watercube

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Elements of plumbing

→ Elements of plumbing

00 Introduction

PLANNING THE PLUMBING OF YOUR FOUNTAINS

When building a fountain a lot of hydraulic parts and component will be needed to provide trouble-free operation of the desired waterworks.
This page contains a highlight of the numerous plumbing issues related to a good-quality fountain.

- Chosing the effects - nozzles
- Basin
- Tubing
- Main pressure pipes
- Water supply lines to the nozzles
- Pumps
- Pre-filters and filters
- Calculation systems
- Storage tank
- Splash
- Noise
- Types of animation
- Example of typical fountain projects
- Conversion data

01

Chosing the effects / nozzles

Different types of nozzle will have different features translating into different types of effect. When choosing a specific effect and the related nozzle, the following considerations shall come into question:

Visibility

visual impact of specific effect

Noise & Sound

noise level related to the chosen effect

Wind force resistance

extent of water movement created by the jet

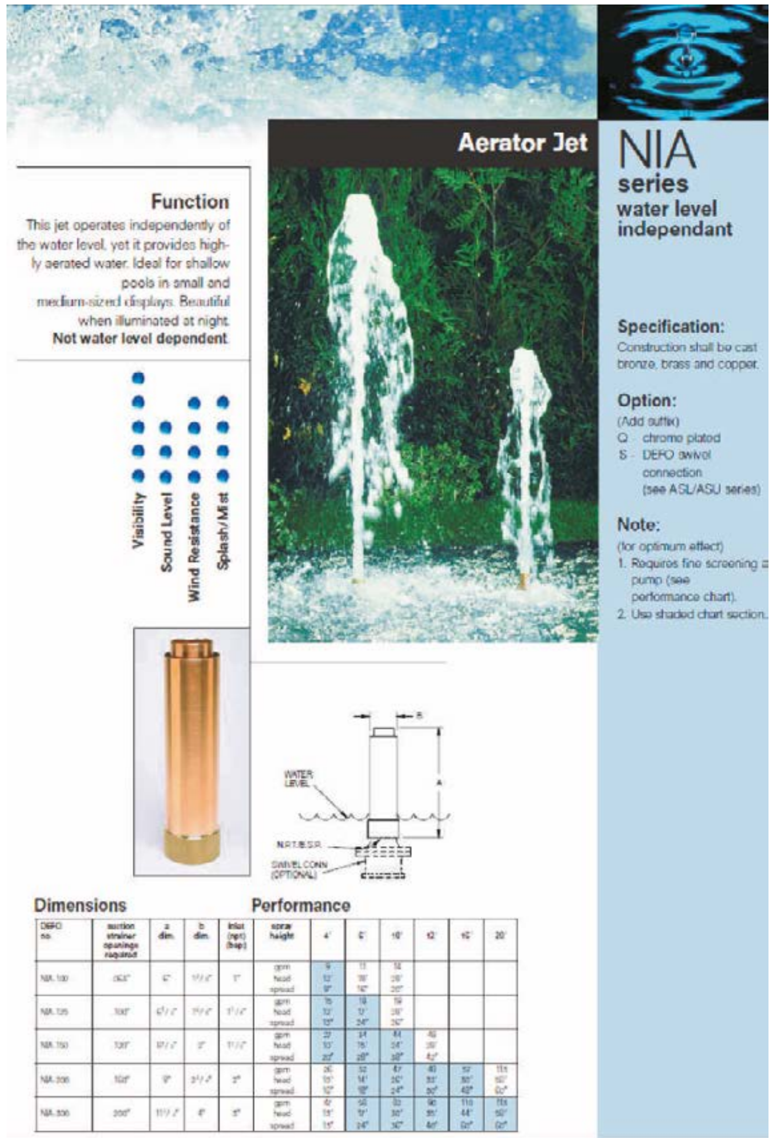
Splash / Spill / Spray

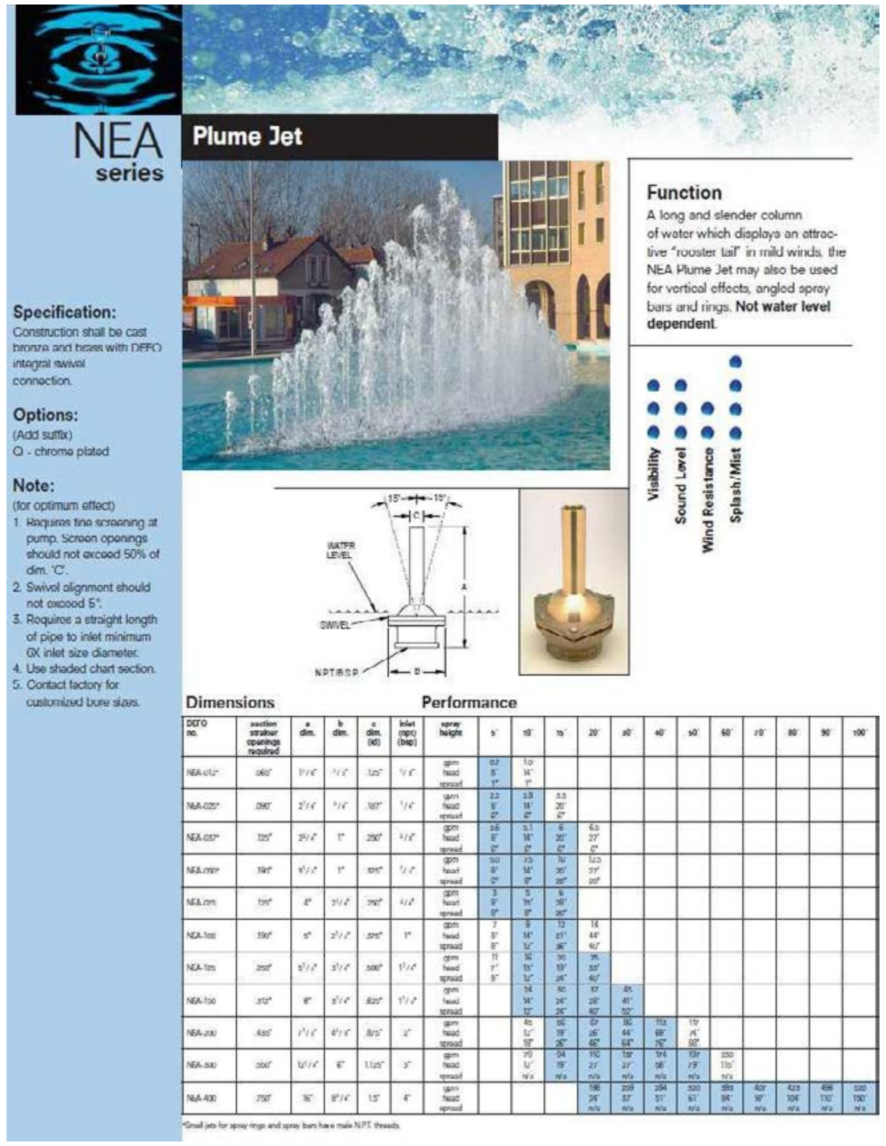
Large-size fountains for outdoor use can handle outstanding, highly visible effects, sounds and fairly strong wind. Indoor decorative fountains will be preferably equipped with nozzles with lower sound levels; it is also possible to install nozzles with low resistance to wind.

