Prof. Ing. Dario Pozzetto

Department of Engineering and Architecture – University of Trieste

Via Valerio, 10 –34127 Trieste – Tel: 040.558.3805 / 7982 Fax: 040.558.3812

E-mail: pozzetto@units.it

INDUSTRIAL PLANTS

Chapter thirty-one:

Piping – Fluid distribution plants – Design of the plants and devices of fire protection

DOUBLE DEGREE MASTER IN

“PRODUCTION ENGINEERING AND MANAGEMENT”

SEAT OF PORDENONE

UNIVERSITY OF TRIESTE

Design of the plants and devices of fire protection

The company considered

The company performs precision machining third parties.
It's specializes in machining by chip removal and works on the production of small and medium series aimed at different markets, including also the automotive market.
The company also carries out the mechanical assembly which, however, have a bearing on the volume of marginal activities. The ATECOFIN classification is as follows: Activity Code 25.62.00, general mechanical engineering.
The plant will be fitted with two saws, five multi-pallet horizontal machining centers vertical four centers, four lathes, three adjustments and other machine tools dedicated to minor odd jobs (drills, grinders).

Design of the plants and devices of fire protection

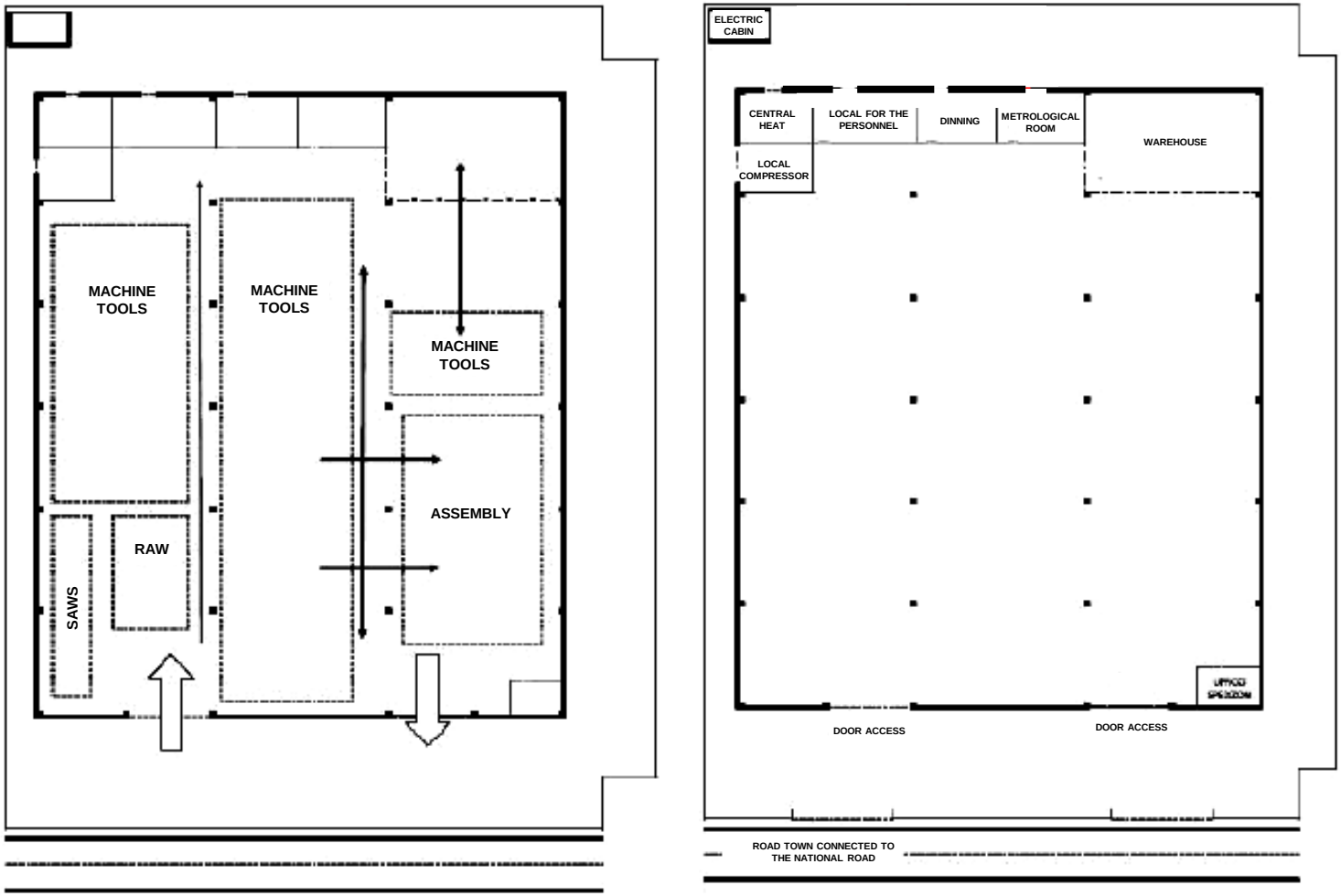
The company considered

The processes are organized by lot, the individual workpieces are unlikely to exceed 50 kg, 100 kg ever, the internal movement is organized on pallets and bins, there is no need a bridge crane, except in the area of saws for operations handling of rough round or billet.

The process flow is as follows: purchase of raw materials and the design details, cutting rough machining processes, heat treatment and surface finishing of parts, assembly, packaging and shipping.

