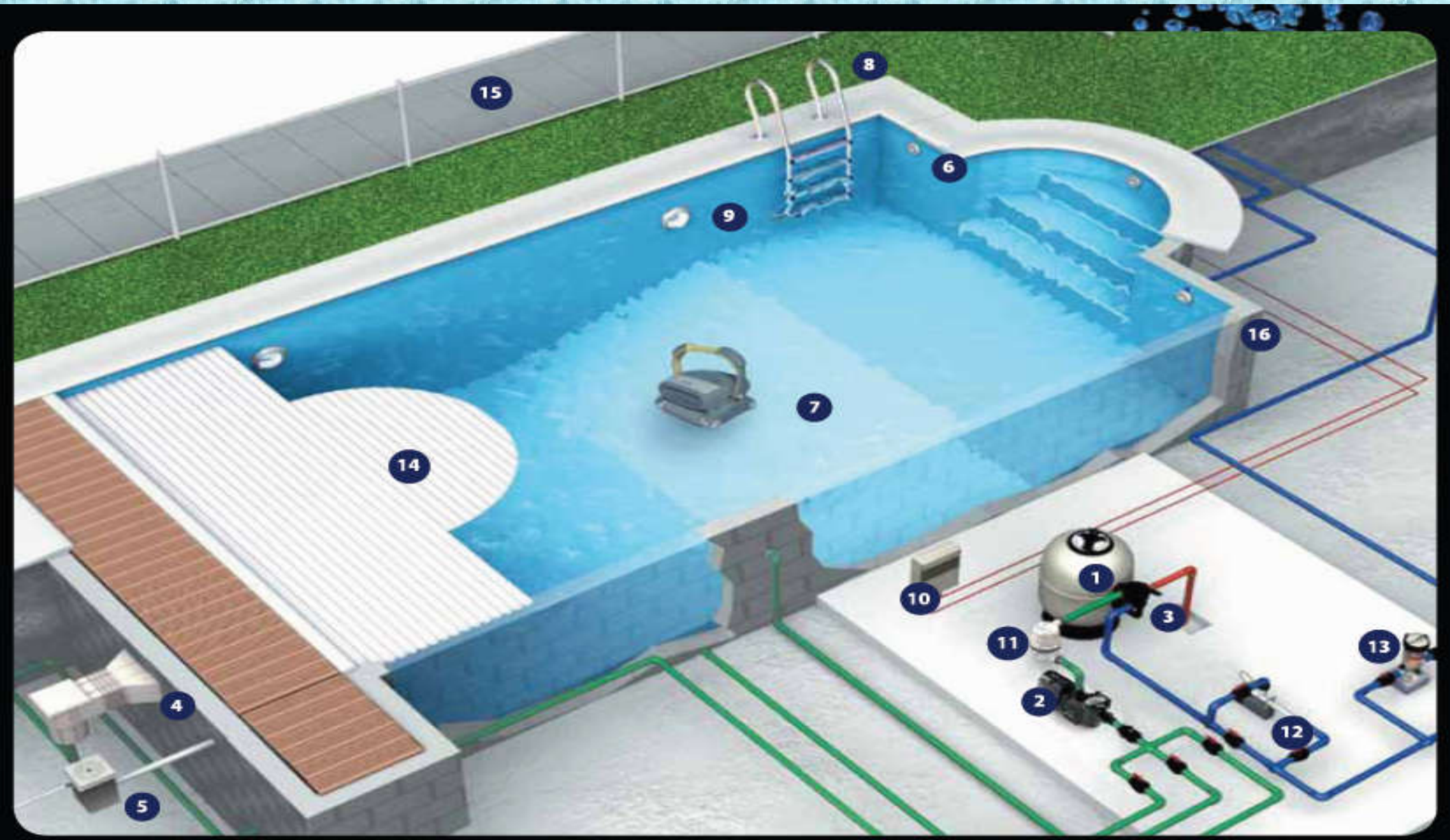
Swimming Pool & Fountain Design

By Eng : Amr Elsayed

Contents

Over View



Swimming Pool Types

1. Skimmer System

- **Component**

1. Skimmer
2. Vacuum
3. Inlet
4. Main Drain
5. Make Up
6. Circulating Pump
7. Treatment
8. Heating System

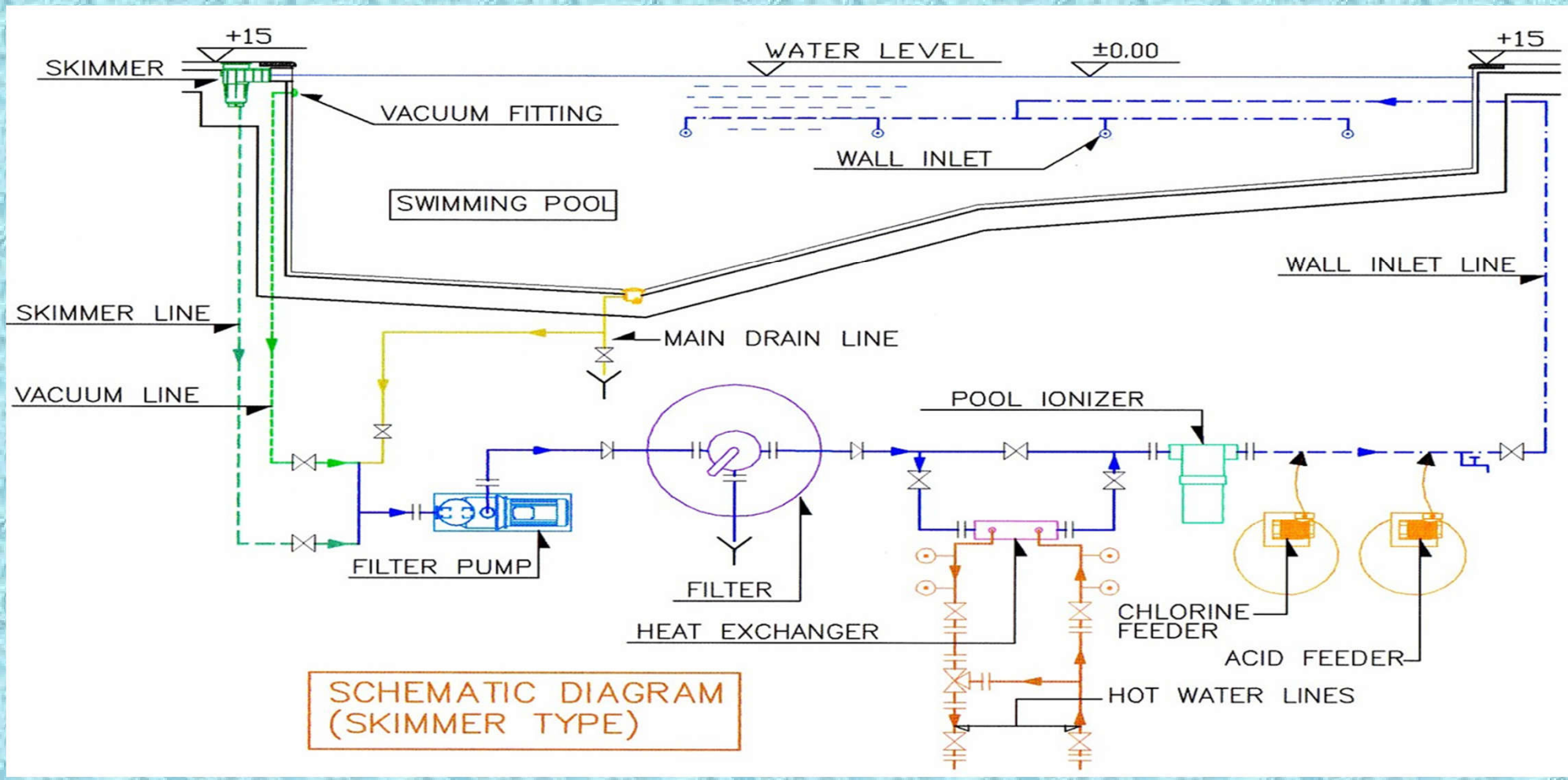
Swimming Pool Types

1. Skimmer System

Skimmer Feature

Swimming Pool Types

1. Skimmer System



Swimming Pool Types

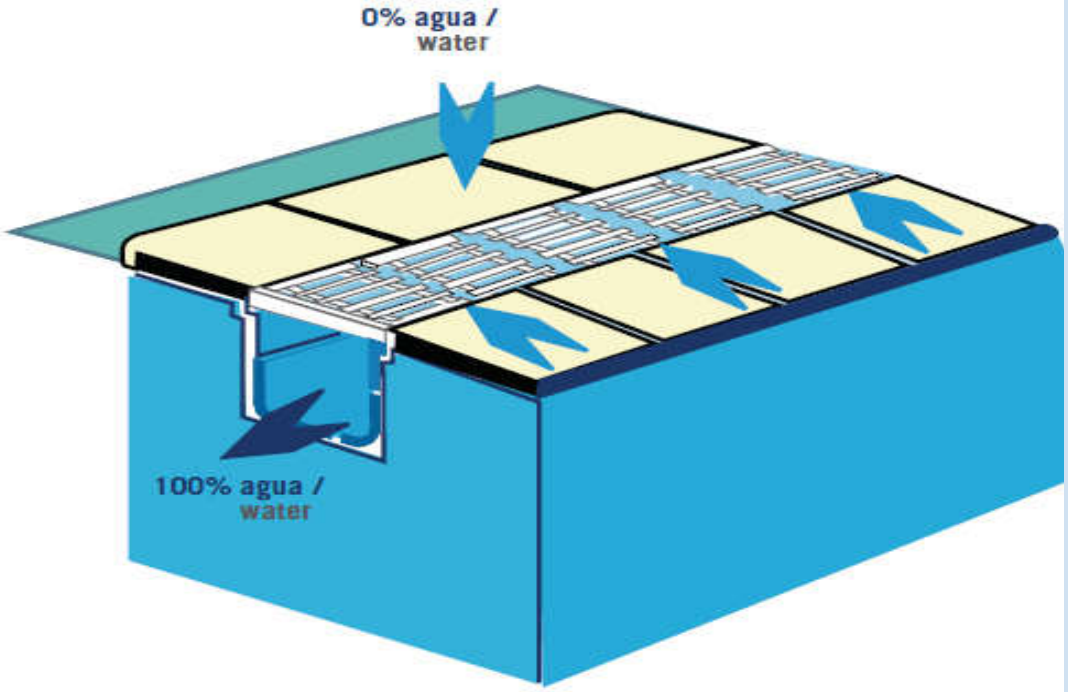
2. Over Flow System