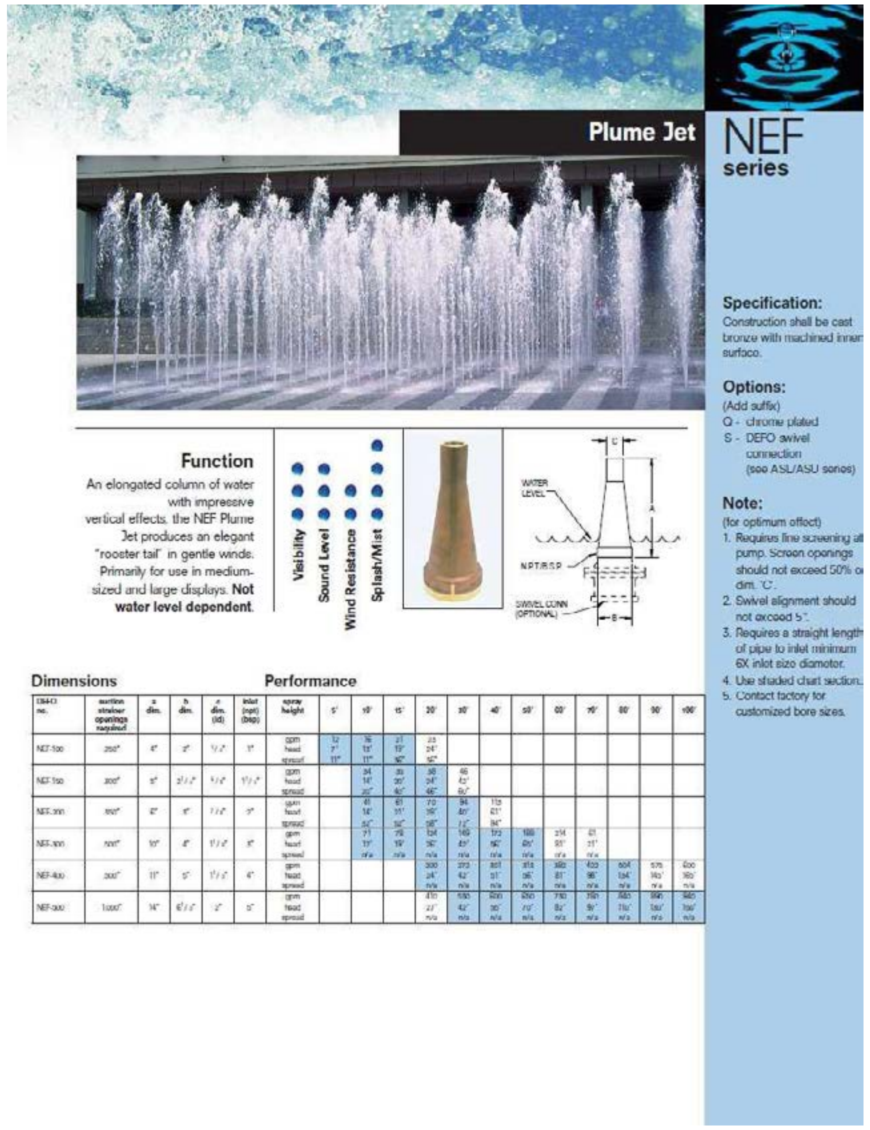
After having identified the desired effect, it is necessary to check the technical specifications and the performance details of the nozzle so as to make the best choice for the required jet height and water consumption.

01

Chosing the effects
/ nozzles







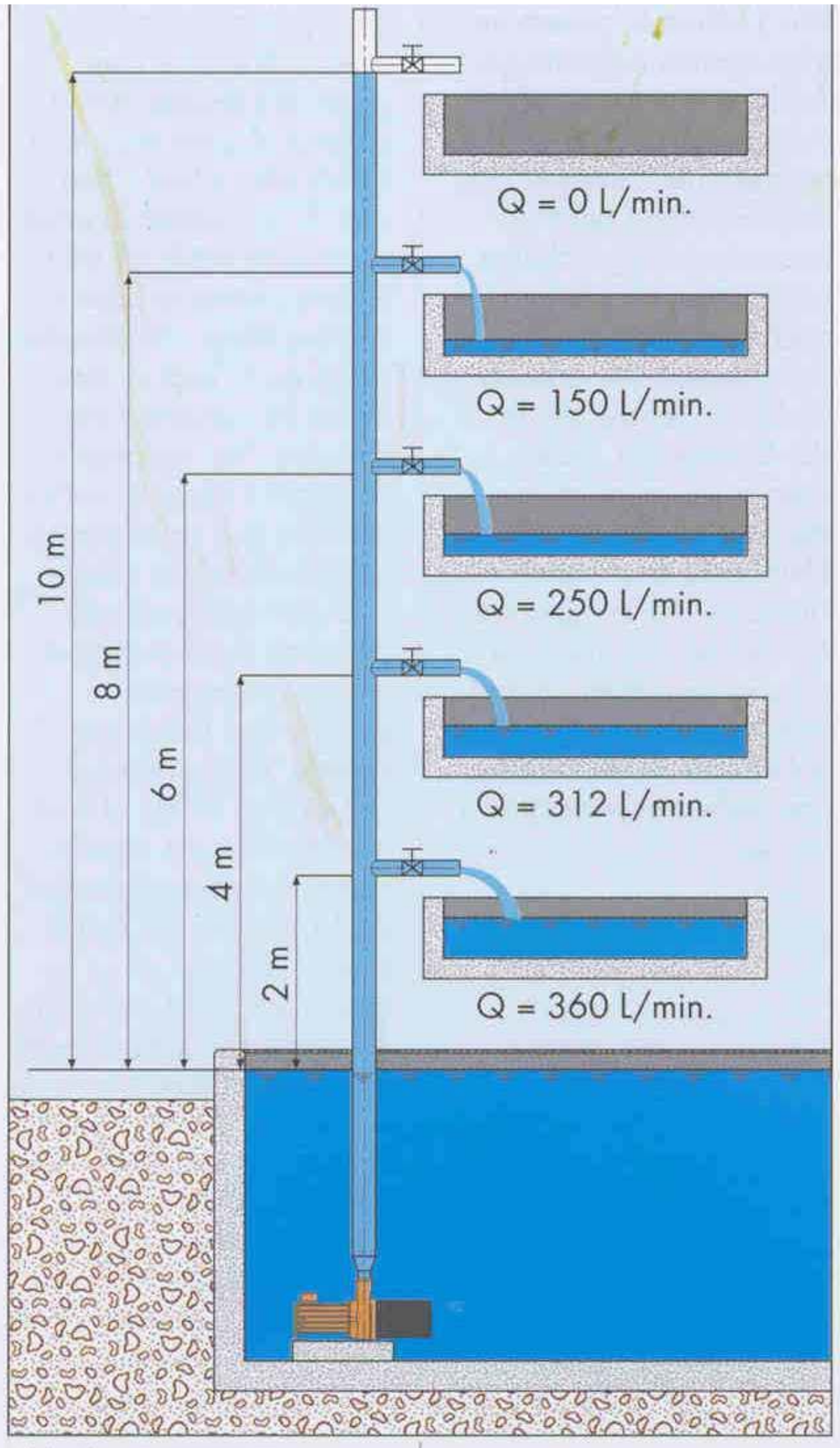
01

Chosing the effects
/ nozzles

The main features of a nozzle are:

- **JET HEIGHT (spray heigth)**
  in feet or meters.
- **CONSUMO DI ACQUA**
  in gpm (gallons per min.) or l/min (litres per min.).
- **WATER-HEAD (head)**
  in feet or metres.
- **WIDTH AT THE BASE (spread)**
  in inches or millimetres.

Starting from the technical specifications of the nozzle, you can calculate the capacity and the water-head applicable for a fountain operation. Care must be taken in designing water-level dependant nozzles from non-dependant ones.