Design of the plants and devices of fire protection

The company considered



Design of the plants and devices of fire protection

External network

The existing rules recommended, for external networks, the use of hydrants at column overground according the UNI 9485, arranged at distances not exceeding 60 m, with a covered area not more than 1000 m^2. The network must be located between 5 and 10 m from the building.

The supports of the pipes must be able to withstand the axial stresses and transverse in dispensing phase. Each log shall be supported, with the exception of the lower stretches to 0.6 m, and the ups and downs of less than 1 m. It requires a maximum distance between the supports less than 6 m.

Design of the plants and devices of fire protection

External network

It is planned the pressure port for fire truck of the type in figure

Typical connection for fire truck

Legend:

1 – Attacks DN 70 with walker (one or more)

2 – Safety valve

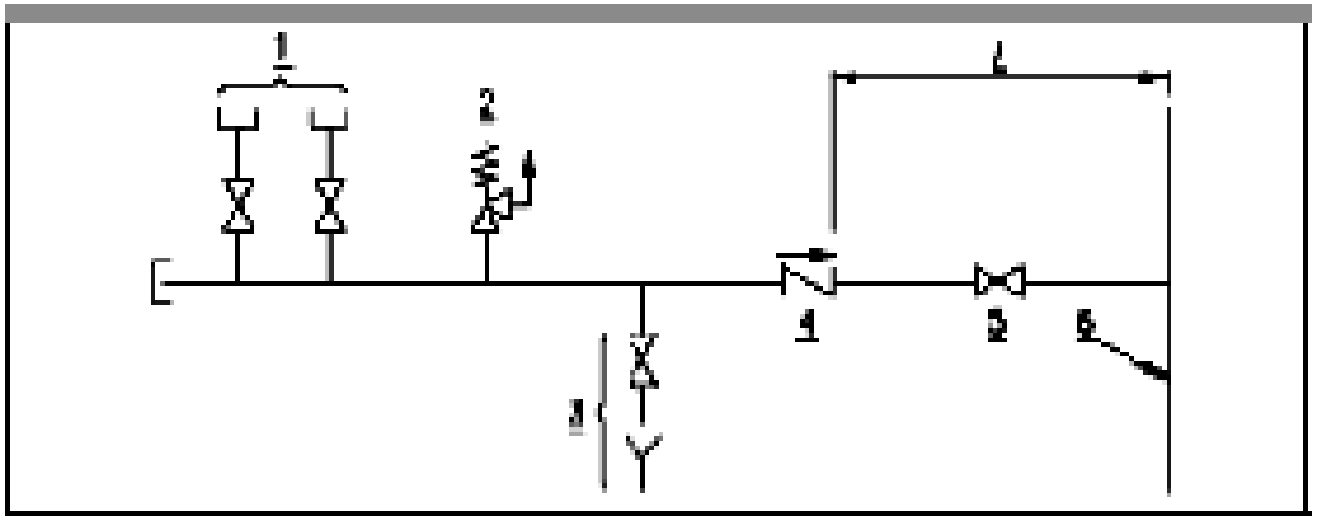
3 – Automatic drainage device (required if there is problem of frost)

4 – Check valve

5 – Valve (normally open)

6 – Collector

7 – Trait of variable length as required, to protect against freezing, if necessary



Design of the plants and devices of fire protection

External network

The first step is to dimensioning the network.

The number of fire hydrants required is calculated according to:

a) of the area to be protected

The protected area is equal to:

$$90 \times 70 = 6300 \text{ m}^2$$

Since the area to be protected from one hydrant is equal to 1000 m^2, the number of hydrants to consider is equal to:

$$\frac{6300}{1000} = 6{,}3 \quad \textbf{hydrants}$$

Design of the plants and devices of fire protection

External network

The first step is to dimensioning the network.

