# PEM
# TECHNICAL INFORMATION
# &
# SUGGESTIONS

## INDEX 2008-2

# DESIGN DATA

1. **QUICK PIPE SIZING GUIDE** for **pressure** flows with appr. 3.0m/0.3bar/10'/3.34kpa pressure drop per 30m / 100 feet of pipe.

| PIPE SIZE: | 1" | 1 1/4" | 1 1/2" | 2" | 3" | 4" | 6" | 8" | 10" | 12" |
|---|---|---|---|---|---|---|---|---|---|---|
| FLOW\USGPM: | 9 | 19 | 28 | 52 | 200 | 380 | 880 | 1600 | 2400 | 3500 |
| FLOW\L/min: | 34 | 72 | 106 | 197 | 757 | 1438 | 3330 | 6056 | 9084 | 13247 |

**DO NOT USE PRESSURE FLOW TABLES FOR GRAVITY FLOWS , use Manning sewer flow tables!**

2. **QUICK SIZING GUIDE FOR PERFORATED SUCTION STRAINERS** WITH 40 % + OPEN AREAS
Opening size to be appr. 50% of nozzle orifices.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| SCREEN OPENINGS: | 1mm | 1.5mm | 2mm | 3mm | 4mm | 6mm | 10mm |
| FLOW \ L/min per m2 : | 220 | 380 | 530 | 740 | 950 | 1200 | 3000 |
| SCREEN OPENINGS: | | 0.063" | 0.125" | 0.250" | 0.375" | 0.500" | 0.750" |
| FLOW \ USGPM per square foot: | | 12 | 17 | 25 | 50 | 100 | 270 |

3. **ANTI VORTEX COVERS** OVER PUMP SUCTION FITTINGS
Required in most installations to prevent entry of air into system by vortexing. Size depends on waterdepth and flow.

4. **NPSHA** : (NET POSITIVE SUCTION HEAD AVAILABLE) :
Term describing the depth of water over the pump suction required to permit pump to perform as advertised , the pump supplier usually furnishes this information, which is essential during design/engineering of a pump system.

5. **SURGE/SPLASH COLLAR**: Structural part of a pool or device that encloses the falling water of a spray effect to prevent content of pool to surge and cause spray effect to jump especially in circular or square pool.

6. **BALANCED OVERFLOW**: An overflow that is sized to remove the greatest possible inflow into a pool before the pool overflows, usually sizing is done to draw off the full flow of a water supply into a pool (2 x #1 on this page). Sizing of overflow is done by establishing linear weir length of overflow device (multiply pipe diameter x 3.14) and possible head of water before pool overflow can occur, then check waterfall data below for flow rates. For very large pool and / or inflows consider an appropriate length overflow weir in front of a suitable size drain in the pool floor. In multi level pools or cascades the overflow to be sized for the entire water surface area and set above non operating water level into base pool.

7. **TO ESTIMATE APPR. 60 Hz PUMP HP / KW FOR A KNOWN PERFORMANCE**:
(Flow in USGPM X MC (total, in feet head)) DIVIDE BY: 2970 or (3960 X 75% of known Efficiency) : KW x 1.34 : HP
TO ESTIMATE APPR. 50 Hz PUMP HP / KW FOR A KNOWN PERFORMANCE:
(Flow in L/min X MC (total , in meter head) DIVIDE BY: 2970 or (3960 X 75% of known Efficiency): KW x 1.34 : HP
(Final engineering calculations might differ from above, as other factors and/or variations are to be considered.)

8. **APPROXIMATE COSTS OF OPERATING A PUMP**: Based upon the hourly operating costs of an electrical motor:
MULTIPLY : KNOWN KWH COSTS X FACTORS SHOWN :

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 1 PHASE HP : | 1/3 | 1/2 | 3/4 | 1 | 2 | 3 | 5 | |
| KW : | | | 1.34 | 2.68 | 4.02 | 6.70 | | |
| FACTOR : | .408 | .535 | .760 | 1.0 | 2.0 | 2.95 | 4.65 | |
| 3 PHASE HP : | 1 | 3 | 5 | 10 | 20 | 30 | 50 | 100 |
| KW : | 1.34 | 4.02 | 6.7 | 13.4 | 26.8 | 40.2 | 67.5 | 135 |
| FACTOR : | .96 | 2.7 | 4.5 | 9.0 | 16.9 | 25.0 | 41.3 | 81.5 |

9. **PERFORMANCE DIFFERENCES BETWEEN 50 Hertz & 60 Hertz (Cycles) ELECTRICAL MOTORS:**
Pumps with 50 Hz motors have an appr. 19% lower performance than with 60 Hz motors.
Pumps with 60 Hz motors have an appr. 16% higher performance than with 50 Hz motors.