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02

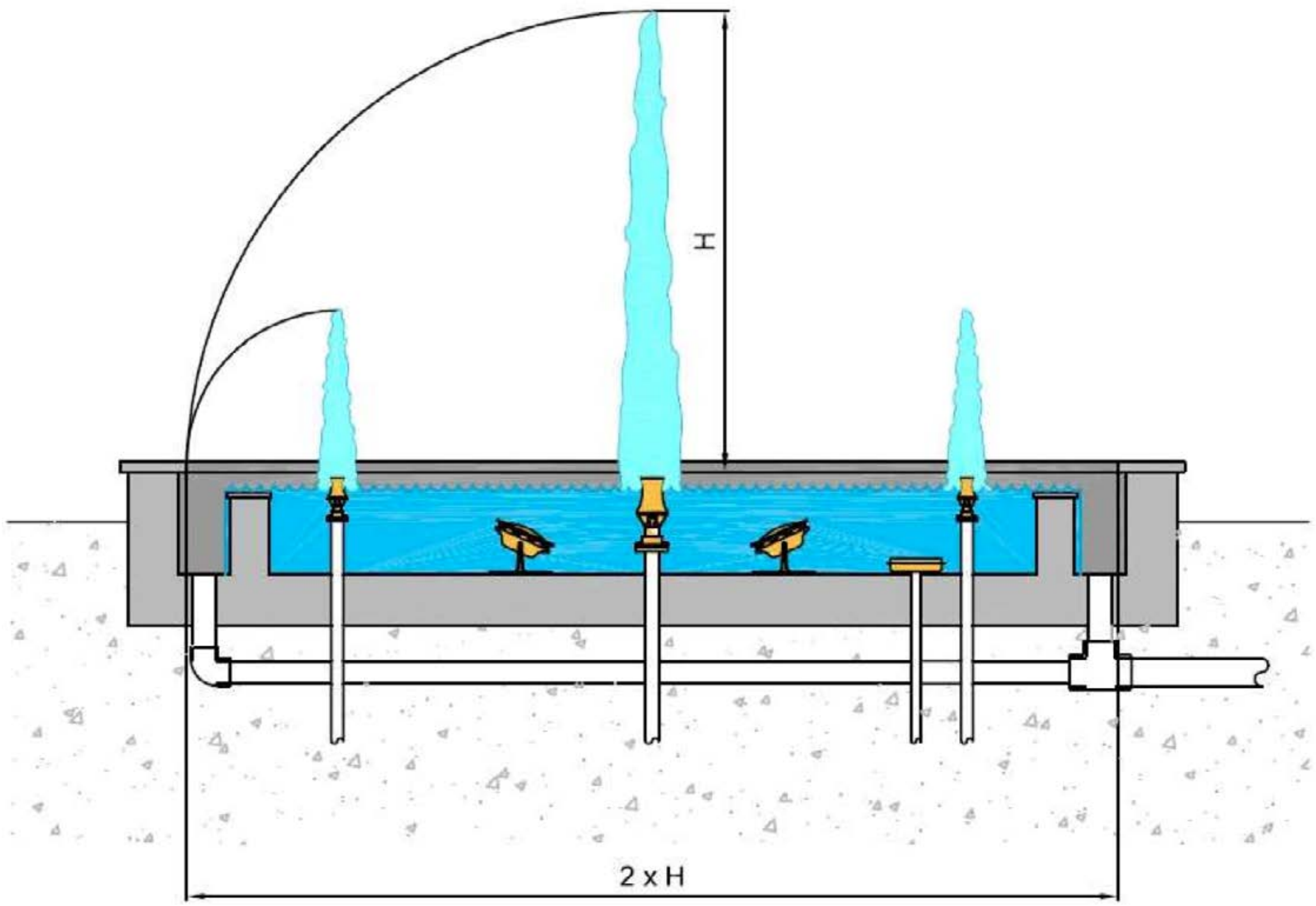
Basins

It is possible to determine the shape and dimensions of a basin depending on the chosen type of effect, or vice versa.

Normally the width of the basin amounts to twice the maximum height that a jet can reach so that water always falls inside the basin without splashing or spilling outside.

A higher jets throw is possible but in this case the jet height will need adjustments depending on wind/weather conditions.

A basin depth shall allow the successful installation of hydraulic components and lighting systems.
Normally a basin depth will not exceed 45 cm.
For deeper fountain basins the same Standards and specifications will apply as for pools.



03

Tubing

A fountain tubing comprises two major families:

- **PRESSURE AND SUCTION LINES supplying water to the effects**

Accurately quantify you load losses before thinking of pressure and suction lines. Load drops within a tube will decrease as the tube diameter increases. Friction loss is caused by turbulence within a tube and its connections. However friction loss will be lower in large diameter tubes.

The diameter of the tubes is calculated based on the required delivery rate. For safety reasons, the following flow rate will be applied:
Pressure lines: Vmax = 1,4 m/s
Suction lines: Vmax = 1,0 m/s

For interactive fountains it is very important to maintain a flow rate of 6.1 m/sec at the lowest nozzle so as to reduce the risk of users' eye lesions and ears injuries.

- **RETURN FLOW AND DISCHARGE LINES conveying water back to the storage tank and discharge water out of the basin, if necessary**

Gravity lines for return flow and drain require a preliminary calculation of the critical gradient to allow conveyance of the water to fountain recirculation.

The gradient of the line will affect the flow and should be so designed as to ensure a smooth return flow. Generally accepted gradients are 1 ÷ 2%.

It is a good practice to install two return lines both for safety reasons and to avoid clogging and obstructions. Moreover, vertical grates should be installed upstream of the lines in order to stop and retain the through-passage of large material likely to cause clogging.

04

Main pressure pipes

Selecting a pipe diameter

- Load losses will decrease for larger pipe diameters
- It is recommended to keep swirling down as much as possible ideally a speed of 0.6 – 1.2 m/sec will so. (if possible 1.2 m/sec)
- High balancing levels are quite hard to obtain inside the main pressure pipe

Design criteria

- The relationship between the width of the main pressure pipe and the width of the lateral supply lines should be of 3 to 1
- For a greater balancing install pipes rings of equal length as the branch pipes

Pipe details

- Laterals should be preferably branched on the upper side so that air may be released easier
- Laterals starting out at the main pressure pipe should be all of equal length