The number of fire hydrants required is calculated according to:

b) the maximum distance between two fire hydrants

The perimeter to be protected is equal to:

$$2 \times (90 + 70) = 320 \text{ m}$$

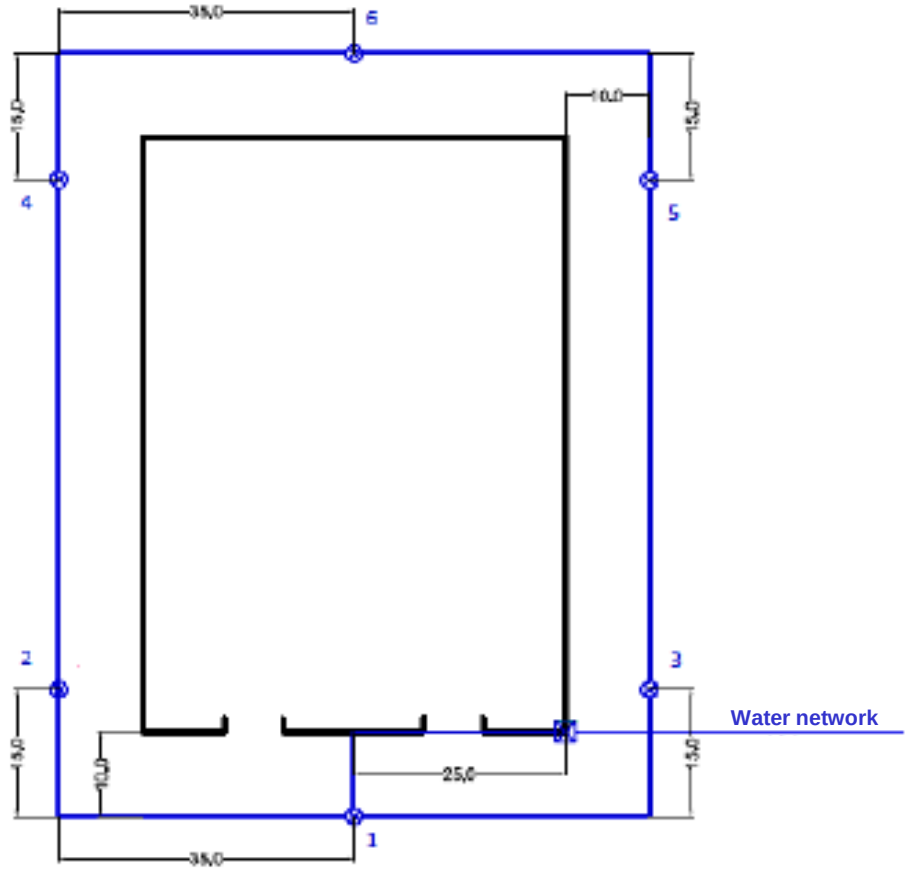
Since the minimum distance is 60 m, the number of hydrants to consider is equal to:

$$\frac{320}{60} = 5{,}3 \quad \textbf{hydrants}$$

Design of the plants and devices of fire protection

External network

Placing 6 hydrants DN 70, powered by a pipe with a nominal diameter d = 80 mm



External network

The minimum capacity of each hydrant shall be calculated according to the relation:

$$Q_{idrante} = k \cdot \sqrt{p} = 150 \cdot \sqrt{4} = 300 \ \ dm^3 / \min$$

Referring at hydrant farthest from the attack, the total pressure losses are the sum of those continuous and those concentrated. These are expressed in terms of equivalent length according to the relation:

$$L_{eq,ext} = k_{incrocio\ a\ T} + 25 + k_{gomito} + 10 + k_{incrocio\ a\ T} + 35 + k_{gomito} + 90 + k_{gomito} + 35 = 200{,}31 \ \ m$$

having place:

k_{gomito} = 0,77 m

$k_{incrocio\ a\ T}$ = 1,5 m

External network

With these data it calculates the pressure drop in the network according to the formula Hazen-Williams:

$$\Delta p = 0{,}65 \cdot 10^8 \cdot \frac{L_{eq,ext} \cdot Q_{idrante}}{C^{1{,}85} \cdot D^{4{,}87}} = 0{,}65 \cdot 10^8 \cdot \frac{200{,}31 \cdot 300}{120^{1{,}85} \cdot 80^{4{,}87}} = 0{,}30 \ \ bar$$

with:

C = constant for the type and condition of the pipe, which pipe is made of galvanized steel = 120

D = internal diameter of the pipe = 80 mm.

