watercube

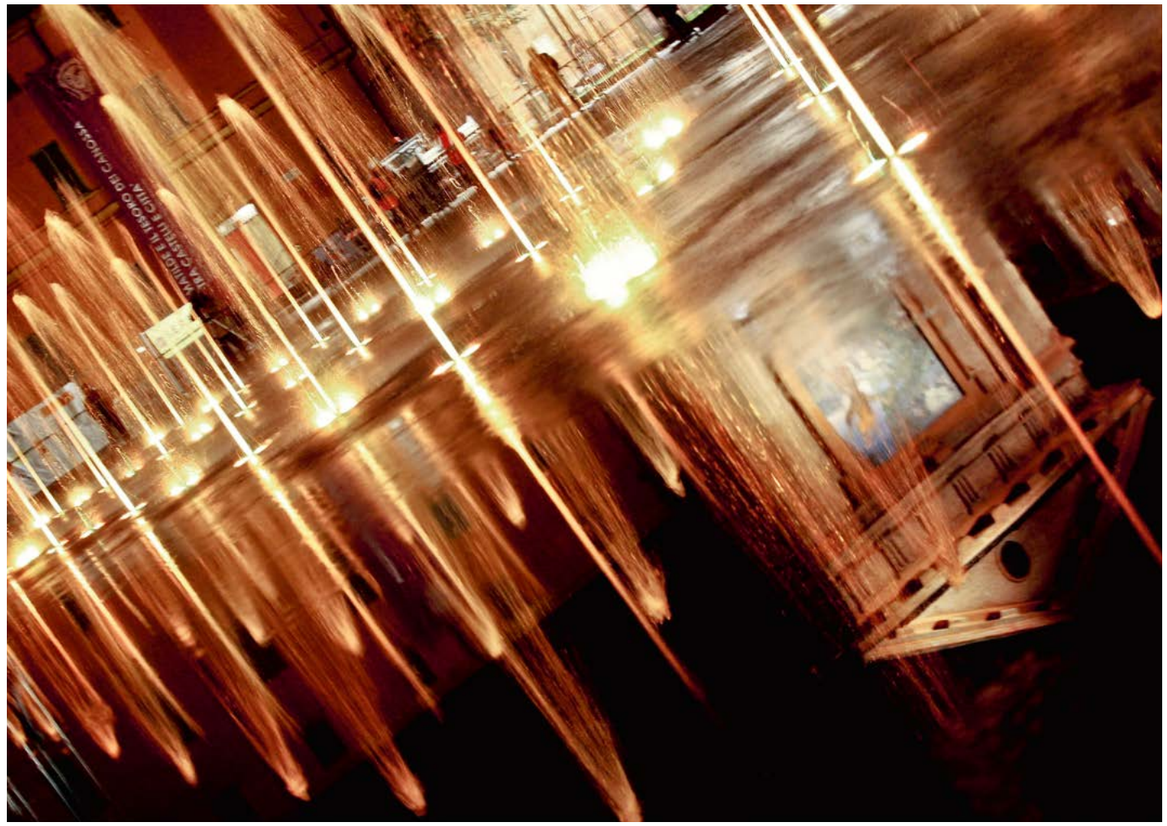
Elements of architecture

01

Introduction

At Watercube we think of water as one of the most interesting elements available in nature. For 20 years we have been using this element to create small and large “pieces of artwork” developing very specific technical components. Our goal here is to transfer the visitor all we know about water works and architecture so that the water architecture of your dreams will come true. This brief paper contains a guide and a list of all major considerations that you need to account for, when thinking of building a fountain. Whether you are setting out to build your first fountain or you are handling a very large and complex project, we are here and happy to back you up with any technical support as you may need from us. The following situations need to be established when you set about your project:

- Climate
- Location
- Size
- Type of required effects
- Maximum level of admissible noise
- Health standards and cleaning requirements
- Maintenance schedule
- Accuracy of water level control facilities
- Applicable wind force (water architectures should never stand in windy areas)
- Schematic design
- Water supply
- Electrical safety
- Accurate flow-dynamics and hydraulic design, engineering of pumps capacity and of pipelines, management of operating pressure, flow control and flow speed design
- Accurate electric design including evaluation of power requirements, management of lights and other utilities, wiring diagrams and electric switchboards
- Budget



01

Project analysis

Modern water architecture can be formal, traditional, organic/ natural, or ornamental. The main challenge is to interpret the expectations of the client and to successfully valorise the site location without any detriment to architectural and technical requirements in order to yield a final project that is feasible and at the same time very attractive and fascinating.
The choice of final effect must be the result of very accurate considerations on the characteristics of the area both in terms of aesthetic impact and functionality. Fountains, pools and water works must interact with the surrounding environment and somehow resemble the geometries and benchmarks of the host area or even become its new identification symbol. Depending on the final project application (attraction point, interactive game, mere decorative etc...), the best mix will be designed as in a special chemistry combining fluidity, movement, sound, reflections and all other typical water properties.