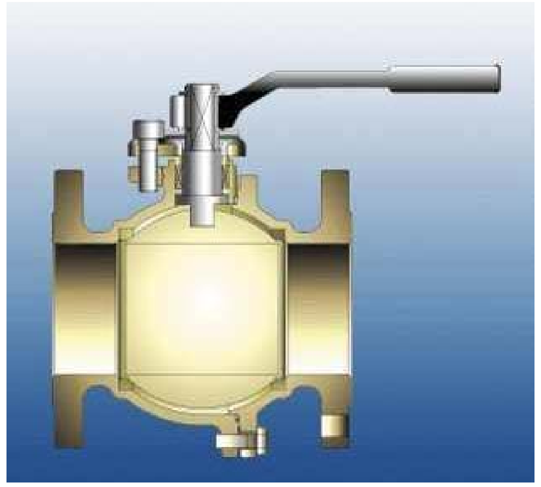
05

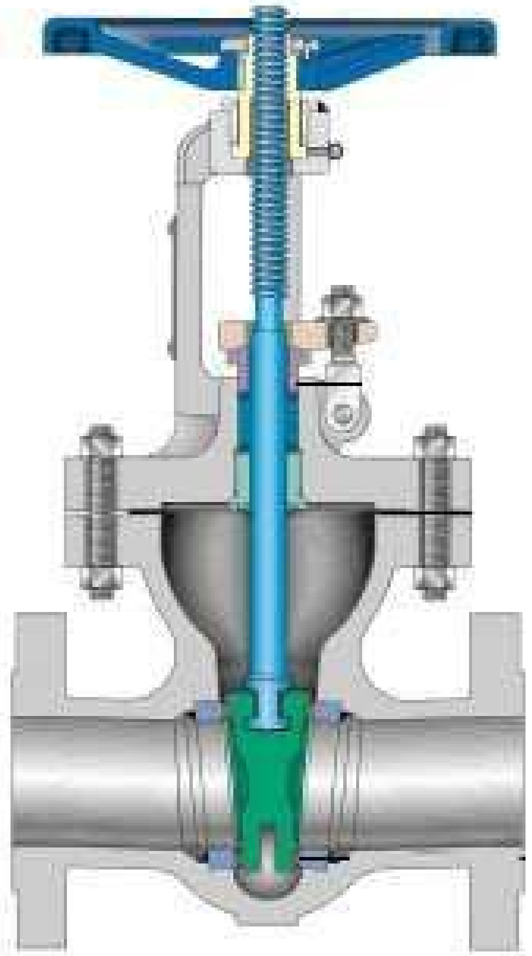
Water supply lines to the nozzles

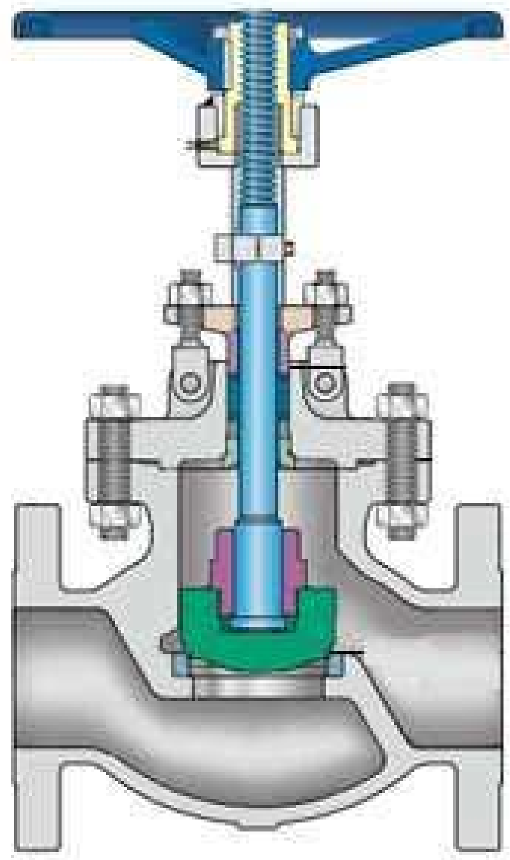
Valves

In order to adjust the various water jets, different types of valves will be installed. As the valves generate turbulence, the nozzle should be ideally placed at a minimum distance from the valves of 5-8 folds of the diameter in order to obtain a clear-cut jet.

- BALL VALVES
  are the best in terms of discontinuance and isolation
- SHUTTER VALVES
  are recommended for best insulation and control of foam fountains
- PLANETARY VALVES
  are the best in terms of control accuracy and a low turbulence. They are mandatory for laminar water flow jets and clear cut plume-jets







Elbows and tees

- Elbows and tees create turbulence
- The nozzle should be ideally placed at a minimum downstream distance from the nearest elbow/tee of 5-8 folds the diameter

A flow stabilizer shall be used to yield clear-cut water jets.

↖ Ball valves

↖ Shutter valves

↑ Planetary valves

06

Pumps
/ type of pumps

Different types of pumps are available to operate a fountain. According to the type of connection of the motor to the pump, any of the following types may be used:

Monolith

with impeller mounted directly to the drive shaft

Vertical line pumps

with suction and pressure ports on the same axis

Submersed pumps

with the motor submersed in water

Base mounted

mounted at the base

Horizontal pumps

↑
Vertical line pump

↑
Monolith

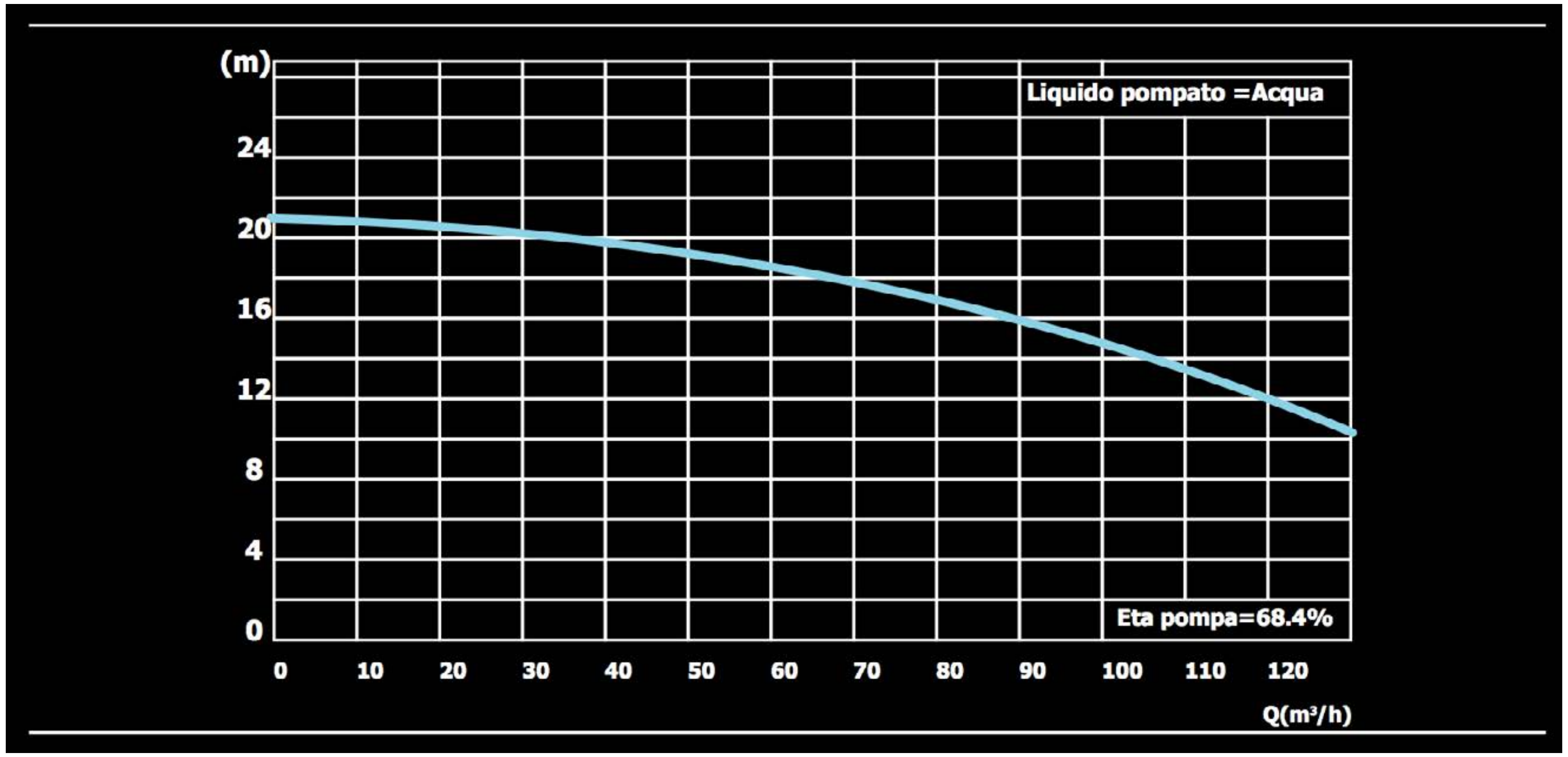
↑
Submersed pump

06

Pumps
/ Pumps typical performance diagrams

Pumps should be basically selected based on their performance diagram supplied by the manufacturer (see typical example here).