10. **CONVERSION DATA:**

**FLOW:**

1 L/min (LPM) : .264 USGPM \ .220 IGPM
1 USGPM (G) : 3.785 L/min \ 0.833 IGPM
1 IGPM : 4.546 L/min \ 1.2 USGPM
1 L/sec. : 15.85 USGPM \ 13.2 IGPM
1m3/min : 264.2 USGPM \ 220.08 IGPM

**PRESSURE**:

1m/head (MC) : 0.1 bar / 9.82kpa / 3.28'head / 1.422PSI
1'/head (FT) : 0.305m / 2.99kpa / 0.0305bar / 0.433PSI

**DISTANCE / HEIGHT / DEPTH** :

1 Meter : 39.37 Inches(") / 3.28083 Feet(')
1 Inch(") : 25.4mm
1 Foot(') : 30.4801cm

**AREA :**

1 m2 : 10.76 Square Feet (Sqft)
1 Sqft : 0.0929 m2

**WEIGHTS OF WATER:**

1Kg or 1 Liter : 2.207 Lbs
1m3 : 1000 kg / 2203 Lbs
1 cbft : 62.4 2Lbs / 28.28 Kg
1 US Gallon : 3.785 Kg / 8.36Lbs

**VOLUMES OF WATER:**

M3 : : Cubic meter
1M3 : 1000 Liter / 35.31 cbft
1 cubic foot : 28.316 Liter / 7.4805 US Gallons
1 Liter : 0.001 M3 / 0.353 cbft

**TORQUE** : (Tightening of facering bolts of lightfixtures)

1 (Newton Meter) NM : 8.85 Inch Lbs
1 (Inch Pound)"lbs : 0.12 NM

**LUMINANCE OF ILLUMINATION:**

1 CP,Candle Power per square foot : 10.764 CP/m2
1 CP,Candle Power per square inch : 1550.0 CP/m2
1 LM,Lumen per square foot : 10.763 LM/m2

11. **WATERFALLS** (**'A'** : Height of water overflowing over weir)
Suggested flow volumes per linear meter of waterfall, waterwall or overflow.

| 'A' | L/min | Suggested maximum free fall height. | |
|---|---|---|---|
| 3.5mm | 66 | 0.5m | The longer the overflow weir , the greater 'A' shall be |
| 7mm | 150 | 1.0m | to overcome minute elevation differences in the weir. |
| 10mm | 250 | 1.2m | For noise and splash reduction of waterfalls |
| 15mm | 380 | 1.5m | have water fall into center of a foam bed generated by |
| 20mm | 510 | 1.8m | a movable double row of PEM 64 Foam Jets. |
| 30mm | 690 | 2.4m | For multi level pools , storage cubic area must be provided into the base pool |
| 40mm | 1100 | 3.0m | to store all of the run off of the upper level pools before it overflows. |
| 50mm | 1500 | 3.5m | Run off happens when the circulating pump is shut off ! |

# FLOWS - NON PRESSURE

## MAX. FLOW THROUGH REMOTE STORAGE TANK RETURN PIPE or BALANCING PIPE BETWEEN POOLS AT GRADIENT (ELEVATION) PRESSURE

* Maximum Discharge / Flow in $m^3$/min (1000 L/min - 264.2 USGPM appr.) of a full (PVC) pipe from above waterlevel at given gradient or slope. For flows through a flooded, below water level of storage tank, pipe emptying submersed into same, use the 0.001% gradient regardless of actual gradient, however add cubic content of flooded pipe to that of tank for storage purposes. For gradients between those shown extrapolate values.