01 Project analysis

Fluidity

Water is an extremely versatile, fluid material whose shape and look are directly dependant on the size, the finish and the location of the container.

Movement

Water can take a static (as in a relaxing pond or pool) or dynamic (as the energy that springs from our creations) movement.

Reflection

Still waters offer a static mirror surface that can be best used to reflect the surrounding environment.

01 Project analysis

Light

Light is the natural complement to water and therefore to any type of fountain or pool. Light valorises water and enhances its choreographic effect notwithstanding the scope of water works. A single water jet will benefit from certain light conditions just as a large waterworks. A well lit water construction can translate a dark water pond into a sparkling mirror. Modern lighting technologies use LED and FIBRE OPTIC to impart water a wide range of colours.

Temperature

At cold temperatures, water changes from its liquid to its solid state and this is when the most important changes take place. Under some particular circumstances, water will freeze forming ice sculptures that will perform very impressively and surrealistically under certain light conditions.

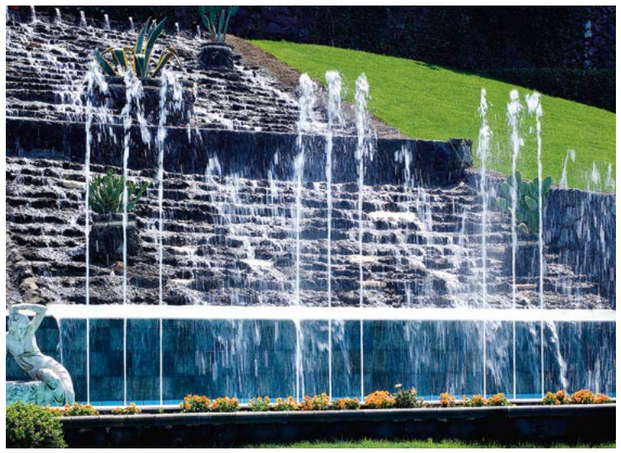
Wind

Wind can mutate water from a flat mirror into a frizzy waved surface. Very high water jets (as compared to the size of the basin) will fall down and tend to tend to spill out of the basin.

01 Project analysis

Incline

Water flows differently on different inclines. Sound intensity and the resulting attracting effect will increase on proportionally greater gradients.



Shape and surface

Water can take different shapes depending on the shape of the basin or container. The same water quantity will perform very quietly in a wide basin but will become more turbulent if confined through a narrow channel. This phenomenon is even more evident when water is forced to flow very slowly on rough surfaces as for instance when flowing down the stairs.

Sound

Sound is one of the water properties that are normally most neglected. Depending on the water volume and the type of movement imparted to water in a system, different sound effects can be yielded. It is very important to give sound the right consideration: a low sound, as of droplets off a tap, can be annoying but similarly a high noise within a small room can be very disturbing.

02

Common fountain types

Floating fountains

This is the easiest and fastest type of fountain as it simply needs to be placed in the desired position in the lake.
The floating construction is designed to ensure throughout firm stability of the fountain on the water surface.

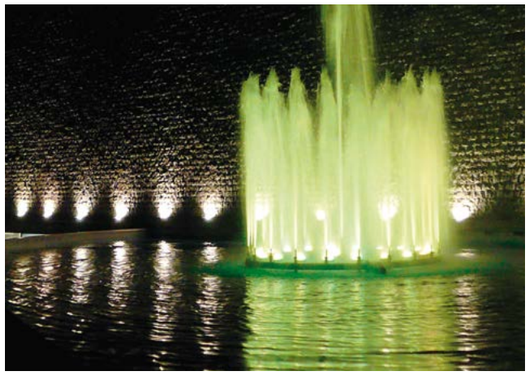
Decorative fountains

This type of fountains includes three major families depending on their most distinguishing construction element: water or architecture (tailoring of the fountain style and structure to the surroundings) or an equal mix of both.