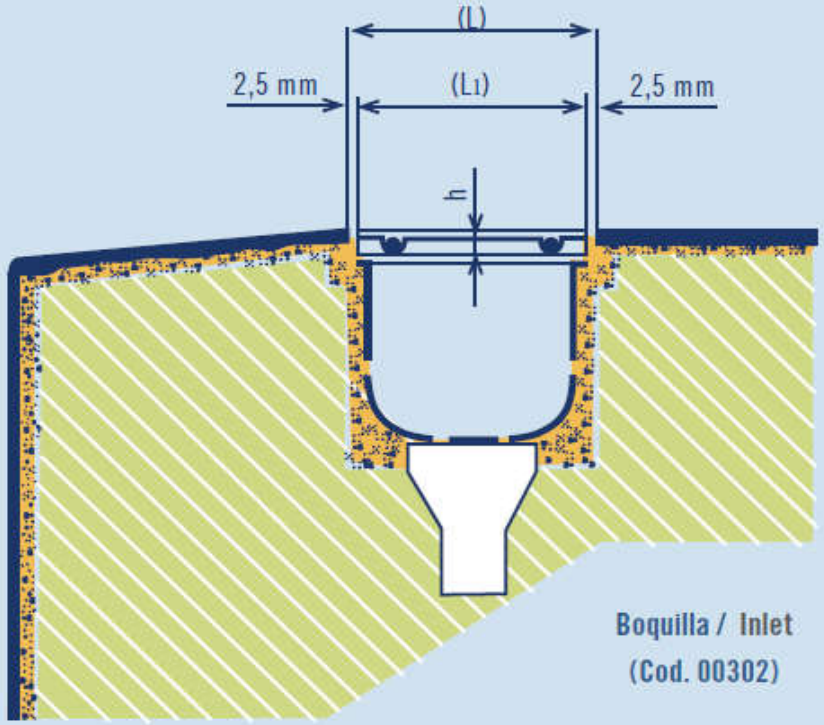
- **Component**

1. Gutter Drain
2. Vacuum
3. Inlet
4. Main Drain
5. Balance Tank
6. Make Up
7. Circulating Pump
8. Treatment
9. Heating System

Swimming Pool Types

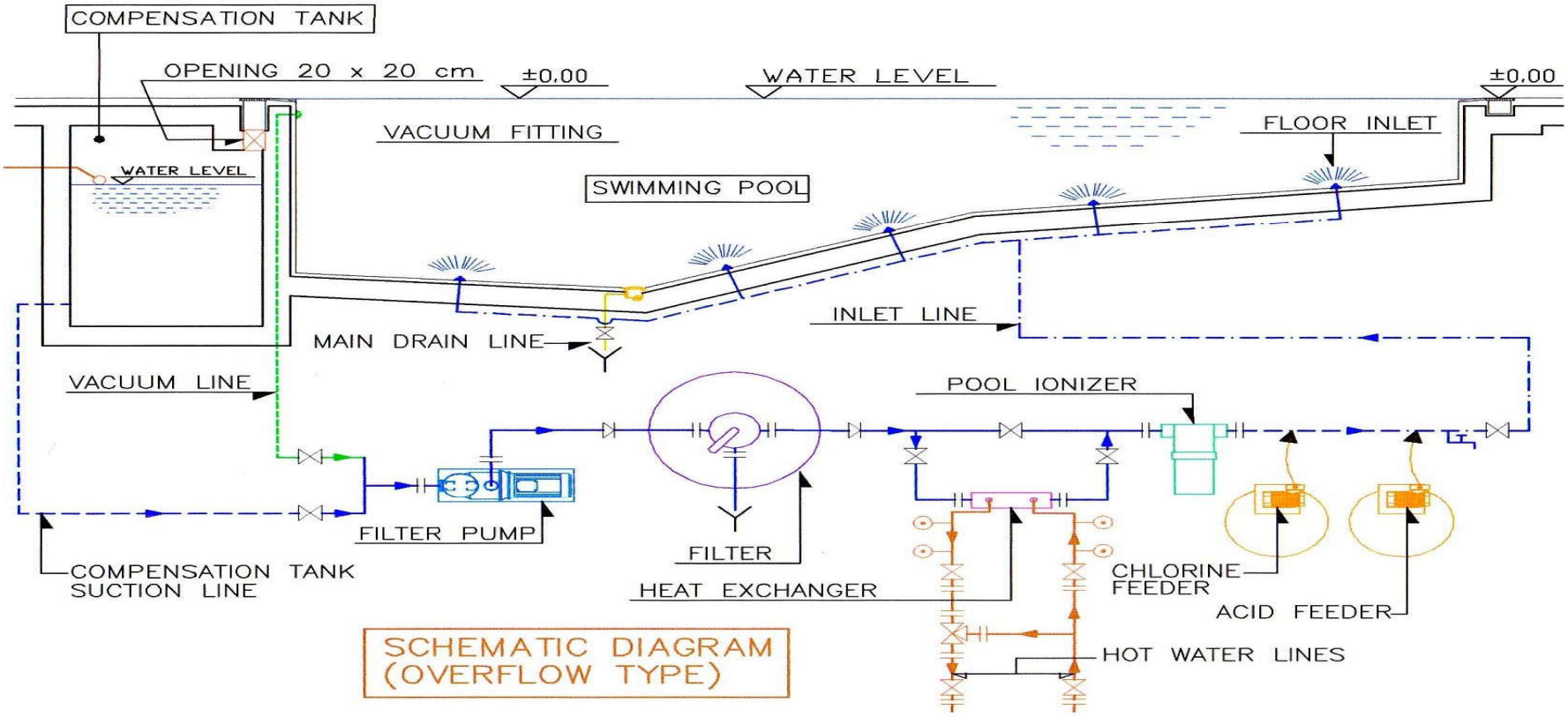
2. Over Flow System



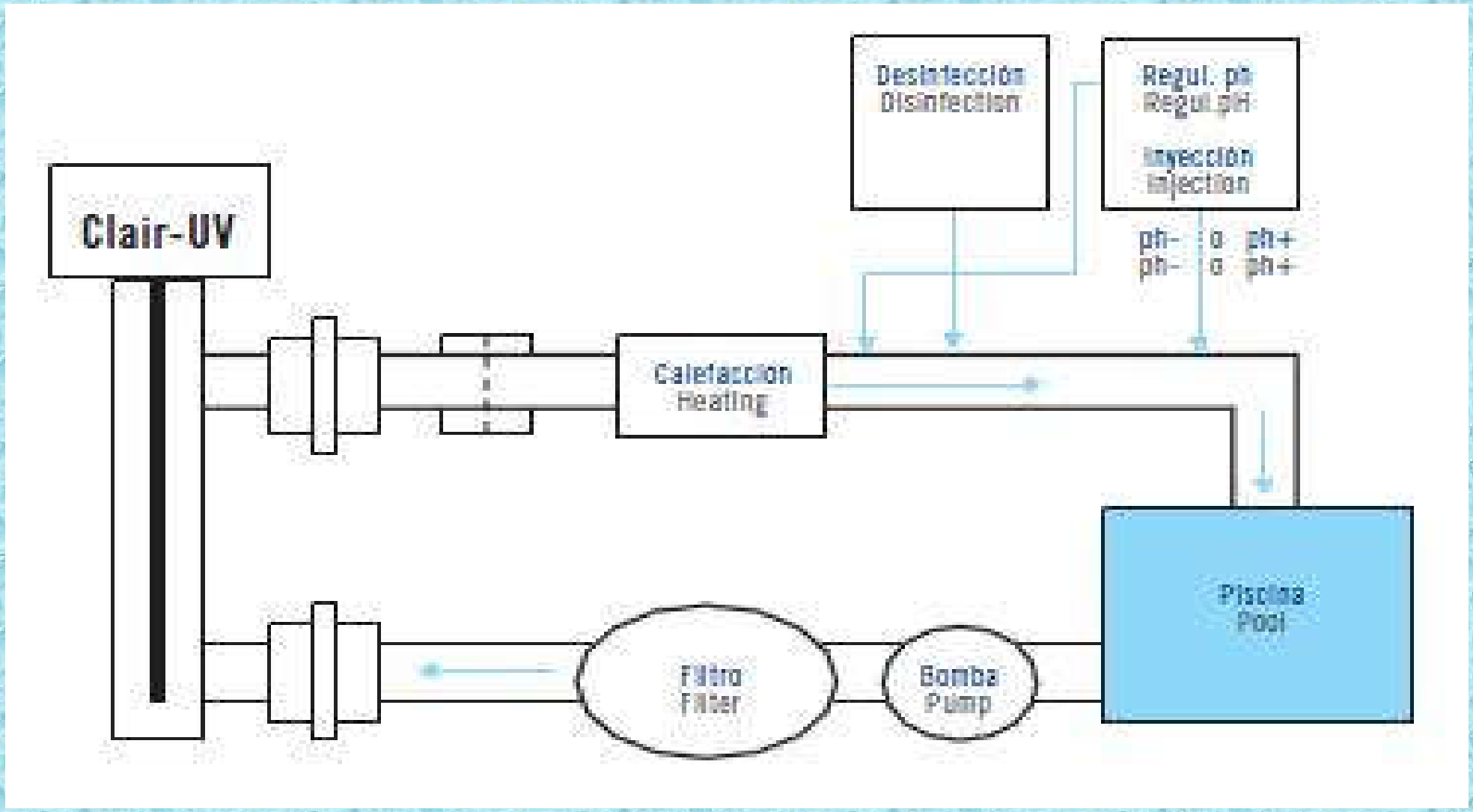


Swimming Pool Types

2. Over Flow System



Treatment


Desinfeccion
Disinfection
Regul. ph
Regul.pH
Inyeccion
Injection
ph- o ph+
ph- o ph+
Clair-UV
Calefaccion
Heating
Piscina
Pool
Filtro
Filter
Bomba
Pump