The pressures for dimensioning the network will be:

p_{max} = 12 bar

$p_{min} = p + \Delta p + \Delta p_{idrante} = 4 + 0{,}35 + 0{,}3 = 4{,}65 \cong 5$ bar

with:

$\Delta p_{idrante}$ = pressure drop inside the hydrant that can be detected by the regulations or, if not known, it takes a standard value of 0,3 bar.

Design of the plants and devices of fire protection

External network

The volume of water required V_{ext} is equal to:

$$V_{ext} = \textbf{Number hydrants} \cdot Q_{idrante} \cdot 60 = 6 \cdot 300 \cdot 60 = 108000 \ dm^3 = 108 \ m^3$$

Internal network

The internal protection is entrusted to systems and automatic sprinkler UNI EN 12845 (are composed of one or more service pumps driven by electric motors or Diesel), instead of hydrants wall. The scope of the project is the same, that is 225 dm^3/min.

The plant is subjected to a slight danger L_H, which is an activity with low loads of fire and low combustibility, with a fire resistance of at least 30 minutes.

For the covered area of the plant is sufficient a control station according to EN 12259-2 or EN 12259-3, with bell of alarm EN 12259-4.

The maximum sprinkler coverage is less than 21 m^2. As a first estimate the number of sprinkler requirement amounts to:

$$n_{sprinkler} = \frac{70 \cdot 50}{17{,}15} = \frac{3500}{17{,}15} = 204 \ \ sprinkler$$

Design of the plants and devices of fire protection

Internal network

Note the size of the plant, is detected:

- number of rows of sprinkler: 17
- number of sprinklers per row: 12

It must therefore dimensioning the water distribution network towards the sprinklers.

204 sprinklers are distributed in two series of opposing spines, with three dispensers per branch, and a central collector for each. All piping, as in the external network, are galvanized steel.

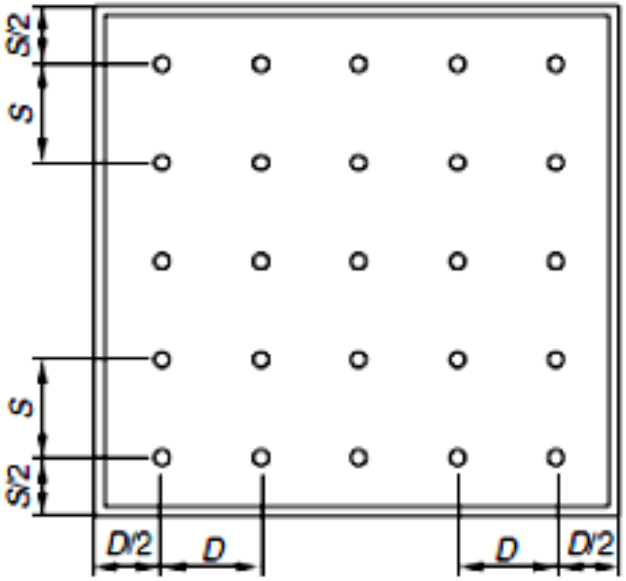
From UNI EN 12845, the diameter of the branches must be at least 25 mm.

Design of the plants and devices of fire protection

Internal network

To adjust the spacing (figure), the distance between each sprinkler must be between 2 m and 4.6 m. On the basis of the fire load reduced plant, were chosen distances equal to:

Spacing of sprinklers on the ceiling
Legend
S distance between sprinklers
D distance between sprinklers



Internal network

The minimum flow rate for sprinklers is given by:

$$Q_{sprinkler} = k \cdot \sqrt{p_{\min}} = 57 \cdot \sqrt{0,7} = 47,7 \ \ dm^3 / \min$$

with:

k = nominal factor = 57;

$p_{min,s}$ = minimum pressure of the sprinkler = 0,7 bar.

The equivalent length of the sprinkler farthest is equal to:

$$L_{eq,ext} = k_{incrocio a\ T} + 50 + k_{gomito} + 33 + k_{gomito} + 13 + k_{incrocio a\ T} + 34 + k_{incrocio a\ T} + 10 =$$

$$L_{eq,ext} = 146,04 \ \ m$$

Internal network

With these data it calculates the pressure drop in the network according to the formula Hazen-Williams:

$$\Delta p = 0{,}65 \cdot 10^8 \cdot \frac{L_{eq,\text{int}} \cdot Q_{sprinkler}}{C^{1{,}85} \cdot D^{4{,}87}} = 0{,}65 \cdot 10^8 \cdot \frac{146{,}04 \cdot 47{,}7}{120^{1{,}85} \cdot 25^{4{,}87}} = 10{,}03 \ \ bar$$

with:

C = constant for the type and condition of the pipe, which pipe is made of galvanized steel **=**120

D = internal diameter of the pipe = 30 mm.