Sequenced fountains

Recent public installations are increasingly featuring advanced technological facilities designed to program special dancing effects on a music rhythm. Individually sequenced water jets are controlled to reach different heights, colours and sounds. These fountains are equipped with control electronics for programming their operation.

Fountains are often built in locations of particular attraction where they are used to separate different areas. Single and multiple jets can be used providing that due illumination and settings are constructed. Most designers act very cautiously in setting the maximum admissible height of a water jet as half of the basin radius where they are directed. In practical cases, this safety rule may prevent the creation of impressive waterworks. In these cases, water elevation can be increased by means of tall elements and statues or, in areas where wind is very limited, a water jet height same as the basin radius may be used.



02 Common fountain types

Cascades and slides

When it comes to impressive waterworks, waterfalls and water walls represent the best opportunities. The power scattered by water with flowing down a surface, produces a remarkable spectacular appeal that can be further enhanced by purposely arranged lighting systems. A variety of materials is available to reproduce a perfect water slide, however slate and marble are recommended for applications at very cold temperatures.

In order to maintain the beauty of the effect, one should also account for formation of any incrustation and possible methods to prevent or remove it. An anti-drip spout shall be installed under every flat slab to prevent water infiltrations underneath the flowing surface. More drains may be provided at the ends of the flowing surface to stop water from flooding adjacent ones.

Tubing and channels

This type of architectures normally involves very dynamic construction designs to attract and force the look into a specific target direction. Tubing must be narrow (usually less than 20 cm wide) in order to compress water and create a feeling of water in motion. In order to achieve maximum effectiveness, tubing shall be as long as possible and cross large water basins. Channels are also long and narrow but on a larger volume scales as they are used to handle large quantities of water.

03

Preliminary technological considerations

The main concept of all fountain technologies is based on moving water to create an effect focusing the attention on the related architectural work. There are three basic considerations belonging to a fountain construction: water source, types of effects and pumps.

- A source of water supply is the first task one should accomplish. If no nearby natural water source is available, suitable provisions shall be made for connection to the aqueduct and related water recirculation and filtration systems.
- After locating a suitable water source, let water run through the fluid circuit and try the different effects.
- After establishing the right type of effects and nozzles, select the related pumping equipment.
- Further construction elements are fountain embellishments and eventual other provisions aimed at simplifying both extraordinary and ordinary maintenance tasks or implementing one or more or automatic functions.

Before moving to describe the structural parts and installation of fountains, it should be noted that hydraulic and electric facilities (tubing, ducts, fairleads and inbuilt accessories) should be duly selected during the design phase and should be compatible with the existing structures. This avoids costly demolishing that sometimes occurs when clients ask us to intervene after they have completed their concrete castings.

04

Fountains structural parts

Shape

the size and the shape of a fountain basin will depend on the fountain effects or vice versa.

Depth

US Standards and regulations provide for maximum 45 cm (18”)-deep water in a fountain. For any greater water depth the same requirement and provision will apply as for pools. A standard construction will normally be 30-35 cm deep in order to accommodate submersed beacons and nozzles. For deeper basins a safety grid is required.

Coating

one of the elements that mainly contribute to a fountain quality is undoubtedly the coating. Based on the type of material used, the coating of a fountain basin will provide a water-proofing performance and at the same time will define the look of the fountain adding a touch of elegance and harmony with the surrounding environment. The choice of a coating is normally subject to aesthetic, technical and economical considerations. The most common materials (sometimes also used in combination with each other) are natural stones, stained glass, ceramic mosaics, reinforced PVC linings, sprayed-on polyurethane and polyurea resin formulations and paints. Among them, natural and bio-ecological stones mostly convey your fountain a clear-cut and a high-quality style while still best fitting the surrounding environment. Although a huge number of fountains has been constructed in marble and stone materials in the past, not all stone materials can be conveniently used for fountains. Granite is no doubt better than marble thanks to its better physical, mechanical and chemical properties. Granites are more resistant and easier to machine even down to a very thin thickness. Marble is more effected by weathering agents and pollutants while granite (silicon-based) will release no dangerous solutions to a fountain installations even if exposed to the eroding water effect. On the contrary marble is a stone containing calcium carbonate and likely to be the direct cause of scaling and incrustations obstructing the pumps, the filters and the nozzles. For the same reason they strongly alter the ph and the efficacy of the cleaning agents. A fountain basin must be flat and smooth to facilitate effective cleaning procedures.

