example:	640,000.00		
	PROY1- 640,000 SQFT	TOTAL COST	PRICE	SAVING
Base Quote	Option 1	2,912,000.00	4.55	0
	Option 2	3,024,000.00	4.73	112,000.00
	Option 3	3,312,000.00	5.18	400,000.00
	Option 4	3,392,000.00	5.30	480,000.00
	Option 5	3,056,000.00	4.78	144,000.00
	Option 6	3,168,000.00	4.95	256,000.00
	Option 7	3,456,000.00	5.40	544,000.00
	Option 8	3,536,000.00	5.53	624,000.00
	Example:	320,000.00		
	PROY2- 320,000 SQFT	TOTAL COST	PRICE	SAVING
Base Quote	Option 1	1,456,000.00	4.55	0
	Option 2	1,512,000.00	4.73	56,000.00
	Option 3	1,656,000.00	5.18	200,000.00
	Option 4	1,696,000.00	5.30	240,000.00
	Option 5	1,528,000.00	4.78	72,000.00
	Option 6	1,584,000.00	4.95	128,000.00
	Option 7	1,728,000.00	5.40	272,000.00
	Option 8	1,768,000.00	5.53	312,000.00

Conclusiones:

- Se debe revisar particularmente cada proyecto.
- Todos los factores de los que hablamos anteriormente son muy importantes al momento de diseñar un sistema de rociadores automáticos contra incendio.
- No se debe afirmar que las condiciones de un proyecto serán igual a otro.
- Siempre habrá condiciones diferentes las cuales se deben verificar puntualmente para poder elegir el equipo de bombeo adecuado para nuestro diseño.

Muchas Gracias!



Ing. Frank Guzmán | VP Business Developer

NICET #130914

Water-Based (Formely Automatic-Sprinkler) Systems Layout, Level IV

Special Hazards Suppression Systems, Level II

Certified Fire Protection Specialist CFPS # 4603

CETRACI "Diseño de Sistemas Básicos de Rociadores Automáticos CI" # 501152

Evaluador CETRACI # 501149

CEMACI "Inspección, Pruebas y Mantenimiento del sistema fijo privado instalado que utiliza agua como medio de protección contra incendios" # 26705123

Evaluador CEMACI # 501149

C-16 - Fire Protection Contractor # 1104012

Mexicali, Baja California.

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VP Business Developer
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