| Pipe Size | Slope: (Gradient) | Flow m3/min |
|---|---|---|
| 4" | 0.001% | – |
| 100mm | 0.01% | 0.4 |
| | 0.1% | 1.2 |
| 6" | 0.001% | 0.3 |
| 150mm | 0.01% | 0.95 |
| | 0.1 % | 2.3 |
| 8" | 0.001% | 0.6 |
| 200mm | 0.01% | 2.0 |
| | 0.1% | 6.0 |
| 10" | 0.001% | 2.0 |
| 250mm | 0.01% | 3.8 |
| | 0.1% | 10.0 |
| 12" | 0.001% | 3.8 |
| 300mm | 0.01% | 6.0 |
| | 0.1% | 18.0 |
| 18" | 0.001% | 8.3 |
| 450mm | 0.01% | 24.0 |
| | 0.1% | 52.0 |
| 24" | 0.001% | 13.0 |
| 600mm | 0.01% | 40.0 |
| | 0.1% | 120.0 |

**DO NOT USE DISCHARGE / FLOW DATA SUCH AS HAZEN-WILLIAMS FORMULA INTENDED FOR PRESSURE OR SUCTION FLOW INSTEAD OF THE ABOVE FOR REMOTE STORAGE TANK RETURN PIPE OR BALANCING PIPE BETWEEN POOLS!**

Sewage / Drainage engineers might refine the above when made aware of all pertinent site conditions. The above discharge / flow rates of completely filled pipe, based on the 'Manning Formula' , were adapted for gravity return flows in horizontal or near horizontal return or balancing pipe of fountains and water displays.

Beware of air locks in such pipe, caused by an upward elevation (bend) in a pipe between both lower pipe terminations, entrapping air.

For flows through partially filled pipe, establish percentage of filled area of pipe cross section , use this percentage to find flow on above information

# PEM TYPE 'A' ANGULAR SPRAY DESIGN SUGGESTIONS

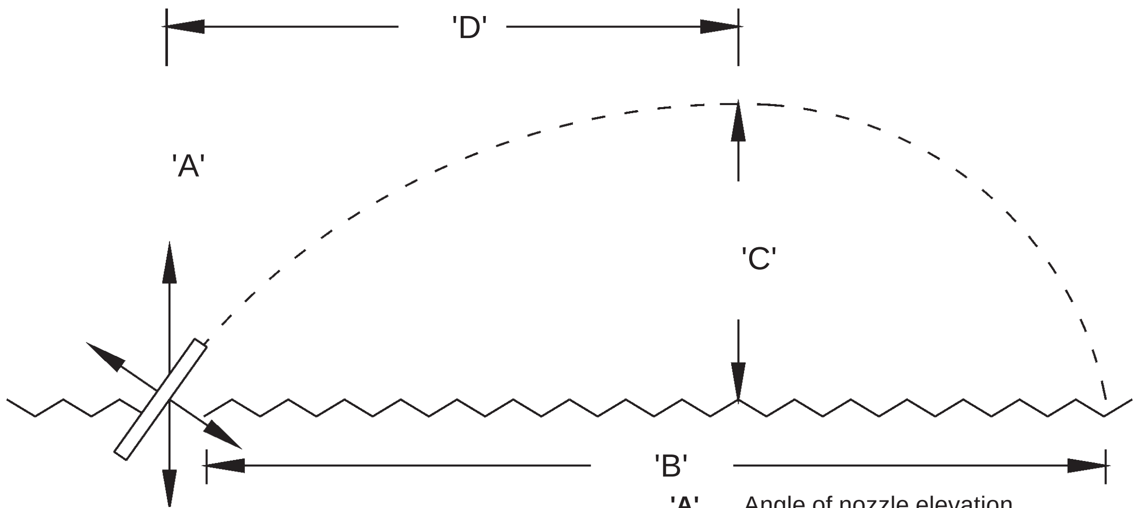
All spray design calculations are based upon linear, non-turbulent and/or non twisting inflow of water into the spray jet having minimum directional adjustment. Where turbulence and/or twisting flow is present and better performance is desired, the use of flow straightening devices in the pipe riser to the jet can show dramatic sprayheight (distance) improvements. Up to 2" pipe size, plastic flow straighteners, PEM 01050 Series, are installed into the base of a jet or in the riser pipe to the jet. Pipe sizes 2 1/2" and larger require PEM flow straightening devices, such as PEM 21000 Series dual action flow straighteners for critical major spray effects or PEM 23000 Series flow straightening flanges for regular spray effects with a lesser inflow turbulence. Follow the installation suggestions of the PEM flow straightening devices, do not follow other flow straightening device information. <u>If not certain about a particular design request assistance from factory</u>

**DESIGN FACTORS**

In General:

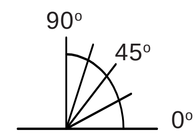
Multiplication Factors are used to find angular spray performances when sprayheight is known.