A pump of required capacity and delivery head shall be used so that it shall be possible to set operating parameters in the middle of the diagram and obtain a suitable pump operation.



07

Suction filters (pre filters)

Suction filters (pre-filters)

Suction filters (pre-filters) protect the pumps against any rough and bulk particles that may damage the pump.
Some pumps (as the ones for swimming pools) have an inbuilt suction filter.
If your pump has no pre-filter, then you need to install a strainer in the suction line. Some type of protection on the pump suction line is required for submersed pumps too.

Filters

SAND FILTERS are normally used to keep the basin water clean and free from dust and foreign matters. This allows you to concurrently ensure a nice, pleasant look and a long life of the pumps and nozzles at reduced fountain maintenance operations.
If you are to use very small nozzles with tiny orifices, there will no longer need to use sand filters but you may still want to install CARTRIDGE FILTER in the pressure line.

A practical rule for choosing the diameter of the filter mesh of CARTRIDGE filters:

df=1/10 dnozzle

where:
df = diameter of the filter mesh
dnozzle = diameter of the smallest orifice of the nozzle

For proper operation of laminar water jets, filter cartridges with a diameter of at least 5 μ m should be used.

08

Calculation systems

Flow

- All pressure flow capacities of the pressure lines (for nozzles operation or any other flow effects) connected to the pumps shall be taken into account.
- Based on these figures, the relevant flow rates and pipes diameters can be determined.

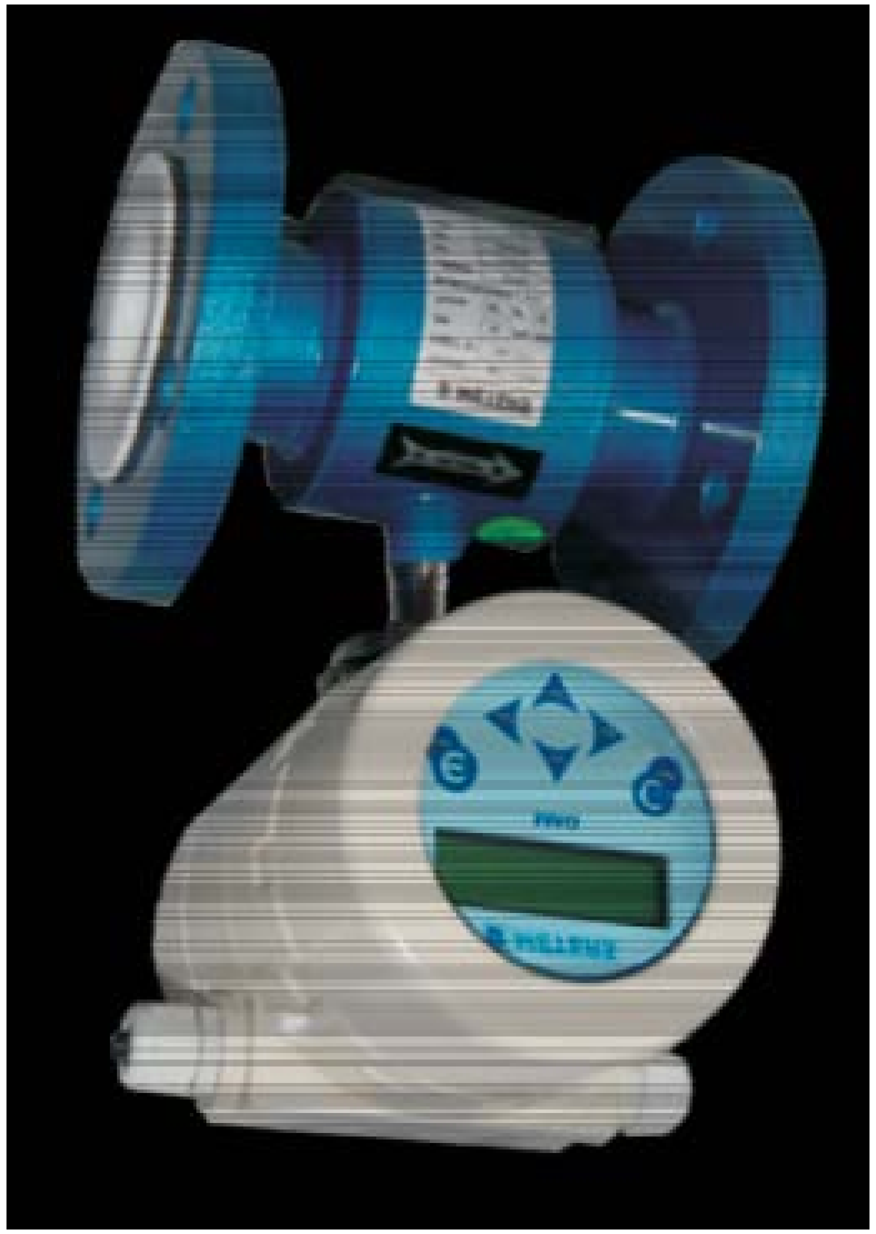
Head (delivery)

In order to calculate the overall delivery head, take into account the following:

- The geodetic head (difference of altitude between the fountain basin and the suction tank)
- The delivery head required to produce the desired effect at the nozzle based on technical specifications of each nozzle
- Reduction of distributed and concentrated loads (valves, elbows, filters,…)

Head (suction)

Duly design the suction pipe accounting for geodetic head and load losses



09

Storage tank

Use of the storage tank

The storage tank is often built next to the pumps room and collects water to be further pumped to the nozzles. When the fountain is switched off, the storage tank should contain the water quantity required to run the fountain effects.

A storage tank is required in the following cases:

- to control the quantity of water coming from various basins
- to operate a fountain equipped with overflow edge (when the water level in the basin reaches up to the basin rim, water is conveyed down to storage tank)
- to operate a dry basin fountain (a fountain where the basin is consistently empty by draining water to the storage tank) so that the effects created by the nozzles become more visible.