04 Fountains structural parts

Colours

accurate care should be taken in selecting the best colour for each effect. Navy blue, gray and black are ideal to create a virtual depth and to hide any parts and accessories. Brown and yellow should be avoided as they tend to make water look dirty. Green tend to look very artificial and in unpleasant contrast with the surrounding vegetation. Solid colours magnify small faults and imperfections while a maculated finishing and other backgrounds will minimize them.

Height of jets

Most designers act very cautiously in setting the maximum admissible height of a water jet as half of the basin radius where they are directed. In practical cases, this safety rule may prevent the creation of impressive waterworks. In these cases, water elevation can be increased by means of tall elements and statues or, in areas where wind is very limited, a water jet height with a he basin radius equal to 50% of the diameter of the basin may be used. For higher throws an anemometer should be installed to make up for eventual critical situations. Further considerations relate to the level of water mist that is normally considered a very critical factor.

Plant room and storage tank

In the easiest cases, the availability of a plant room in a nearby building provides for accommodation of the pumps, filter, electrical switch box and plumbing controls. Alternatively, an underground plant room may be provided underneath the fountain depending on the type of basin. The type of surface suction (surface skimmers or overflow edge) may require the construction of a storage tank adjacent to the technical room. A storage tank will dually perform: A) to collect overflown water and B) to store water that will be taken in by pumps. For this reason the storage tank needs to be designed with an accurate capacity and size taking into accurate consideration the total water volume required for the various effects and the extra water quantity to be always available in the tank in order to prevent pumps cavitation.

Equally important is the calculation of the water elevation and the incline imparted to the return pipes conveying overflown water back into the storage tank. A gravity drain against overspill should be provided and designed to operate every time when the water level inside of the main basin dangerously raises due to weather precipitations. In this case, an inbuilt overflow safety must drain excess water and covey it into the public sewers or another dedicated drainage tank. Alternatively an independent pumping station must be provided and equipped with own generator to operate even in case of general power blackout. The same level of protection must be provided for the technical room. Pre-fabricated plant rooms of reinforced pre-stressed concrete pre-assembled and delivered on site ready for connection to hydraulic, electric and drainage networks will greatly facilitate the construction of a technical room.

05

Main systems and components of a fountain

Nozzles and tubing

A detailed list of the most popular nozzles available at Watercube can be downloaded from www.watercube.it.
More variants can be obtained by rearranging different nozzles together and combining them to different decorative elements or lights. The generally accepted rule is that a water jet height shall equal the radius of the basin. In order to yield the desire effects, some nozzles must receive non turbulent water while other will require use of a wave suppression device to remove the waves caused by the nozzles especially in round basins. To perform vertical alignment of the nozzles along their axis, either adjustment flanges or levelling studs may be used. Nozzles requiring a very accurate positioning over the water surface level will be affected by the Venturi effect due to mixing of water and air. Watercube staff will be glad to help in the choice of the most appropriate type of nozzle for your application.

Pumps

Pumps are chosen based on capacity and pressure requirements of the various waterworks. Based on the CEI Standards 64.8 submerged pumps may no longer be used (except for very special cases). They have been replaced by 2 or 4 pole centrifugal pumps. All pumps shall be equipped with suction pre-filter. Watercube staff will be glad to help in the choice of the most appropriate type of pump for your application.