The values of the minimum and maximum pressure are:

p_{max} = 12 bar;

$p_{min} = p_{min,s} + \Delta p = 0{,}7 + 4{,}12 = 4{,}72 \cong 5$ bar

Design of the plants and devices of fire protection

Internal network

The existing regulations, for precalculated LH and OH systems, we require a minimum volume of 9 m^3 specific water of the plant at sprinklers. According to the fire load, the volume required is equal to:

$$V_{int} = Q_{int} \cdot 30 = 225 \cdot 30 = 6750 \ \ dm^3 = 6{,}8 \ \ m^3$$

In the further precaution, take as a reference for sizing the water supply 9 m^3 established by the norm.

Design of the plants and devices of fire protection

Additional considerations

The feeds are permitted by law:

- permanent connection with a truncated aqueduct;
- tank or fixed tank by gravity or virtually inexhaustible reserves in an elevated position;
- fixed pump to start automatically connected to the tank or storage tank, or to reserve a virtually inexhaustible;
- fixed tank at pressure.

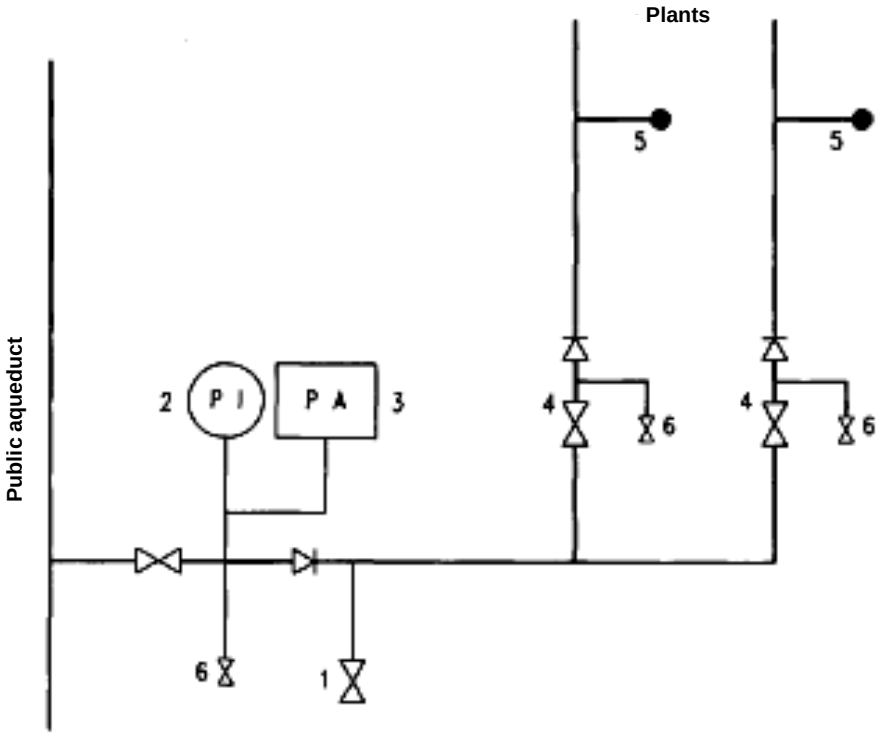
The total volume required by the two networks, external and internal, is given by the sum of the individual volumes:

$$V_{totale} = V_{ext} + V_{\text{int}} = 108 + 6{,}8 = 114{,}8 \ \ m^3$$

Design of the plants and devices of fire protection

Additional considerations

Based on the volume required in the event of fire and the likelihood of the occurrence of a fire, it was decided to entrust power to a fixed connection to the aqueduct. There is also another connection to the public network of the type in figure



1 – Possible attack ≤ DN 40 at use non industrial
2 – Gauge
3 – Pressure
4 – Valves of firefighting plants
5 – Couplings for fire truck (see 4.5)
6 – Tap of probationary

Design of the plants and devices of fire protection

Additional considerations

The aqueduct near the corporate reality assures a flow of 3500 dm^3/s, well above what is required by the plant, for which there is no need to add a collection basin raised, or provide for the installation of a pump system to maintain pressure in the fire-fighting plant.