Filtration

1. Filter

Note: No. Of Filter Equal No. Of Operating Pump

Treatment

2. Ultraviolet

Treatment

3. Ozone

650 W

850 W

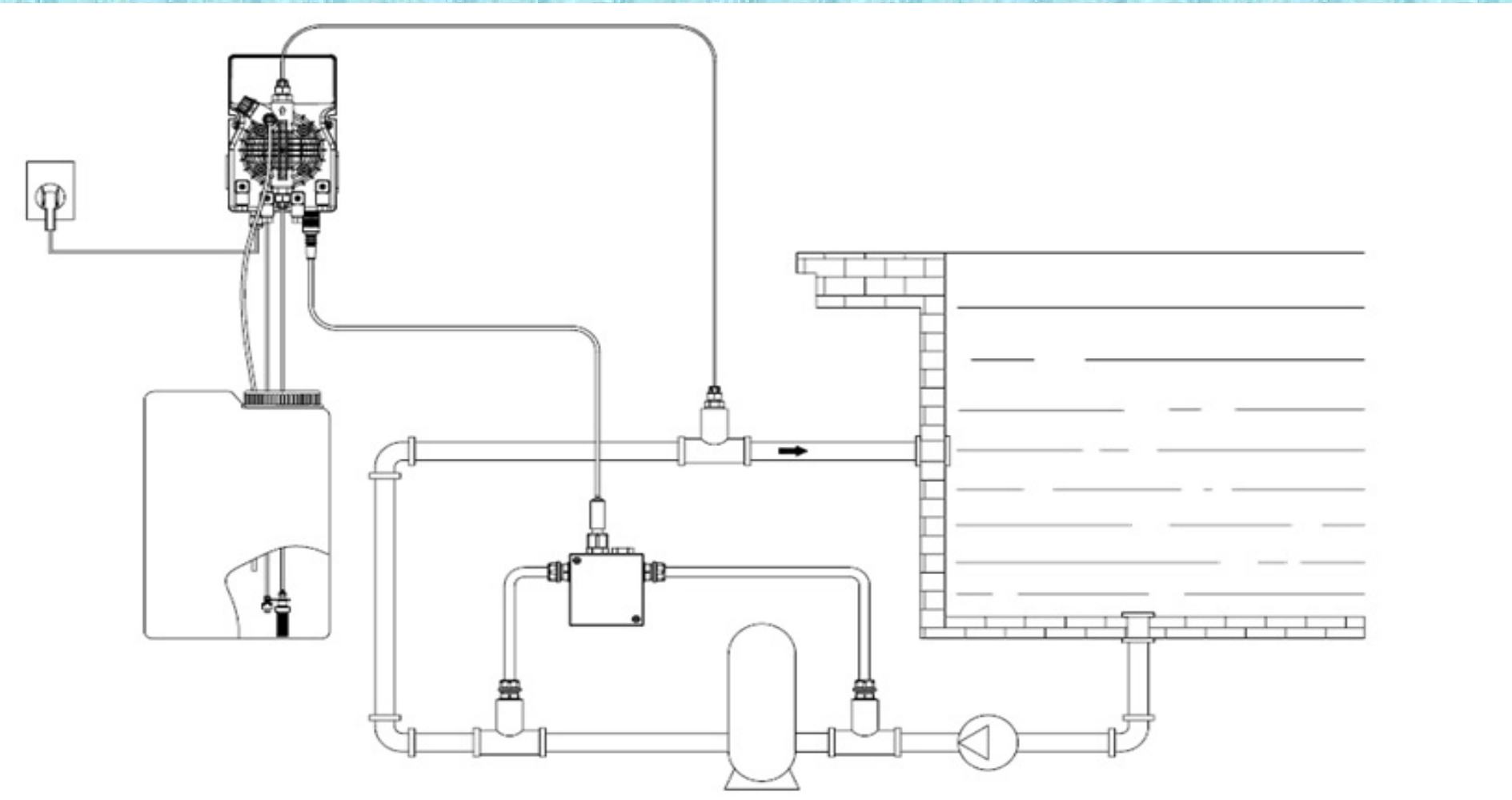
1150 W

Chemical Treatment

4. Dosing Pump

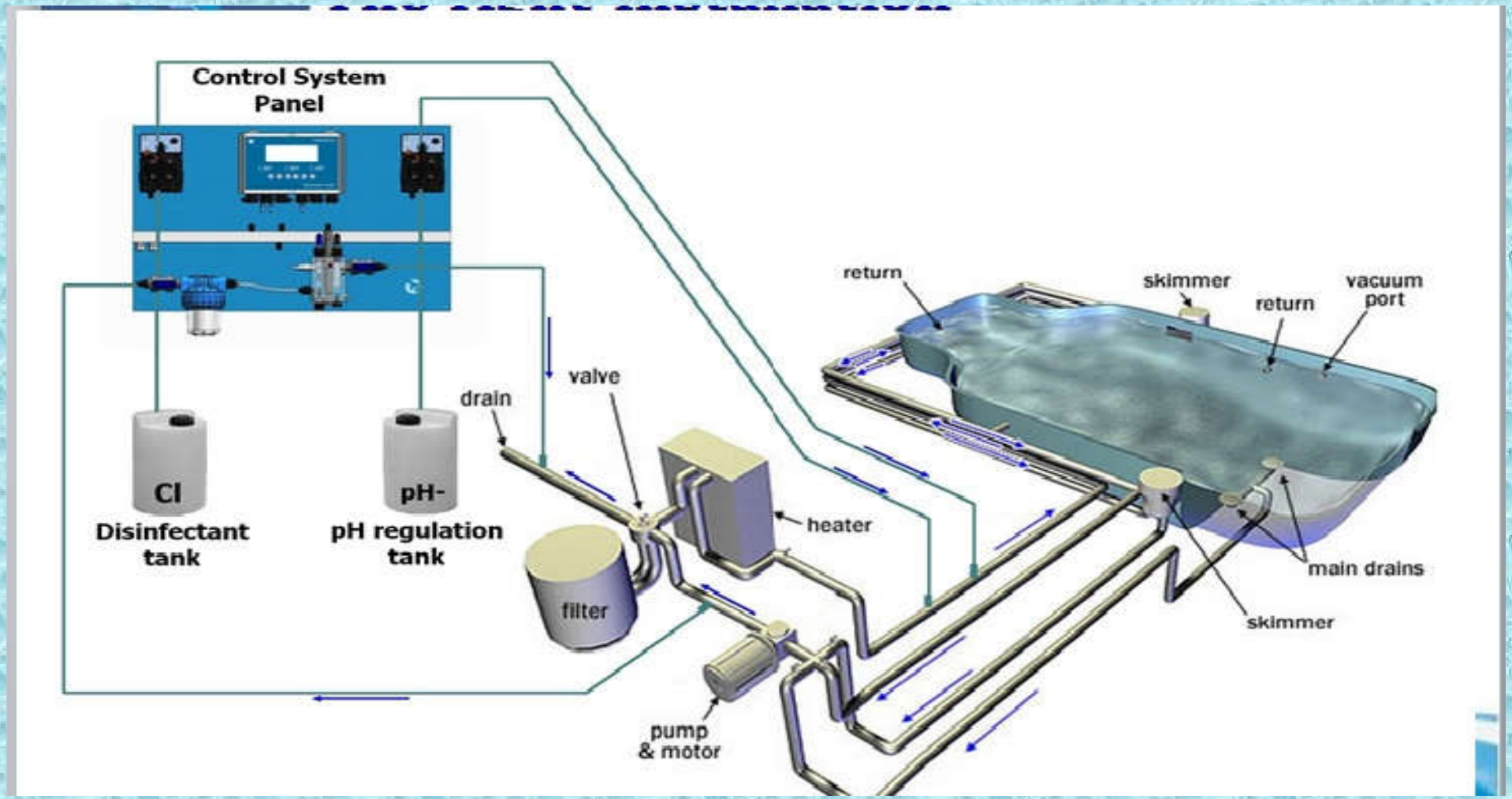
Chemical Treatment

4. Dosing Pump



Chemical Treatment

4. Dosing Pump



Design

1. Requirements

A. Equipments

- Circulation Pumps
- Filter
- Balance Tank
- UV
- Dosing Pump
- Heaters

Design

- Case Study
  - Pool Data

1. Length = 20 m
2. Wide = 10 m
3. Depth = 1.5 m

Design

- **Pumps**

I. **Requirements Data**

1. **Pool Parameters (From Pool Plan & Sections)**
2. **Turn Over (According To Application)**

- **Turn Over:**

A. **Kids (2 Hours)**
B. **Private (4 Hours)**
C. **Public (6 Hours)**

Design

- **Pumps**

TITLE : Swimming Pool Calculation

Pool Data		
Length	20.00	m
Wide	10.00	m
Perimeter	60.00	m
Area	200.00	m2
Average Depth	1.5	m
Volume	300.00	m3
Turnover Period	6.00	hrs
Flow rate	50.00	m3/ hrs
	220.14	gpm

Pump		
Using	2	Pump Operating
Using	1	Pump Standby
Capacity of each pump	25.00	m3/ hrs
	110.07	gpm
Approx. Pipe length	25	m
Static Head	4	m
Residual Head	5	m
Filter Head Loss	5	m
Friction Head Loss	0.77	m
Pump Head	14.77	m
Pump Efficiency	0.55	
Approx. Pump Power	1.83	kW
	2.5	HP