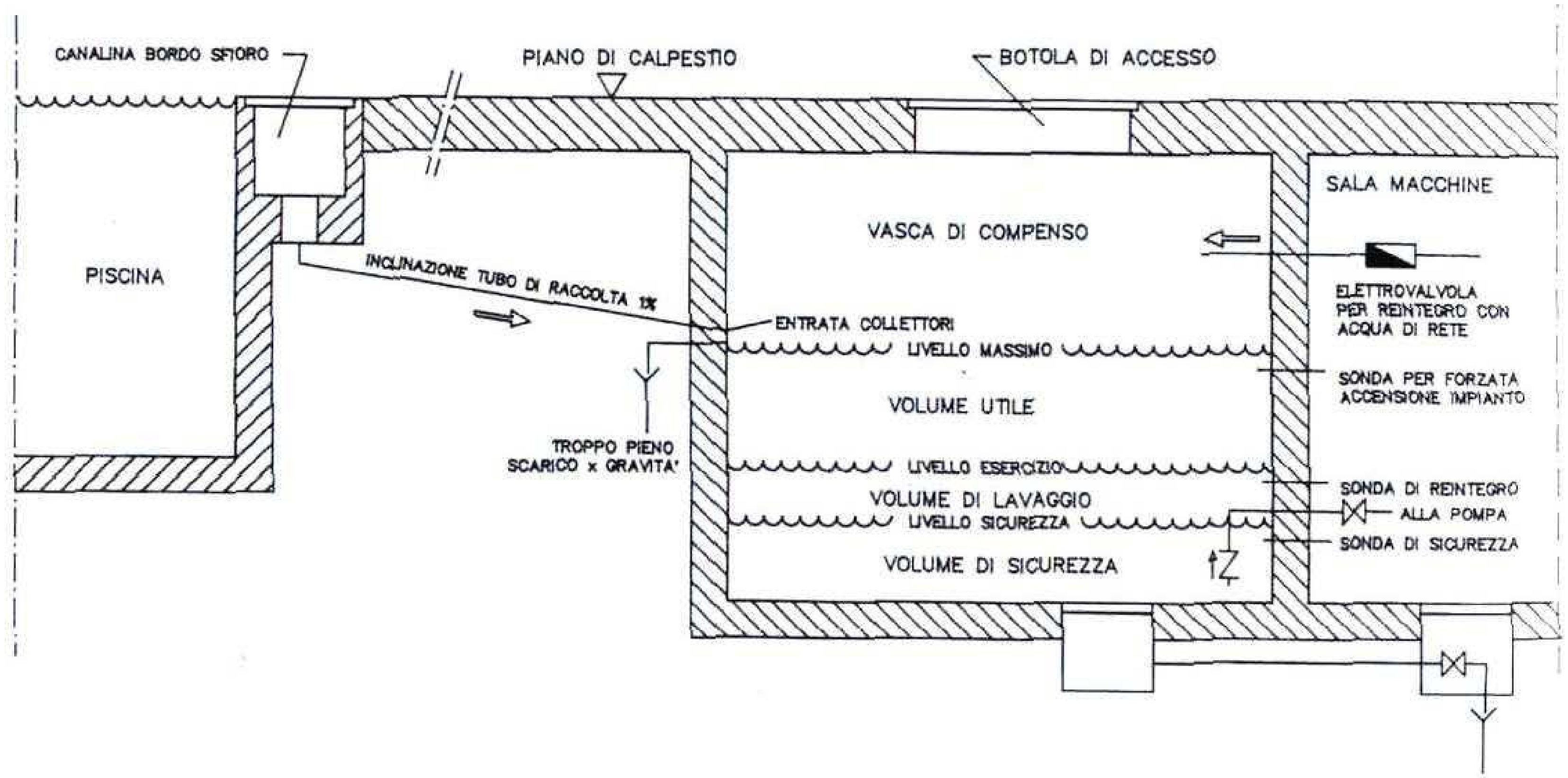
Dimensioning

The size of a storage tank must be accurately designed based on the following parameters:

- quantity of water conveyed to the tank when the fountain is switched off
- the surface of the fountain
- the depth of the tank
- the surface is a critical data
- the total quantity of moving water

Water level control sensors

- storage tanks mostly require three sensors to measure the water level in the tank
- the STATIC LEVEL is the water level when pumps are switched off
- the DYNAMIC LEVEL is the water level when the effects are operating



10

Splash

Splash

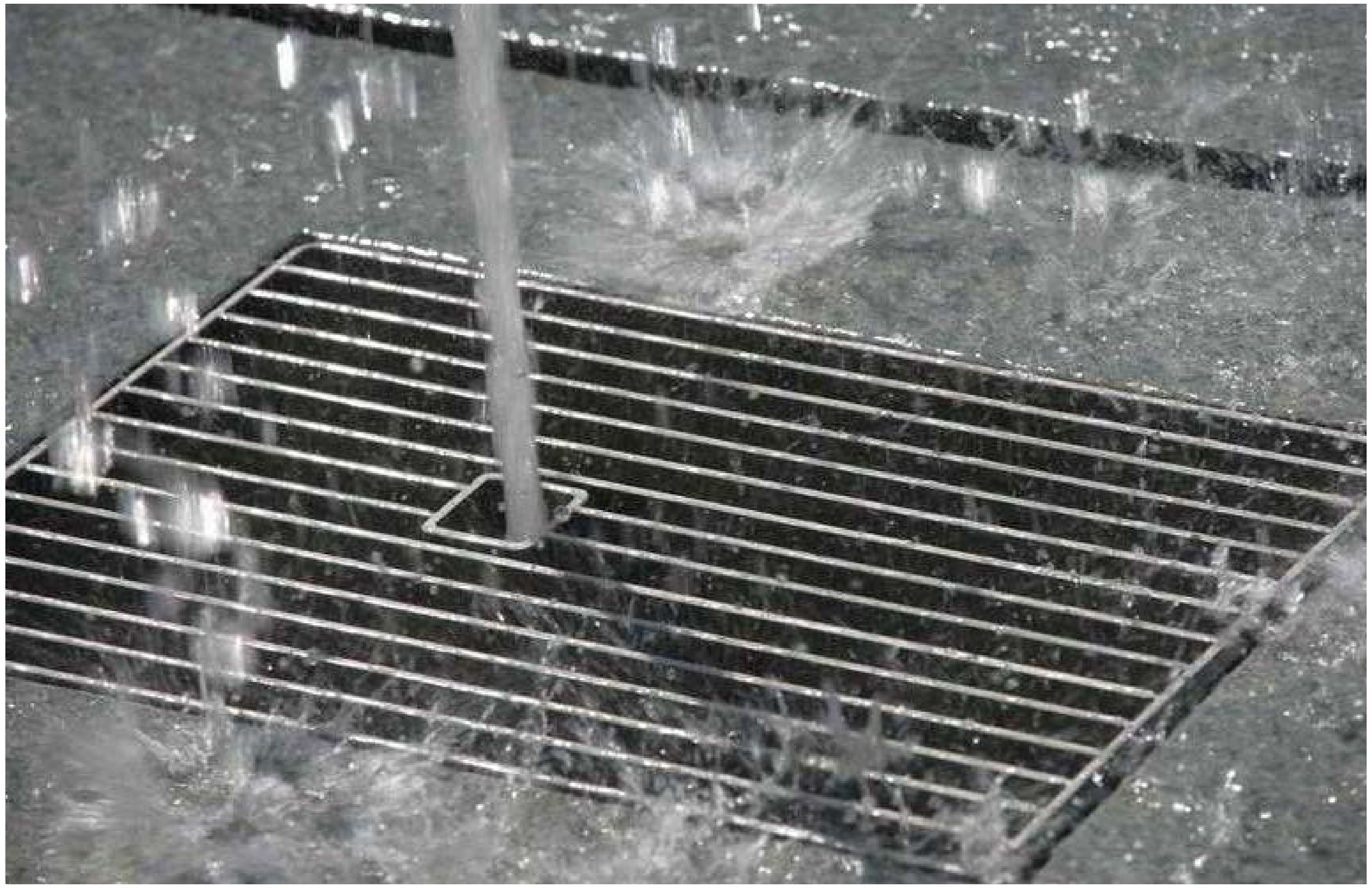
“SPLASHING occurs when water flows and spills where it is not supposed to”. Splashing can occur for different reasons:

- water collides against other surfaces, other objects or other water
- splash may be caused by mist produced by the jets
- splash may be generated by the turbulence caused by the jets

Splash control

The following provisions can help controlling WATER SPLASHING problems:

- carry out an accurate planning of the pressure lines in order to limit the turbulence
- create a soft “landing” surface for the jets by means of aerated water
- install anti-splash devices
- use architectural anti-splash barriers



11

Noise

Rumore

Water sound is a pleasant one. However when sound is not the right one for the type of project, it becomes unpleasant. Noise can be originated by water hitting against other objects or against other water, by the nozzles and by the turbulence of the jets.