05

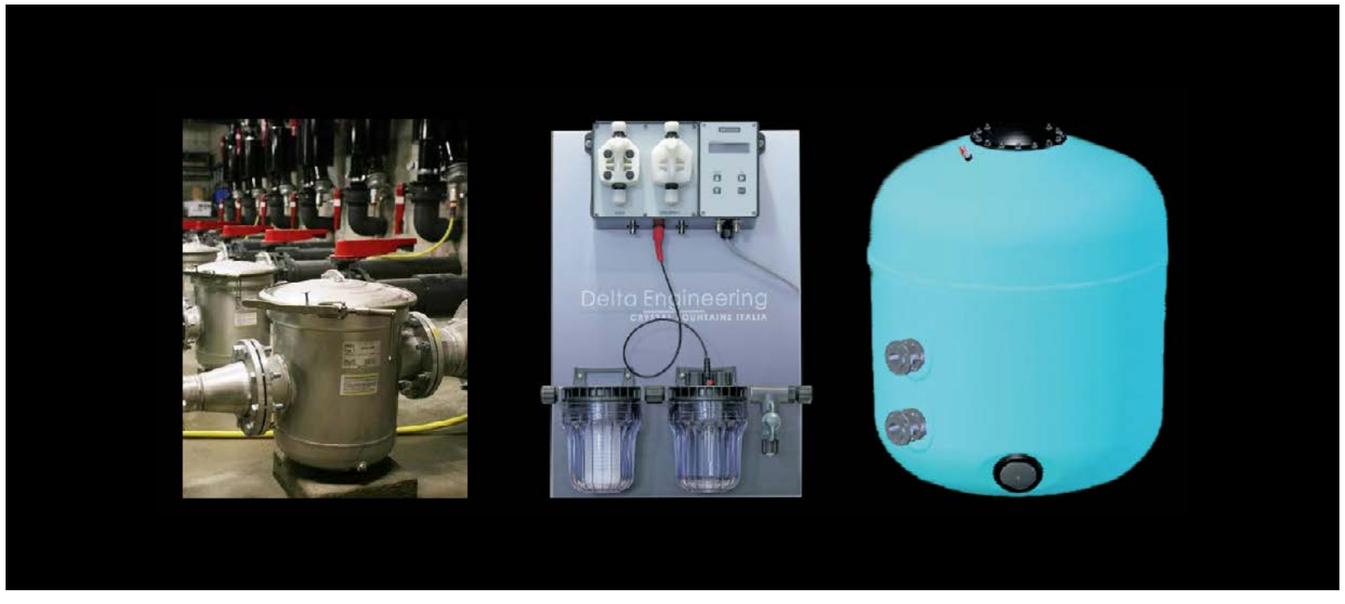
Main systems and components of a fountain

Filtration and water treatment

Water of any pool or fountain requires a proper filtration system to maintain its quality and clearness.
A sand filter will effectively suffice to stop floating dirt, avoid deposits and accumulation of residues on the bottom coating and hence prevent environmental eutrophization. The size of the filters will depend on the water quantity in the basin and by its surface. Filtration of small water quantities (2000 l or less) may be too expensive and not worth the investment. In this case emptying, cleaning and refilling the fountain may be the best solution for small basins. Bacteria and algae will grow and colonize in a fountain without an efficient water oxidation system such as chlorine and the bromine. The same water treatments will apply for swimming pools, pools and fountains, as for instance sand filters, the chlorination, 4-hours recirculation systems and other appropriate recirculation devices. Anti algae agents may be used during normal maintenance operations or pumped into the system by means of a timed pump.

Suction cups and pre-filters

Mechanical filtration is accomplished by means of pre-filters installed on the pumps suction and/or pressure lines in order to prevent damages to the pumps and obstructions of the nozzles. Protection grids may be additionally put in place to avoid large plastic remains or bags obstructing the tubing and damaging the system.



05 Main systems and components of a fountain

Lights and illumination

A well-planned lighting system can set off some very nice evening effects, for instance by illuminating the water jets.
A swimming-pool lighting system is designed for horizontal illumination of the tank and for swimmers' safety. A fountain lighting system is vertical and deals with flowing water.
They are two completely different concepts and are not interchangeable or alternative to each other. One or two beacons are recommended for efficient lighting of the single nozzles. The type and the power of the lamps are determined by the size and the height of the jets. Use of colourful light is entirely up to clients wish.

- In order to illuminate a ring of jets of less than 120 cm diameter, it is recommended to use a submersible lamp with an open parabola.
- When using colour filters, keep in mind that they alter the initial light intensity:
  Amber and cyan filters: 50% more light
  Red: 100% more light
  Blue and Green: 250% more light
  So, when selecting the lights, account should be taken for surrounding light contamination in areas that are over-exposed to the light.
- Moreover, all beacons should be submersed before they are switched on and must be installed by a certified electrician releasing a certificate of compliance. VERY IMPORTANT: homologated fountain beacons are not approved for use in swimming pools and vice versa. The latest Standards provide for use of lamps of 12 V maximum power and a protection level IP68. Safety measures shall be implemented in form of transformers with insulation control device.

05

Main systems and components of a fountain

Switch box

Encapsulated and watertight housings are required for shunting boxes for underground application. The number of cables and sockets in the box obviously depends on the number of illuminants and on the type of electric circuit.