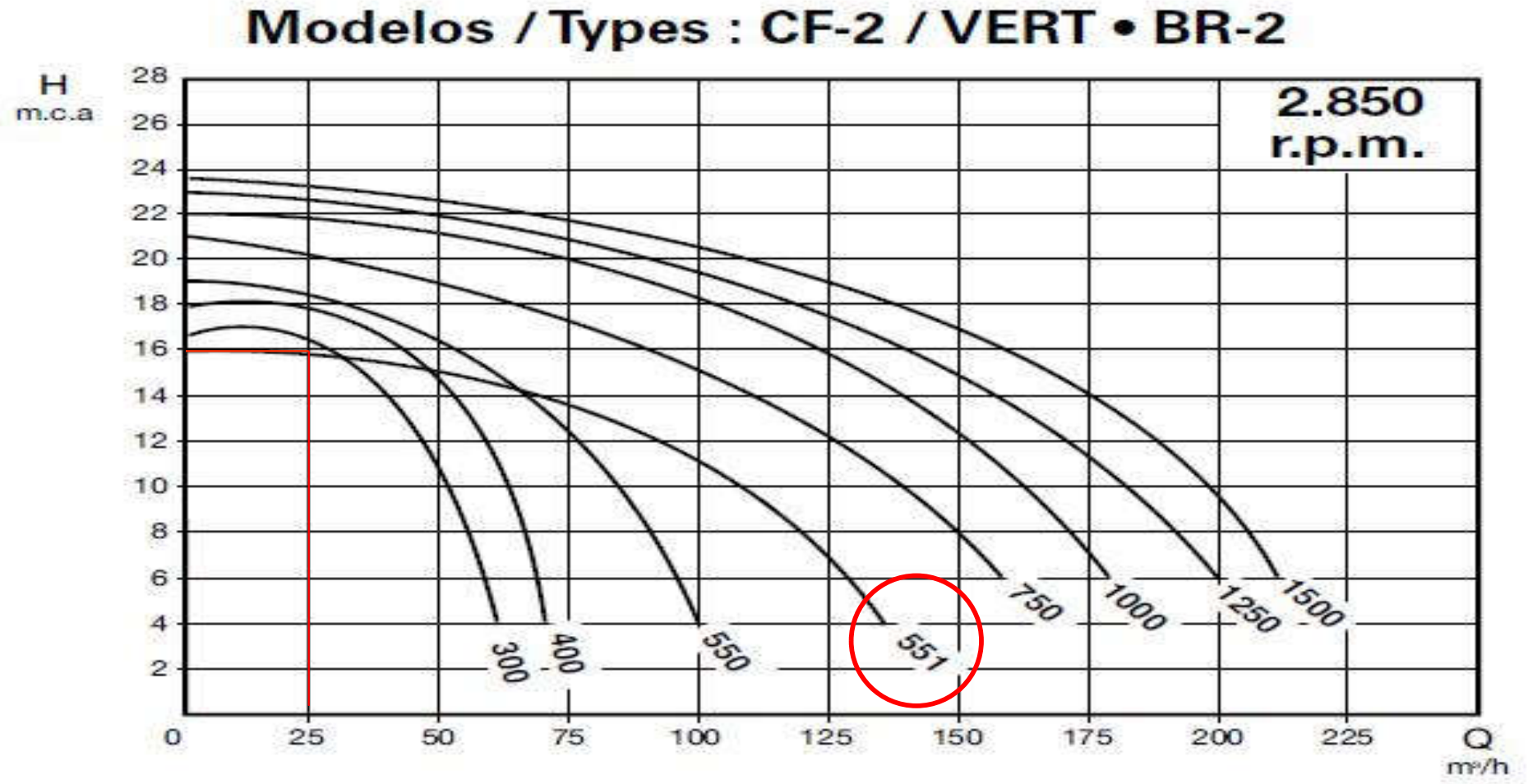
Design

- **Pumps**

Inlet Pipe	Main	Branhes	
Nubmer of inlet	10	10	No.
Flow rate per each inlet	5.00	5.00	m3/ hrs
Total Water flow rate	50.00	50.00	m3/ hrs
Water Velocity	1.50	1.50	m/s
	4.92	4.92	ft/s
Main pipe inside diameter	**110.00**	**110.00**	mm
Hazen roughness constant	150	150	PVC
Friction head loss per 100 meter	**1.720**	**1.720**	m H2O/100m
Pipe length	50.00	10.00	m
Friction head loss	**0.86**	**0.17**	m H2O

Design

- **Pump Selection**



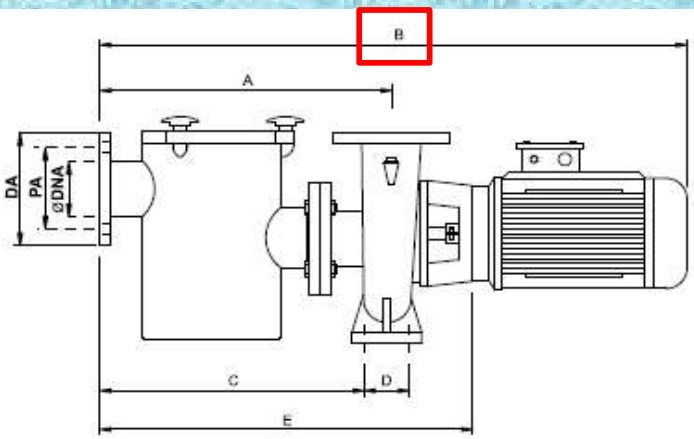
Design

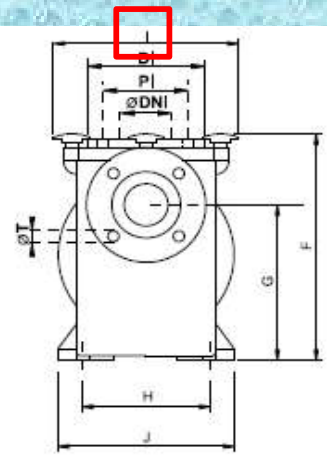
- **Pump Selection**

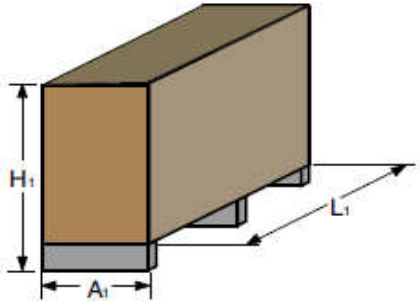
Tipo / Type		HP	KW	R.P.M	"A"		Altura manométrica m.c.a. - Manometric height w.c.m.									DNA	DNI
Hierro Cast Iron	Bronce Bronze				230 V	400 V	6	8	10	12	14	16	18	20	22		
							Caudal m³/h - Flow m³/h										
CF-2 300 / VERT	BR-2 300	3	2,2	2.850	9	5,2	61	54	51	46	35	29				DN80*	DN80*
CF-2 400 / VERT	BR-2 400	4	3	2.850	12	6,9	70	64	59	55	49	42	30			DN80*	DN80*
CF-2 550 / VERT	BR-2 550	5,5	4	2.850	16,5	9,5	95	90	84	77	65	54	32			DN125	DN100
CF-2 551 / VERT	BR-2 551	5,5	4	2.850	16,5	9,5	128	121	107	90	69	30				DN125	DN100
CF-2 750 / VERT	BR-2 750	7,5	5,5	2.850	21,7	12,5	159	152	135	125	109	88	60			DN125	DN100
CF-2 1000 / VERT	BR-2 1000	10	7,5	2.850	-	15,5	180	175	162	149	135	119	101	78		DN125	DN100
CF-2 1250 / VERT	BR-2 1250	12,5	9,2	2.850	-	19	200	196	182	165	150	136	110	95		DN125	DN100
CF-2 1500 / VERT	BR-2 1500	15	11	2.850	-	23	216	210	200	185	171	155	137	118	95	DN125	DN100

Design

- **Pump Selection**







HIERRO CAST IRON	BRONCE BRONZE	Modelos/Types a 2.900 r.p.m.										Aspiración/Intake					Impulsión/Output					Embalaje			Peso Kg.	
		A	B	C	D	E	F	G	H	I	J	ØDNA	DA	PA	N°T	ØT	ØDNI	DI	PI	N°T	ØT	L_1	A_1	H_1	Hi	Br
CF-2 300	BR-2 300	465	880	425	80	605	410	275	200	320	250	80	200	160	4	18	80	200	160	4	18	1.050	400	660	75	90
CF-2 400	BR-2 400	465	910	425	80	605	410	275	200	320	250	80	200	160	4	18	80	200	160	4	18	1.050	400	660	79	96
CF-2 550	BR-2 550	500	985	455	105	635	435	280	215	330	280	125	250	210	8	18	100	220	180	8	18	1.150	400	660	104	124
CF-2 551	BR-2 551	500	985	455	105	635	435	280	215	330	280	125	250	210	8	18	100	220	180	8	18	1.150	400	660	104	124
CF-2 750	BR-2 750	500	1050	455	105	675	435	280	215	330	280	125	250	210	8	18	100	220	180	8	18	1.150	400	660	121	140
CF-2 1000	BR-2 1000	525	1095	470	120	725	465	325	275	345	330	125	250	210	8	18	100	220	180	8	18	1.150	400	660	140	163
CF-2 1250	BR-2 1250	525	1130	470	120	725	465	325	275	345	330	125	250	210	8	18	100	220	180	8	18	1.150	400	660	148	163
CF-2 1500	BR-2 1500	525	1130	470	120	725	465	325	275	345	330	125	250	210	8	18	100	220	180	8	18	1.150	400	660	148	168

* Para dimensiones de bomba en montaje vertical, consulte con nuestro departamento técnico.

* Please contact our technical department for measure of vertical mounted pump.