Dividing Factors are used to find the sprayheight when angular peformances are known




| 'A' | 'E' | 'C' | 'D' |
|---|---|---|---|
| 5° | 0.90 | 6% | 36% |
| 15° | 1.33 | 11% | 46% |
| 25° | 1.83 | 17% | 49% |
| 35° | 1.94 | 22% | 51% |
| 45° | 2.10 | 27% | 52% |
| 55° | 1.80 | 36% | 53% |
| 65° | 1.50 | 50% | 56% |
| 75° | 0.90 | 99% | 59% |
| 85° | 0.40 | 245% | 64% |

**'A'** Angle of nozzle elevation




**'B'** Horizontal distance of throw from nozzle.

**'C'** Height of trajectory in percentage of ' B '.

**'D'** Highest point of trajectory in horizontal distance from nozzle, measured in percentage of ' B '

**'E'** Multiplying or dividing factor for spray design calculations

**'V'** Vertical sprayheight (1967-'X')

| | **TO FIND:** | **HOW:** |
|---|---|---|
| 1. | Horizontal distance of throw for a desired angle of spray, when only the vertical sprayheight is known. | Establish vertical sprayheight (factor 'V') and multiply the same by factor 'E' to achieve horizontal spray distance.<br>('X') x ('E') : Horizontal Distance |
| 2. | Performance requirement of a spray pattern with known angle of nozzle discharge or the equivalent vertical sprayheight performance requirements | Establish horizontal distance of throw from nozzle and divide by factor 'E' on same line as shown discharge angle of nozzle . This will give vertical sprayheight which is then used to find performance requirements.<br>(A) - ('B') : ('E') : Vertical Sprayheight |
| 3. | Trajectory of a spray of water | Establish horizontal distance of throw (factor 'B') then calculate factors 'D' and 'C' thereof and combine the results with 'B' to lay out the trajectory. |
| 4. | The jet elevation angle (factor 'A')for the specifi cation of particular trajectories or spray effects. | Establish horizontal distance of throw (factor 'B'),calculate highest point of trajectory (factor 'C') thereof and read on the factors table the angle of elevation (factor'A') on the same line as the result of the calculated height of trajectory (factor 'C') |
| 5. | The manometric <u>nozzle</u> pressure for a sprayheight | Multiply vertical sprayheight (factor 'V') x 1.22 + 10% . |

**Data given on this page are stricly infomative only, to be used in the layout of normal size water displays, for special applications provide full scale prototype testing as <u>to be installed</u> before providing artistic impressions of the project.**

# SUGGESTIONS
# ABOUT
# FLOTATION DEVICES
# FOR FLOATING FOUNTAINS

The basic construction of a platform to support the equipment including submersible pump to be expanded stainless steel with stainless steel angle supports and frame. The platform to be suspended from 2 or 4 floatation pontoons by means of threaded stainless steel rods
These pontoons may consist of stacked closed pore styrofoam panels held in place by a U shape stainless steel cross bar on top of the styrofoam panels. The styrofoam floatation to be covered with fibreglass or stainless steel cover, protecting it from sun and floating chemicals.Styrofoam Floatation cannot be sunk by small caliber gun shots or ramming by boats
Pontoons can also be of sealed plastic or stainless steel tubing or fabricated of stainless steel or fibreglass. Any air filled flotation tank can cause the pontoon to be sunk by gun shots unless filled with Ping Pong Balls or similar floatation devices.
In order to design the carrying capacity the following is suggested:

**A. STYROFOAM FLOATION OR COMPRESSED AIR FILLED FLOATATION TANKS**
1 cubic decimeter (Liter) of closed cell styrofoam floatation ( or air) supports appr. 10 kg of weight less its own weight or 6 to 7 kg
1 cubic decimeter (L) of styrofoam floatation with cover and fittings weighs appr. 3 to 4 kg,
PVC or stainless steel tube will weigh somewhat more.
The same as for styrofoam flotation dimensions applies to compressed airfilled tanks,
except that the weight of tanks must be added to the total weight.