Sound control

The following provisions may help reducing/controlling disturbing sound levels in the system:

- carry out an accurate planning of the pressure lines in order to limit the turbulence
- create a soft “landing” surface for the jets by means of aerated water
- install anti-splash devices (i.e. splash pads)
- use architectural insulation facilities
- establish the ambient noise level in the area where the fountain stands

12

Animation types

Numerous devices are available for jets animation:

Valves

- Solenoid valves
- Air-operated valves
- Sealed cylinder valves
- Motorized valves
- Valves with controlled positioning

Special fountain applications

- Waterswitch
- Leaper

Pumps

- frequency shifter (inverter)
- multiple start program

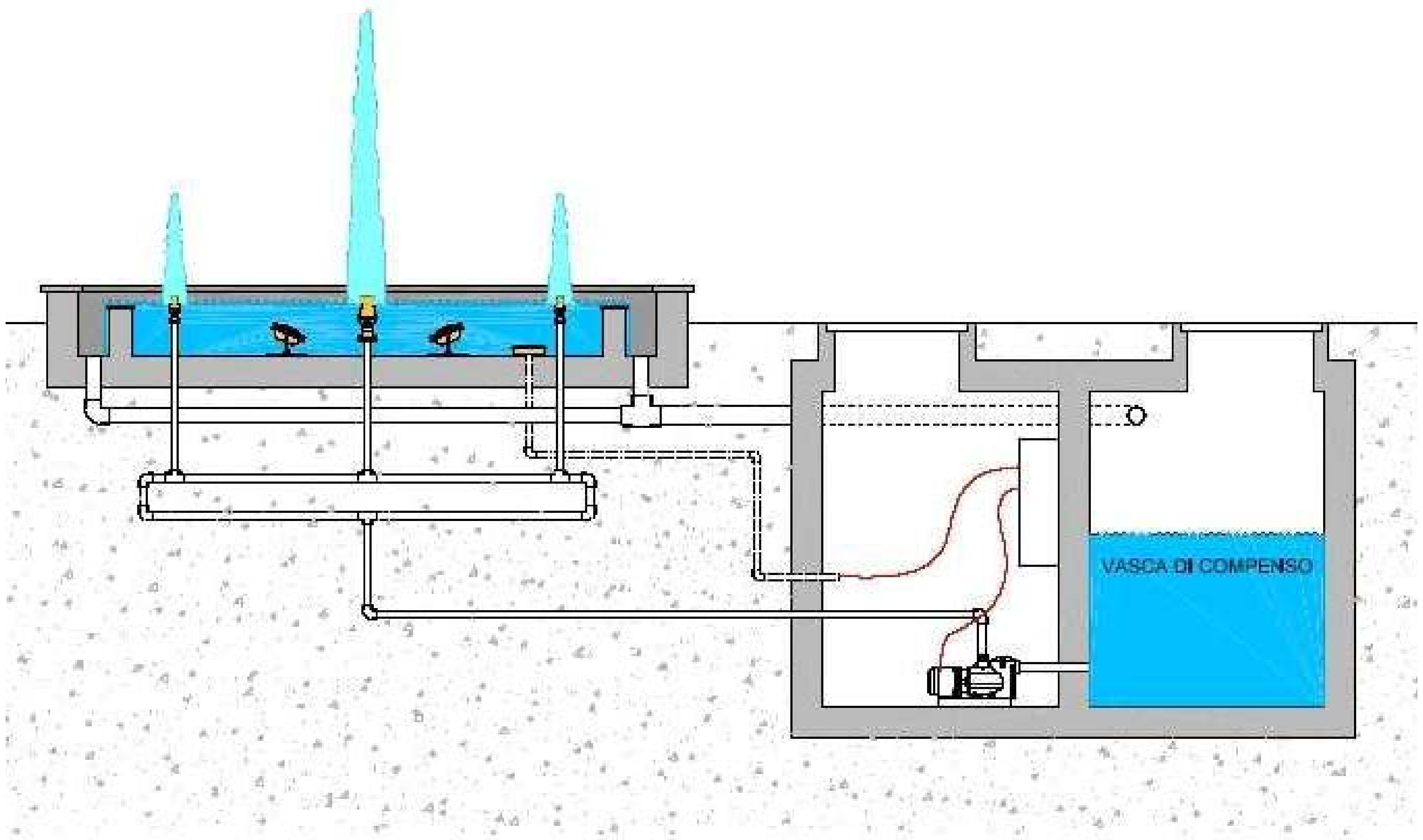
13

Example of a fountain design

For a project as outlined in the following pages:

Fountain with overflow safety rim equipped with 3 nozzles, one return pipe to convey water out of the basin into a storage tank from where water is recirculated through a pressure pipe.

Assuming you want a central jet to throw as high as approximately 6 m and the lateral jets to spray to approximately 2.5 m.



13

Example of a fountain design

Type of nozzles

2 NAE 150 Aerator Jet
1 NAE 300 Aerator Jet

H: geodetic delivery head, 1.5 m

Based on technical specifications the performance of the nozzles is the following:

Type of nozzles	Jet height [m]	Capacity [l/min}	Delivery head [m water head]
NAE 150 Aerator Jet	2,4	106	9,8
NAE 300 Aerator Jet	6,1	556	12,8

Total capacity: *Q=2x106 [l/min]+1x556 [l/min]= 768 [l/min] = 46 m3/h*

Delivery head: *H=h+12.8+Hperdite of cargo =1.5+12.8 +12.8x15% = 16.2 m*

Perdite di carico =*1,5+12,8 +12,8x15% = 16,2 m*

Load losses: a load was assumed amounting to 15% of nozzle delivery head to globally account for pumps wear out, loss of efficiency, concentrated leaks (filters, elbows, tee) and leaks distributed along the pipe and pipe degradation (a specific report will be released about load loss).