Design

- **Filter**

Filter		
Number of Filters	2	
Service factor	1.25	
Flow rate per each filter	31.25	m3/ hrs
	137.59	gpm
Filtration speed	30.00	m3/ hrs /m2
Filtration Area	1.04	m2
Filter Diameter	1.15	m
	45.35	inch
Backwash time	5.00	mins
Backwash per each filter	31.25	m3/ hrs

Design

- **Filter Selection**

Velocidad de filtración / Filtration Rate / Vitesse Filtration: 30m³/h/m²

Codigo / Code	Caudal/Flow/Débit	Ø mm	Conexión / Connection	Arena / Sand / Sable
75100063	25m³/h	1.050	DN 75	1.100 Kg
75100064	33m³/h	1.200	DN 75	1.400 Kg
75100065	46m³/h	1.400	DN 90	1.900 Kg
75100066	60m³/h	1.600	DN 110	2.600 Kg
75100067	76m³/h	1.800	DN 110	3.500 Kg
75100068	94m³/h	2.000	DN 125	4.500 Kg

Design

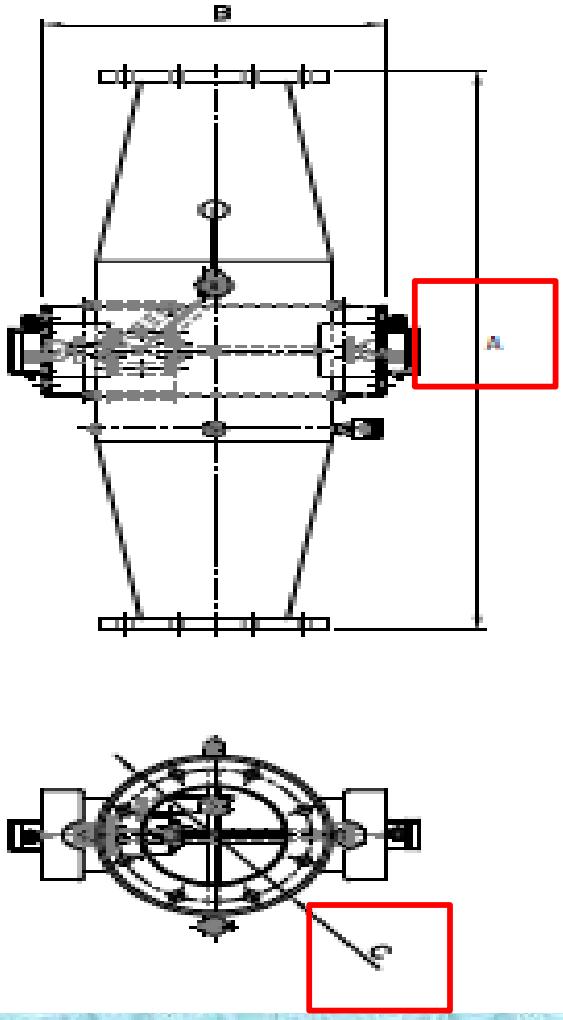
- **Balance Tank**

Balancing Tank		
Bathers Water displacement	41.00	liters/m2
	1.01	gallons/ft2
Total water displaced	8.20	m3
Backwash volume	2.60	m3
Evaporation rate	10.00	mm/m2/day
Evaporation volume	2.00	m3
Safty Factor	1.20	
Tank Effective volume	**15.37**	m3
Tank Height	3.00	m
Tank Area	5.12	m2
Make-Up Water period	1.00	hr
Make-Up Water flow rate	15.37	m3/ hrs
Water Velocity	1.50	m/s
	4.92	ft/s
Make-Up Water pipe diameter	**60.21**	mm

Design

- **UV**

Code	Model Clair-UV MP	Flow rate Q (m^3/h)	N° Lamps	Consumpt. lamps	Total lamp power UV-C (W)	DN flange inlet/outlet	Total Height A (mm)	Ø C of reactor
36831	MP30	30	1	600W	90	80 or 100	450	273
36832	MP30	50	1	1kW	150	80 or 100	450	273
32679	MP100	80	1	1kW	150	125	1175	273
32680	MP125	140	1	2.5kW	375	150	1168	273
32681	MP140	300	1	4kW	600	200	1244	355.6
32682	MP240	450	2	4kW	1200	250	1020	355.6
32683	MP340	675	3	4kW	1800	300	1016	355.6
32684	MP440	900	4	4kW	2400	300	824	355.6



Design

- **Dosing Pump Calculation**

1. VOLUME Of Water To be Treated= 20*10*1.5 = 300 m3
2. As 3 gm Of Chlorine For 1 m3 Of Water
3. So Weight Of Chlorine To be Dosed = 900 gm,
4. 1 Kg Of Chlorine Used For 100 Liter Of Water To Make Solution With 10% Concentration , So For 900 gm Of Chlorine IT Requires 90 L
5. Flow Of Dosing Pumps= 90 / Turn Over =15 L / H
6. Dosing Pump Head = 1.5 Circulating Pump Head

Design

- **Electric Heaters Calculation**

Water Heater

1- Water direct heating

$Q_1 = \rho\ c_p\ V\ (t_f - t_i)/x$

where:

ρ :	water denisty,	998.00	kg/m3
c_p :	water specific heat,	4.18	kJ/Kg.K
V :	Pool volume, m^3	300.00	m3
t_f :	desired water temperature, °C	27	°C
t_i :	initial temperature, °C	14	°C
x :	pool heat-up time, hrs	48.00	hrs
Q_1:	pool heat-up rate, kW	94.15	kW
		321544.6	BTU/hr

2- Heat Loss

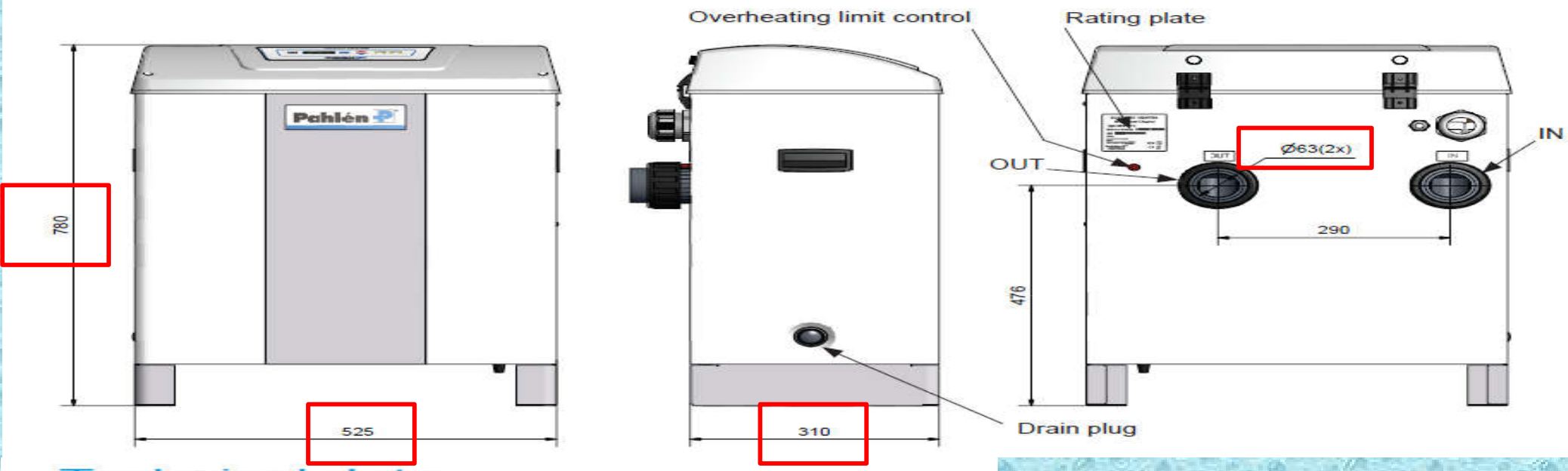
$Q_2 = U\ A\ (t_p - t_a)$

where:

U :	Overall coefficient of heat transfer,	0.06	kW/m2.K
A :	water surface area	200.00	m2
t_p :	water pool temperature	27	°C
t_a :	ambient temperature	14.00	°C
	sheltered positions	1.00	
Q_2 :	heat loss from pool surface	156.00	kW
		532,767.9	BTU/hr
Required heater output = $Q_1 + Q_2$		250.15	kW
		854,312.5	BTU/hr