**B. COMPRESSED AIR FILLED FLOTATION TANKS**
In most placed that experience freezing winters, the raft has to be removed for the winter. With air filled flotation tanks, the air can be released through pairs of red and white long plastic tubes leading to shore or marker buoys, the red tube terminates inside the air chamber at the bottom, the white on the top. The lower tube can be held below water, allowing water into the chamber with the air to escape through the upper tube and the unit settles to the bottom of the lake. In the spring , compressed air is pumped into the upper tube, the replaced water leaves through the lower tube and the unit rises to the surface.

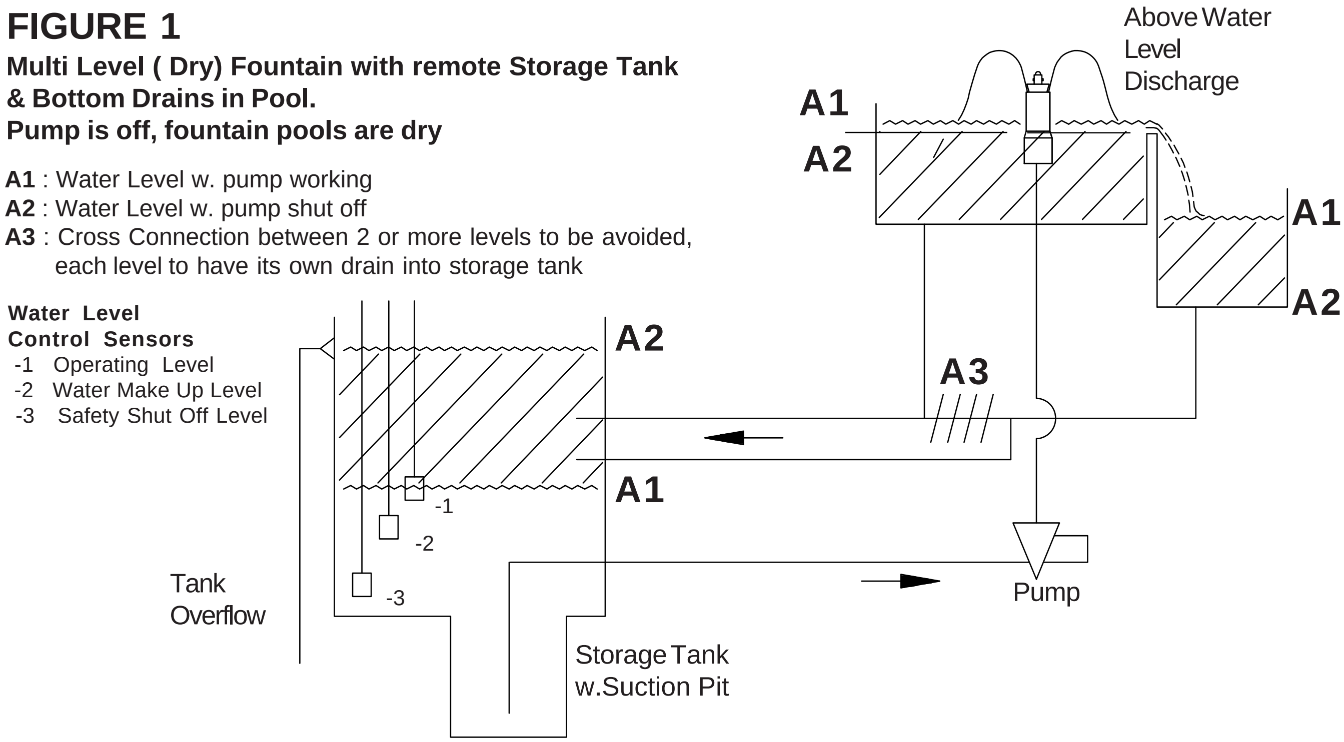
**NOTE:**
The total weight of the construction must include the weight of the anchoring and electrical cable suspended from the raft. In open waters subject to wave action, the anchoring must be of the self leveling type with counter weights suspended over rolls.
In addition to weight of construction, the vertical downwards back thrust of the jet(s) must also be accounted for . To do this, multiply nozzle orifice area by ejection pressure in Kgcm.
As the weight of a floatation raft with mounted equipment can be substantial, proper eye mounts for crane cable hooks must be present, usually 4, evenly spaced and supported.
Always attach at least 2 stainless steel ropes of sufficient size to the raft and long enough to have 2 marker buoys riding the water surface, this to identify the site and when need be to lift it up.