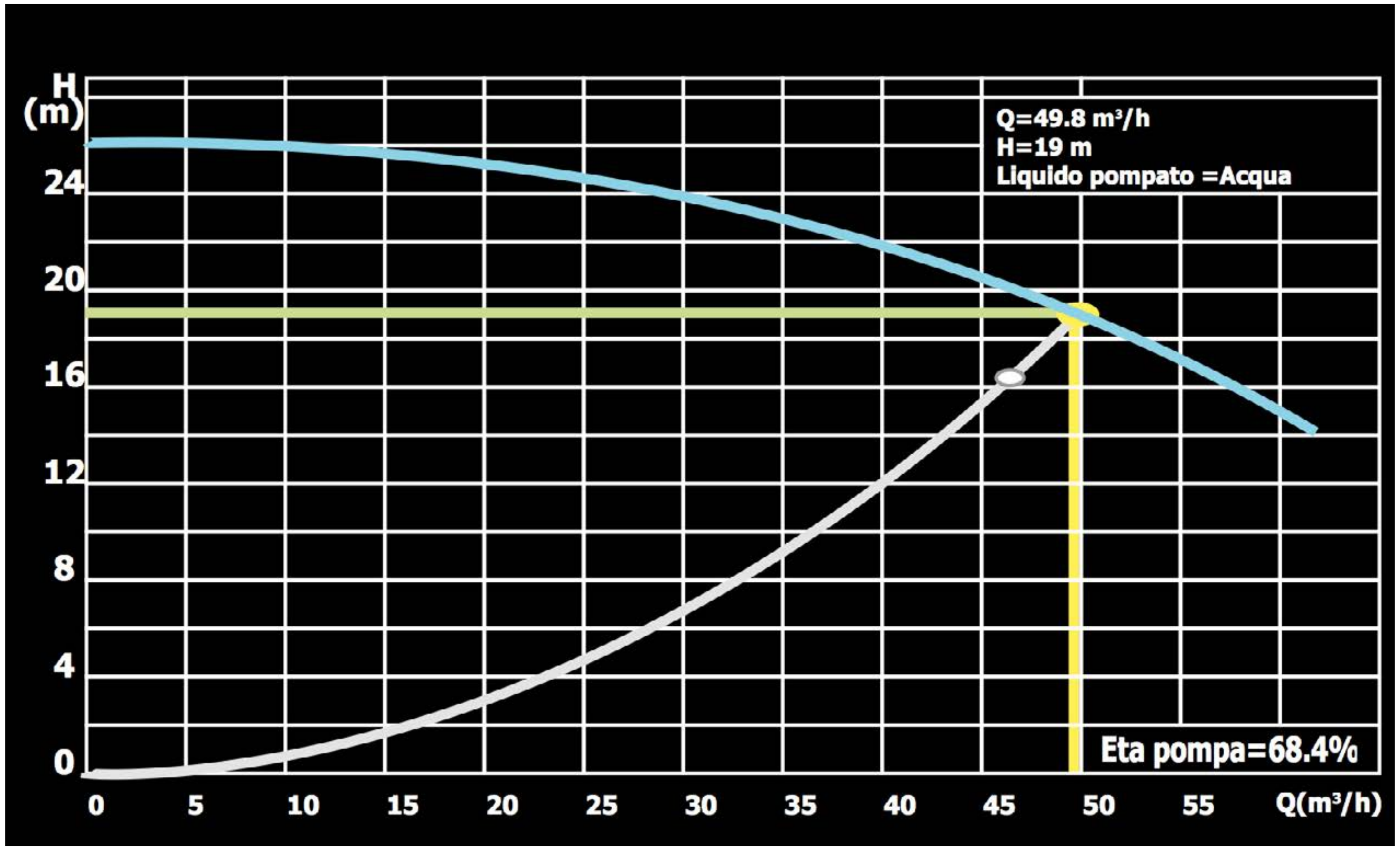
13

Example of a fountain design

Pumps

Pumps shall be selected considering a capacity Q =46 m3/h and a delivery head H=16.2 m.

A pump was selected with the following characteristic curve.



13

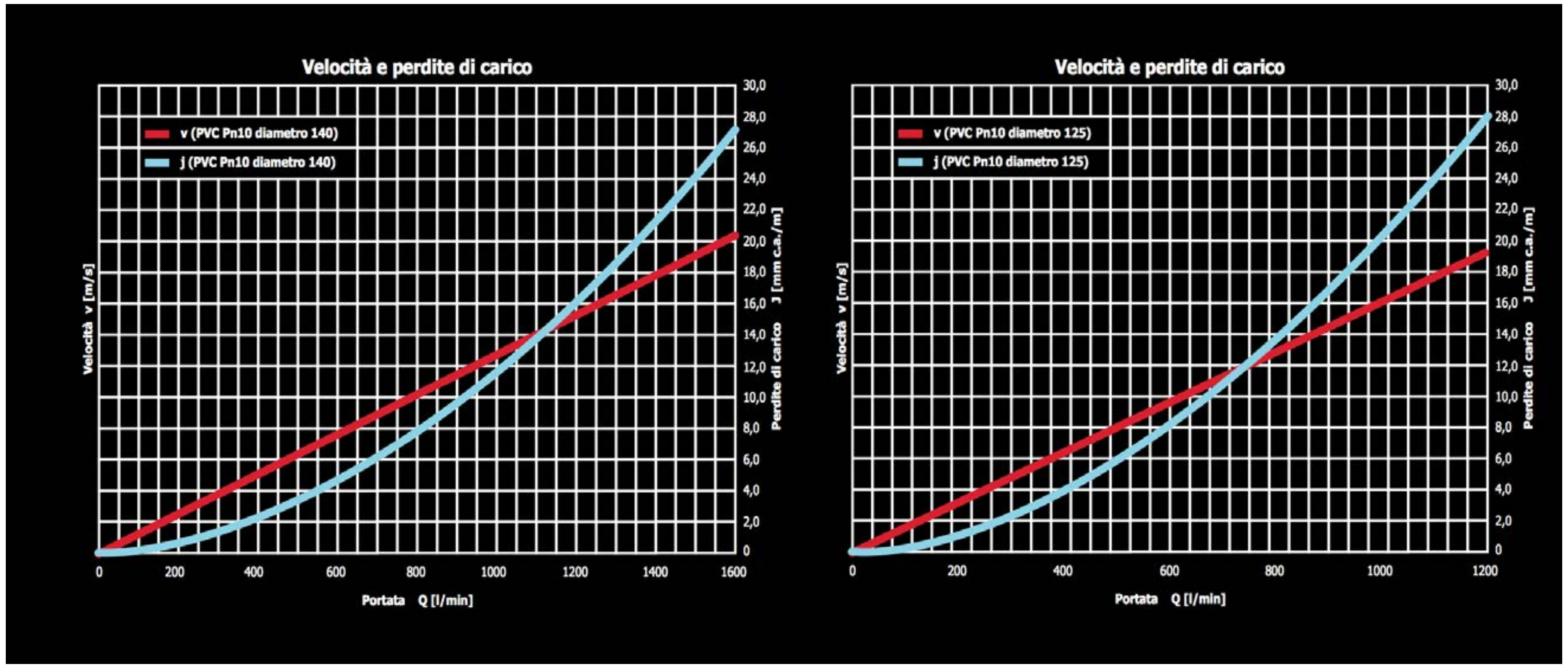
Example of a fountain design

Suction and pressure pipes

Considering a suction speed of 1.0 m/sec, a suction pipe diameter ø 140 mm is calculated based on the “flow rate/load loss” table for PVC pipes.

Accounting for a maximum delivery speed of 1.4 m/sec, a pressure pipe diameter ø 125 mm is calculated based on the “flow rate/load loss” table for PVC pipes.

The aforesaid tables have been laid out using the DATEI-MARZOLO formula for PVC tubes with inside diameter int > 47 mm



Return pipe

Based on the GAUCKLER-STRICKLER formula for PVC tubes, assuming a gradient of 2% and a pipe filling of 60% , a PVC return pipe diameter ø = 160 mm may be used to handle a flow rate of 768 l/min. Alternatively 2 return pipes each of 125 mm diam. may be used in accordance to Section 3.

14 Conversion table

Grandezza	Unità di misura	Unità di misura
Lunghezza	["] Pollice	[m] Metro
	1	0,0254
	['] Piede	[m] Metro
	1	0,305
Pressione	[psi] Poundsquareinche	[bar]
	1	0,069
	[bar]	[m c.a.] Metro di colonna d'acqua
	1	10,198

Grandezza	Unità di misura	Unità di misura
Portata	[gpm] Gallons per minute	[l/min] Litri al minuto
	1	3,785
Volume	Gallons	Litri
	1	3,785
Potenza	[hp] Horsepower	[Kw] Kilowatts
	1	0,746

Conclusion

This document was drawn up to supply an overview and a general aid to fountain designers. Our technicians are available to answer any further question you may have and help you realize a properly functioning fountain.

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