Design

- **Electric Heaters Selection**



Technical data

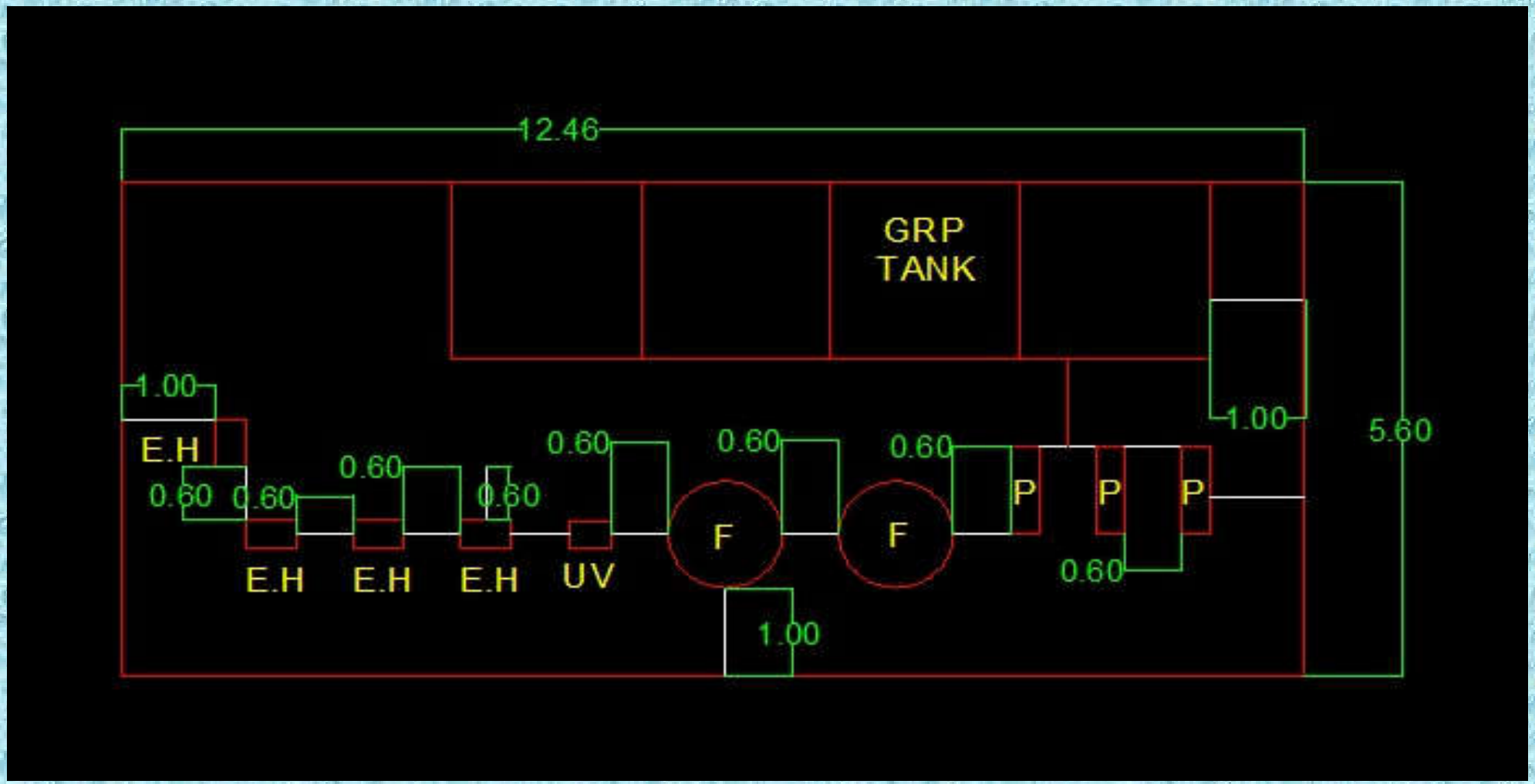
Item no.	Capacity kW	400V 3-phase	415V 3-phase
1510018	2x9=18	18kW 26A	19.5kW 27A
1510024	2x12=24	24kW 35A	26kW 36A
1510030	2x15=30	30kW 43A	32kW 45A
1510036	3x12=36	36kW 52A	39kW 54A
1510045	3x15=45	45kW 66A	49kW 68A
1510060	4x15=60	60kW 87A	65kW 90A
1510072	4x18=72	72kW 104A	78kW 108A
Item no.	**Capacity**	**230V 3-phase**	
1510218	2x9=18	18kW 45A	
1510224	2x12=24	24kW 60A	
1510230	2x15=30	30kW 75A	
1510236	3x12=36	36kW 90A	
1510245	3x15=45	45kW 113A	
1510260	4x15=60	60kW 151A	

For heaters with titanium element add T after the item no.

3 Electric Heaters Each
72 Kw & 1 Electric Heater
36 Kw

Design

- **Mechanical Room Dimensions**



Manual Calculation

- Pumps
  - Q=(L * W * D) / Turn Over
  - No of Pumps = Q / (No of Operating Pumps)
  - Head = ((P static + P residual + P filter) major + (P friction) minor)

  Where :
  - P static = Pump Room Height
  - P residual = 5m
  - P filter = 5m
  - P friction :

$$H_{f.pipe} = 6.78 \left(\left(L / D^{1.165} \right) * \left[V / C \right]^{1.85} \right)$$

$$H_{f.fit} = k * H_{f.pipe}$$

$$H_{minor} = H_{f.pipe} + H_{f.fit}$$

Manual Calculation

- Filter
  - Q=(Service Factor * Q pumps flow rate)/ No of Filter
  - Where NO of Filter = No of Operating Pump
  - Service Factor = 1.25

Manual Calculation

- **Balance Tank**
  - **Tank Effective volume = Safety Factor * (Total water displaced + Backwash volume + Evaporation volume)**
  - **Safety Factor = 1.2**
  - **Total water displaced = (Pool Area * Bathers Water displacement)/ 1000**

Where : Bathers Water displacement = 41 L/m2

Manual Calculation

- **Balance Tank**

  - **Backwash volume = Number of Filters * Backwash time * Backwash per each filter)/ 60**

    Where : Backwash time = 5 min

  - **Evaporation volume = (Pool Area * Evaporation rate) /1000**

    Where : Evaporation rate = 10 mm/m2

Manual Calculation

- **Balance Tank**

  - **Make Up Flow Rate = Tank Effective volume / Make-Up Water period**

    Where : Make-Up Water period = 1 hour

  - **Make Up Diameter = (4*(Make Up Flow Rate /3600)/(3.14* Water Velocity))^0.5*1000**

    Where : Water Velocity = 2 m/s

Manual Calculation

- **Heaters**

1- Water direct heating

- $Q_1 = (r\ c_p\ V\ (t_f - t_i))/x * 3600$

  Where:

- r : water density, (998) kg/m3
- c_p : water specific heat, (4.18) kJ/ Kg
- V : Pool volume, m^3
- t_f : desired water temperature, ^oC (27) ^oC
- t_i : initial temperature, ^oC (14) ^oC
- x pool heat-up time, hrs (48.00) hr
- **Q_1:** pool heat-up rate, kW

Manual Calculation

- **Heaters**

2- Heat Loss

- Q2= U A (tp - ta)

  Where:

- U: Overall coefficient of heat transfer, (0.06) kW/m2
- A: water surface area,
- tp : water pool temperature (27) ^{o}C
- ta ambient temperature, ^{o}C (14) ^{o}C
- sheltered positions

  Where 1 hr for Uncovered Pool & 0.5 hr For Covered Pool

- **Q_2:** heat loss from pool surface, kW

Manual Calculation

- **Heaters**

Required heater output = Q1 + Q2

Manual Calculation

- **Pool Routing**

  Inlet Nozzle :

  Based on MFG recommendation = 5 m3/h

  Max Distance = 6 m

  Dist. From corner = 1.5 m

Wall Inlet

Floor Inlet

Manual Calculation

- **Pool Routing**

Gutter Drain:

Max Distance = 4.6 m

Skimmer :

Max Distance = (15 to 25) ft

Vacuum :

Max Distance = (20) m

Manual Calculation

- **Pool Routing**

Main Drain :

Max Distance :

Dist. From corner :

Egy. Code	ASPE
6	9.20
1.80	4.60

Note :

At less 2 Main Drain If Possible

Manual Calculation

- **Pool Routing**

Pipe Sizing:

Suction (Pressurized) : 1 to 1.5 m/s

Suction (By Gravity) : 0.8 m/s

Discharge : 1.5 to 2.4 m/s

Note :

Pipe Diameter Should be Not Exceeds 110 mm

All Feature 50 mm

Manual Calculation

- **Pool Routing**

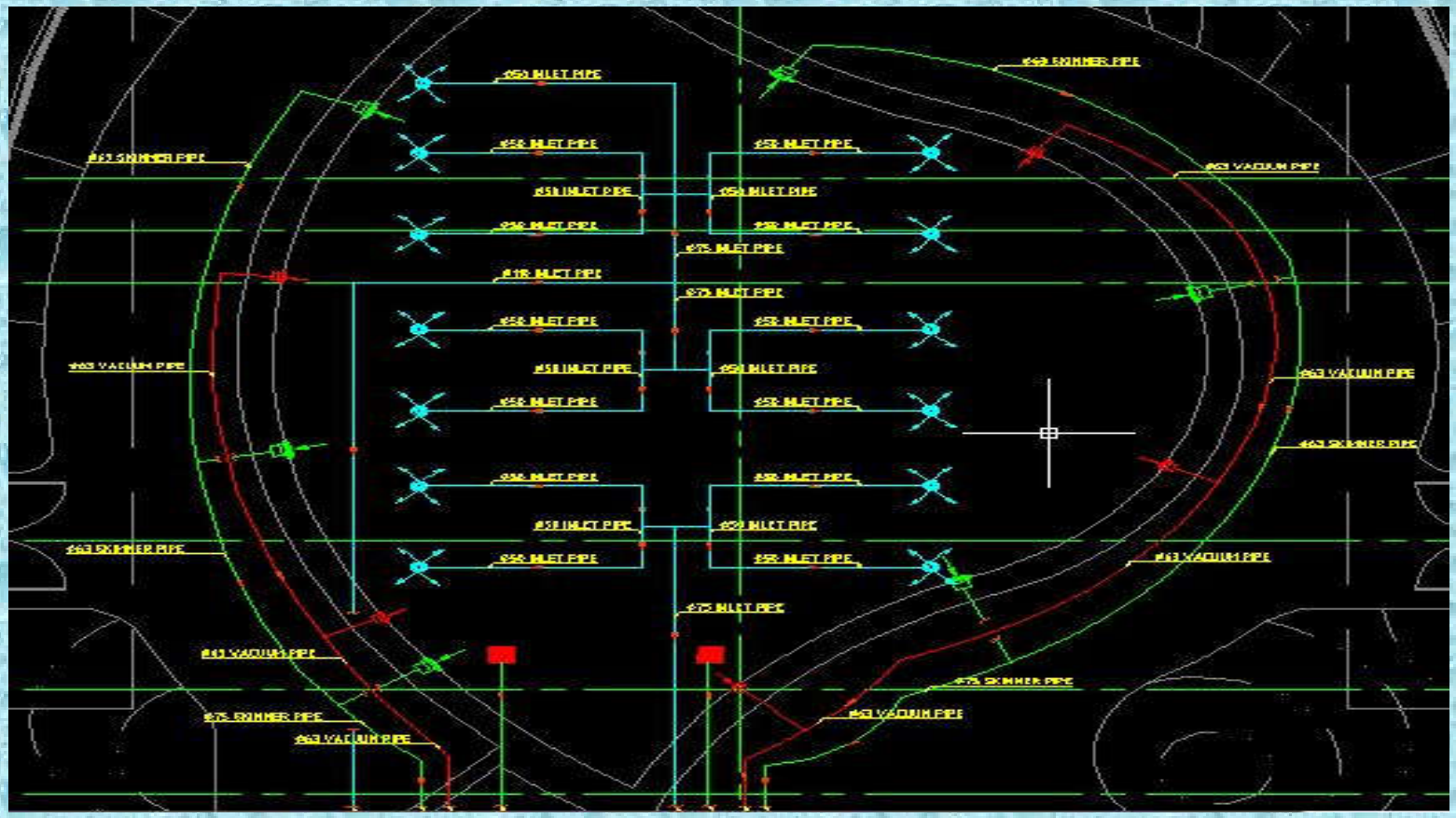
Pipe Sizing:

Flow Rate M3/hr	Pipe MM	Diameter Meter	Area M2	Velocity M/sec
50	25	0.022	0.00037994	36.56
50	32	0.0284	0.00063315	21.94
50	40	0.0362	0.001028695	13.50
50	50	0.0452	0.001603786	8.66
50	63	0.057	0.002550465	5.45
50	75	0.0678	0.003608519	3.85
50	90	0.0814	0.005201379	2.67
50	110	0.0994	0.007756083	1.79
50	125	0.113	0.010023665	1.39
50	140	0.1266	0.012581635	1.10
50	160	0.1446	0.016413691	0.85
50	200	0.1808	0.025660582	0.54
50	225	0.214	0.03594986	0.39
50	250	0.238	0.04446554	0.31
50	280	0.2666	0.055794315	0.25
50	315	0.3	0.07065	0.20
50	355	0.3381	0.089734614	0.15
50	400	0.3809	0.113891576	0.12

Manual Calculation

- **Pool Routing**

Pipe Distributions:



Special Cases

- **Combo Unit 1**

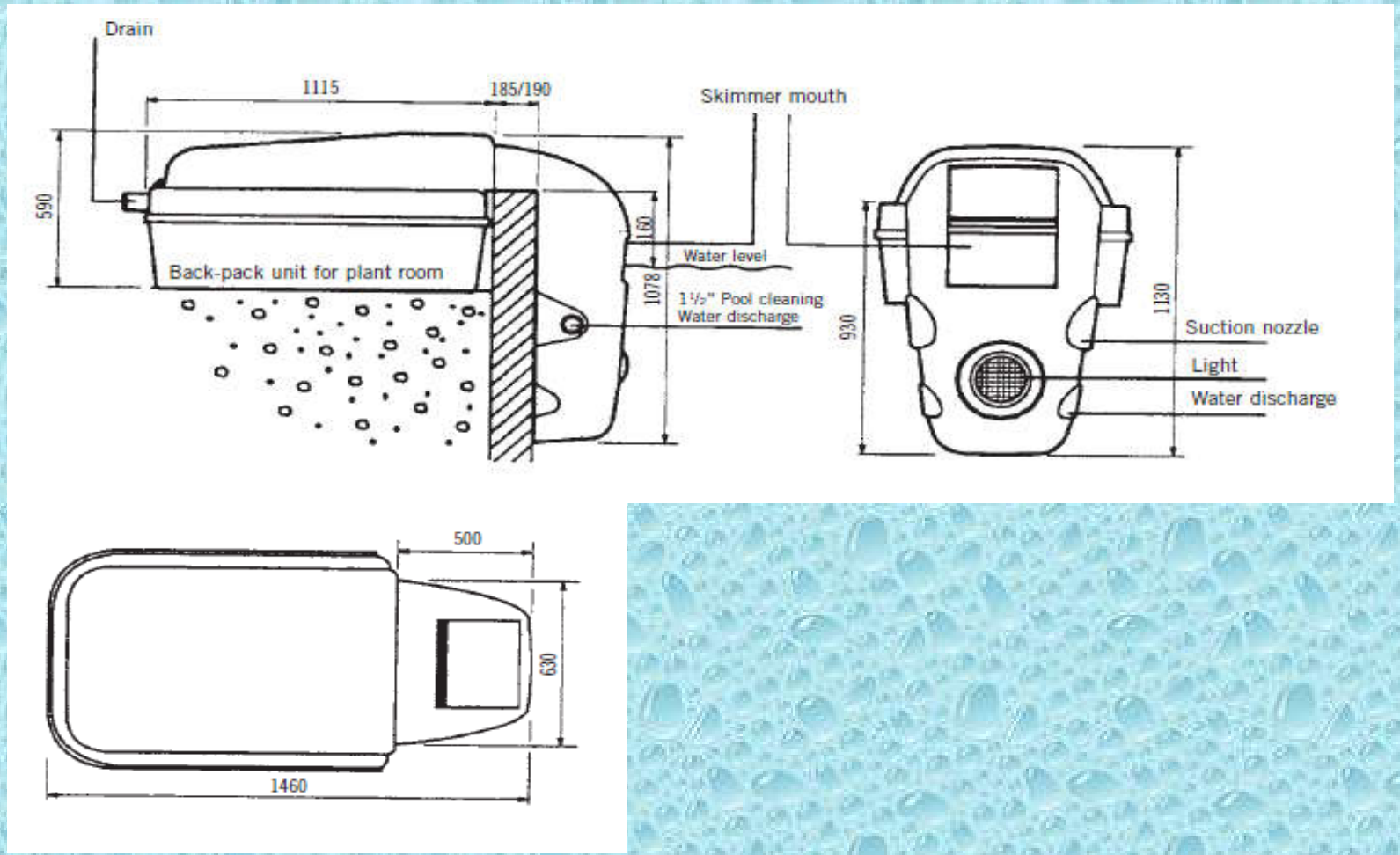
Combo I

With 3/4 HP pump with 11 m³/h flow at 10 m.c.a., 3 cartridge filters of 5 m³/h flow rate each. Total filtration surface 6.9 m². Control box included.

Code	Standard Packing	Standard Weight Kg	Standard Volume m³
18546	1	92	1.241

Special Cases

- **Combo Unit 1**



Special Cases

- **Combo Unit 2**

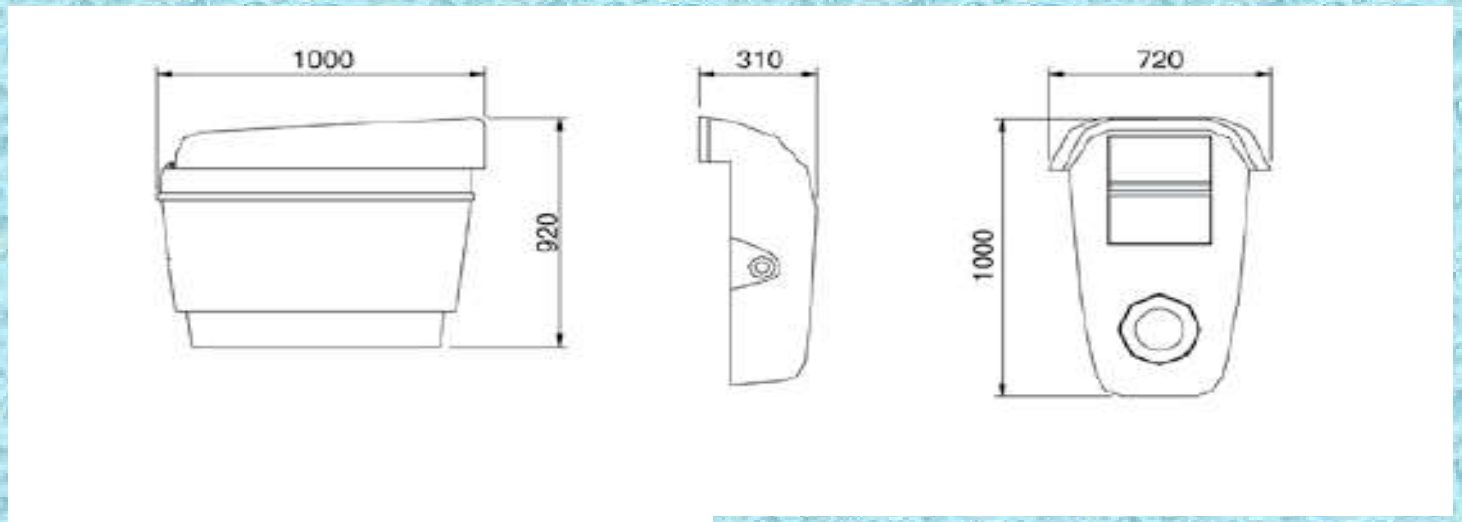
Combo II

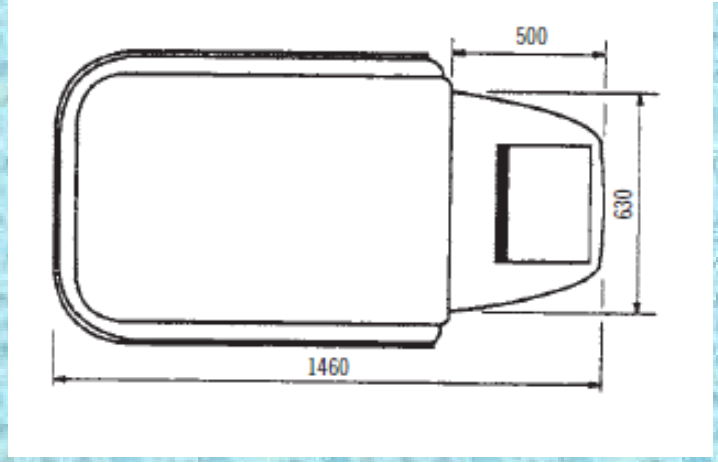
With Terra 50 cartridge filter with maximum flow 15 m³/h, Sena pump 1.25 HP, 100 W light and programmable control box. An electric heater and chlorinator can also be incorporated. One single filter replaces the three used in Combo I. Improved return of water to pool. This Combo II can also be installed as one compact unit or can be installed as 2 separated parts.