Overflow devices

Overflow devices are to handle excess water in a fountain due to weather precipitations or technical problems tied up to filling operations. An overflow device will make up for both the foregoing conditions. The right position of an overflow device in a wall fountain is exactly on the wall itself. For wall fountains with compensation tank, the overflow shall be obviously placed of the walls of the storage tank. Overflows are designed to hold back the largest residues that may obstruct the drain pipe.

Filling devices

Every basin must be equipped with an automatic device designed to touch-up the water level after water evaporation, water spillage or dispersion by the wind. Automatic touch-up devices can be installed on the walls by means of a special mount or on a pillar. Filling and touch-up devices can be built into the same housing as the overflow.

Fairleads

Tubing through a fountain walls and bottom are the main cause of water infiltrations. Wall fairleads and their membranes provide excellent mechanical properties and wall resistance.

Control panel

A certified control panel shall be provided for electric control and operation of the pumps, the lights, the water level and wind. The panel must be duly earthed and very accurate resistance values shall be provided so that safety of bystanders will be ensured at all times. Remember a fountain is a dangerous combination of water and electric power and safety issues should be your top priority. The panel is also used to accommodate the timers for management of the waterworks controlled by the electric-valves.

06 Basic structures

Some of the basic types of ancient historical fountains have been recently laid off by the latest CEI Directive that basically precludes the certification of these systems to the provisions of Law No. 46-90. However, this is another issue. To read more about it, please visit the “Standards” area.

Construction type A

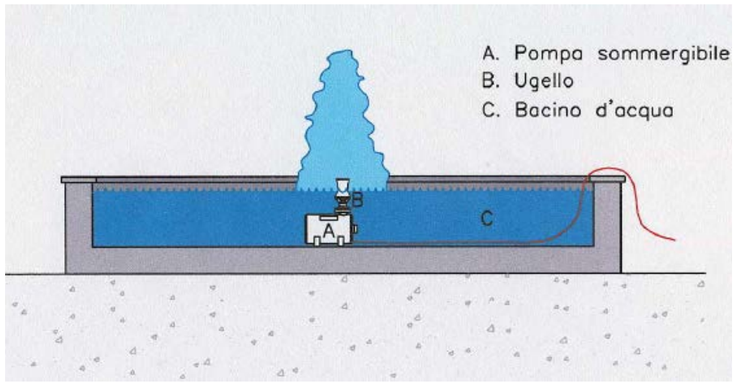
This is most simple free-standing type of fountain, which is placed directly on the ground so that no trenching works are required. The pump is installed on the bottom of the basin while the power cable is conveniently hanged on the outer wall face. This is the lowest cost-option but all electric and mechanical components are exposed. Moreover a great extent of maintenance will be required as this type of function has no filtration facilities.

Construction type B

This solution includes an underground reservoir with a built-in room for the pump and the tubing. This type is definitely more attractive but involves greater construction costs. This system allows the creation of any shape and creative design.

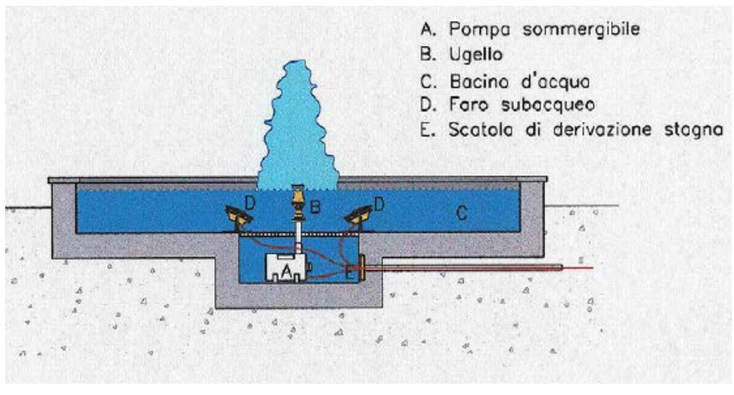
Construction type C

This is a simple type of fountain operated by a dry pump. The basin is placed at floor level while the suction and pressure pipes are pulled in from outside. A plant room with the pumps, the switch box, the control panel and the filters is conveniently set somewhere near the fountain. This is an underground pool-like construction and should be applied for a water quantity of more than 4000 l.