	Code	Standard Packing	Standard Weight Kg	Standard Volume m³
White cartridge filter, 15 m³/h flow	**27413**	1	79	1.41

Special Cases

- **Combo Unit 2**





Special Cases

- **COMPACT FILTRATION UNITS**

- **Flow Rate Up TO 60 m3\h**

Fountain

A. Equipments

- Circulation Pumps
- Filter
- Balance Tank
- Dosing Pump
- Display Pumps

Fountain

Display Nozzle

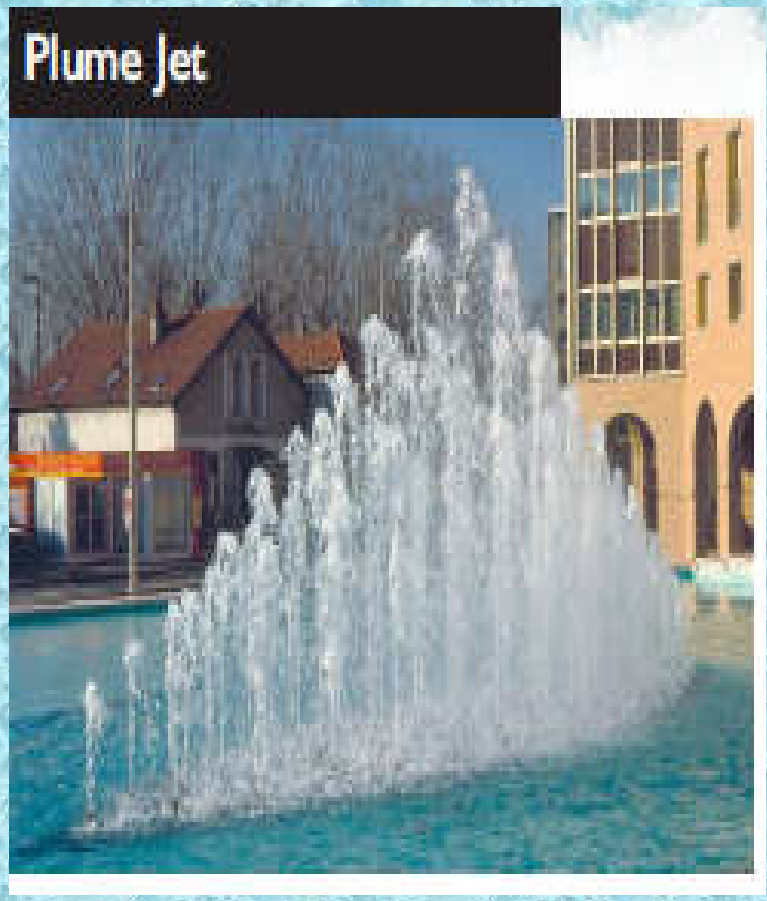
NAE series

NBU series

NCA series

Display Nozzle

NEF
series



NEA
series

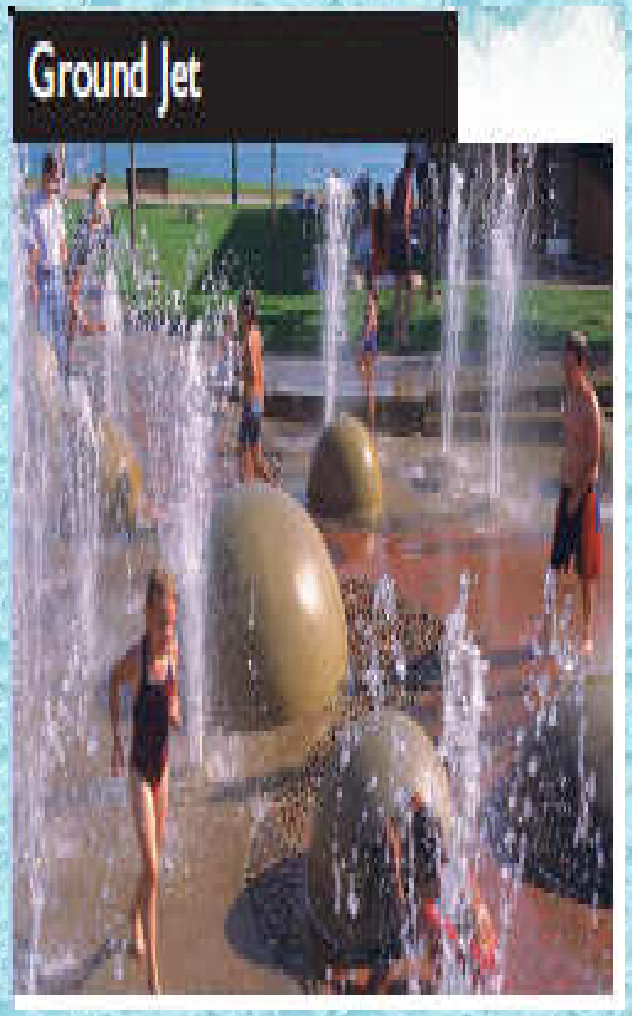
Display Nozzle

NPD series

NRC series

NSJ series

Display Nozzle



NLG series

NSR series

NTO series

Display Nozzle

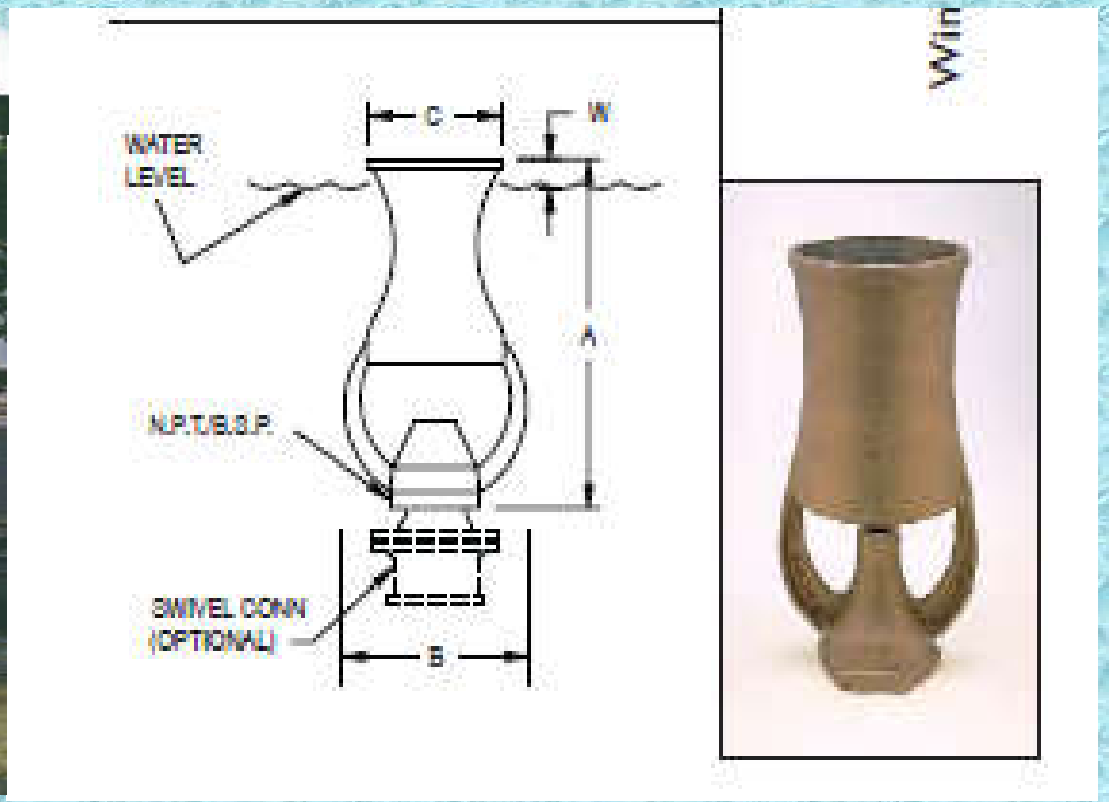
NPF series

NGA series

NMB series

Fountain Design

- **Nozzle Selection**



Fountain Design

- **Nozzle Selection**

Dimensions (in mm) Performance

DEFO no.	suction strainer openings required	a dim.	b dim.	c dim.	w dim.	inlet (npt) (bsp)	spray height (meters)	.60	0.9	1.2	1.5	1.8	2.4	3.0	3.7	4.6	6.1	7.6	9.1
NCA-050	6	100	50	50	-32	12	L/min M head spread	26 5 203	34 8 381	38 11 559	42 12 813								
NCA-075	8	140	70	65	-25	20	L/min M head spread	45 6 254	57 7 279	61 10 432	76 13 610	76 16 762	87 21 864						
NCA-125	8	203	114	89	12	32	L/min M head spread	61 4 229	79 5 305	87 7 457	98 9 610	110 11 711	129 15 737	144 18 914	151 20 1016				
NCA-150	8	229	121	95	12	40	L/min M head spread	87 3 254	110 4 381	121 5 483	136 7 610	159 10 762	170 11 813	185 14 914	201 15 940	220 19 1016			
NCA-200	17	273	140	114	12	50	L/min M head spread			159 4 381	178 6 508	189 7 508	231 10 914	254 12 1016	269 13 1092	284 15 1270	348 22 1397		
NCA-300	22	362	203	165	20	75	L/min M head spread				333 7 610	341 8 610	352 11 660	424 13 1067	439 15 1219	545 19 1524	628 24 1524	708 32 2134	776 35 2438

Fountain Design

- **Circulation Pump**

Pump Calculation :

Q = Volume / Turn Over

Where :Turn Over = Max 2 Hours

Head = P residual + P static + P filter + P friction

Where :
P residual : From Catalogue
P filter : 5m
P static : Pump Room Height

P friction :

$$H_{f.pipe} = 6.78 \left(\left(L / D^{1.165} \right) * \left[V / C \right]^{1.85} \right)$$

$$H_{f.fit} = k * H_{f.pipe}$$

$$H_{minor} = H_{f.pipe} + H_{f.fit}$$

Fountain Design

- **Display Pumps**

Pump Calculation :

Q = (No of Nozzle * Q nozzle)

Head = P residual + P static + P friction

Where :
P residual : From Catalogue

P static : Pump Room Height

P friction :

H f.pipe = 6.78 ((L / D ^1.165) * [V / C]^1.85)

H f.fit = k * H f.pipe

H minor = H f.pipe + H f.fit

Fountain Design

- **Check**

We Need Balance Tank or Not ?

Q = (Q circulation pump + Q display pump) = Gallon / min

V circulation = (Gallon / min) * 6 min

IF V circulation < V fountain We Not Need

IF V circulation > V fountain We Need

Or Increase Fountain Depth