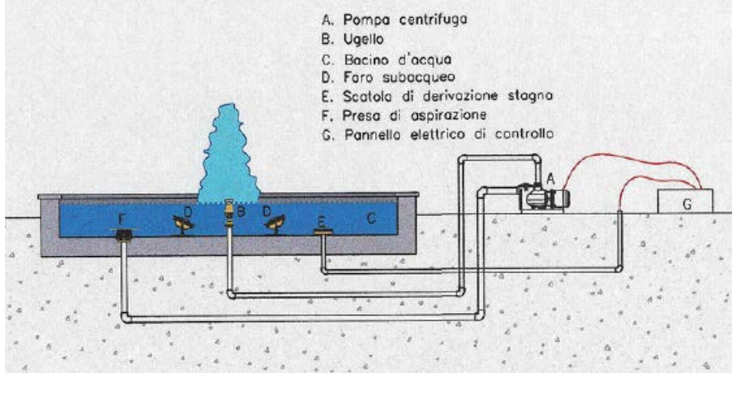
Construction type D

This type is similar to type C however with underground plant room. This makes it a more complex and expensive solution basically used by commercial, industrial and investment contractors and less popular for residential installations.



Construction type E

As in type D with additional overflow edge and compensation tank adjacent to the underground plant room. This system allows maximum design and architectural freedom and still ensures efficient cleaning and dirt removal from the water surface.



07 Summary of the design steps

Step 1

DECIDING WHAT BEST EFFECT SHOULD BE CREATED

Account for extent of your effect as against the basin size, the location and the characteristics of the surrounding environment.

Step 2

ESTABLISHING THE SIZE, THE SHAPE AND THE DEPTH OF THE BASIN

This design step involves some major considerations that are mandatory for best configuration, placement, material choice, plumbing methods and location of the basin based on the environmental traits of the selected location.

Step 3

CHOOSING THE RIGHT TYPE OF TUBING AND PUMPS

The capacity of pump depends on the required type of effect, the height and the pacing of the nozzles, the pipe-work and the valves. Larger fountains are normally equipped with 2 or 4 poles centrifugal pumps. Subject to strict compliance with the applicable safety rules and provisions, submersed pumps should be preferred for less impressive effects due to their lower price and easier installation.

Step 4

CHOOSING THE FILTERS

Water treatment and filtration are crucial functions for any fountain. Most fountains feature a small recirculation circuit with a sand filter, skimmers or overflow edge.
The recirculation circuit should be preferably separated from the waterworks which is especially true for large fountains with variable operating pressures. In order to prevent water eutrophization, use of disinfectants is strictly recommended.

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07

Summary of the design steps

Step 5

DESIGNING AND INSTALLING THE FITTINGS FOR THE PUMPS AND THE FILTRATION SYSTEM; WATER LEVEL CONTROL SENSOR, LIGHTS, SWITCH AND SHUNTING BOXES SHALL BE INSIDE THE BASIN

Anti-vortex devices and water level control sensors for the valves and the filters are often installed on the pressure line. The electric systems include a twilight switch, wind sensors, watertight shunting boxes, timers etc.

Step 6

ASSESSING THE LIGHT REQUIREMENTS

Light shall be arranged to illuminate the key elements of the water architecture establishing the right contrast. Submersed lights shall be installed 5 cm underneath the water level and directed toward the water fall, the water jets ring, the laminar flow jets etc.

Step 7

DESIGNING THE CONTROL PANEL

The control panel shall include provisions for timing the operation of the pumps, the lights and the filtration. Additionally required safeties shall be built in the panel. Account shall be taken for any PLC or DMX units instead of traditional electro-mechanical devices.

Step 8

DESIGNING A PLANT ROOM

Basic fountains with a submersed pump are equipped with a small and easy to install control panel. This is not the case for larger fountains operated by timers, pumps, micros, electric boards, fuses, protections, water treatment and filtration systems and other controls for which a dedicated plant room must be constructed. Plant rooms must comply with ventilation and access standards as well as other reference rules and directives.

Summary of the most common arrangements

The initial concept design shall be followed by an accurate analysis of the construction and management systems:

1. Pumping system including nozzles, swirl diffusers and air blowers in addition to water filling devices and the related valves and tubing.

2. Filtration system to maintain the water clean and treated and a recirculation system including skimmers, pipe emptying , valves and tubing plus the necessary equipment to perform a chemical treatment of the water.

3. Electrical system with water level control sensors, safeties against dry operation, automatic filling provisions, wind control, PLC management, electronic protections, pumps activation devices, waterworks, lights and their management.

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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