# SUGGESTIONS FOR FOUNTAINS WITH REMOTE STORAGE TANK PIPING

## FIGURE 1

**Multi Level ( Dry) Fountain with remote Storage Tank & Bottom Drains in Pool.**
**Pump is off, fountain pools are dry**

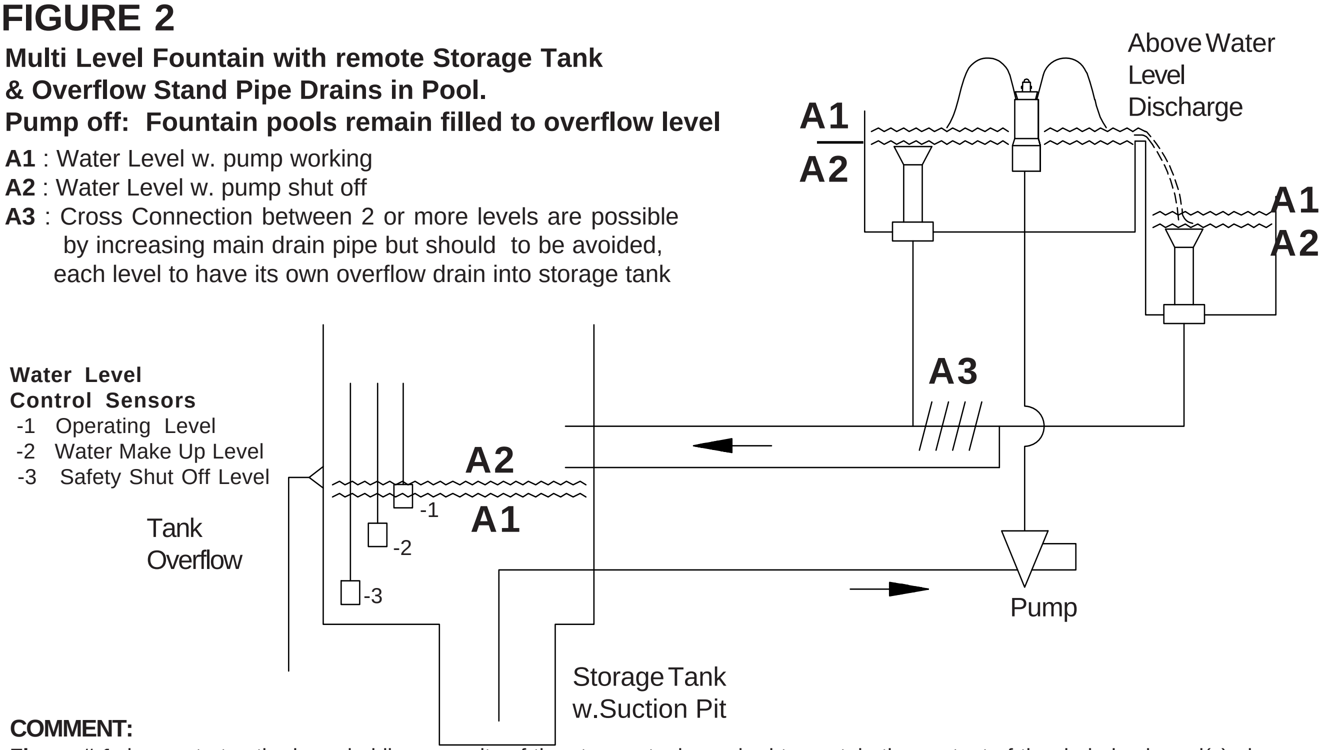
**A1** : Water Level w. pump working
**A2** : Water Level w. pump shut off
**A3** : Cross Connection between 2 or more levels to be avoided, each level to have its own drain into storage tank




## FIGURE 2

**Multi Level Fountain with remote Storage Tank & Overflow Stand Pipe Drains in Pool.**
**Pump off: Fountain pools remain filled to overflow level**

**A1** : Water Level w. pump working
**A2** : Water Level w. pump shut off
**A3** : Cross Connection between 2 or more levels are possible by increasing main drain pipe but should to be avoided, each level to have its own overflow drain into storage tank




**COMMENT:**

**Figure # 1** demonstrates the large holding capacity of the storage tank required to contain the content of the drain back pool(s) also cross connection(s) must be be avoided between levels, each level to be separately drained into storage tank.
In this figures, the water make up is discharged into the storage tank.

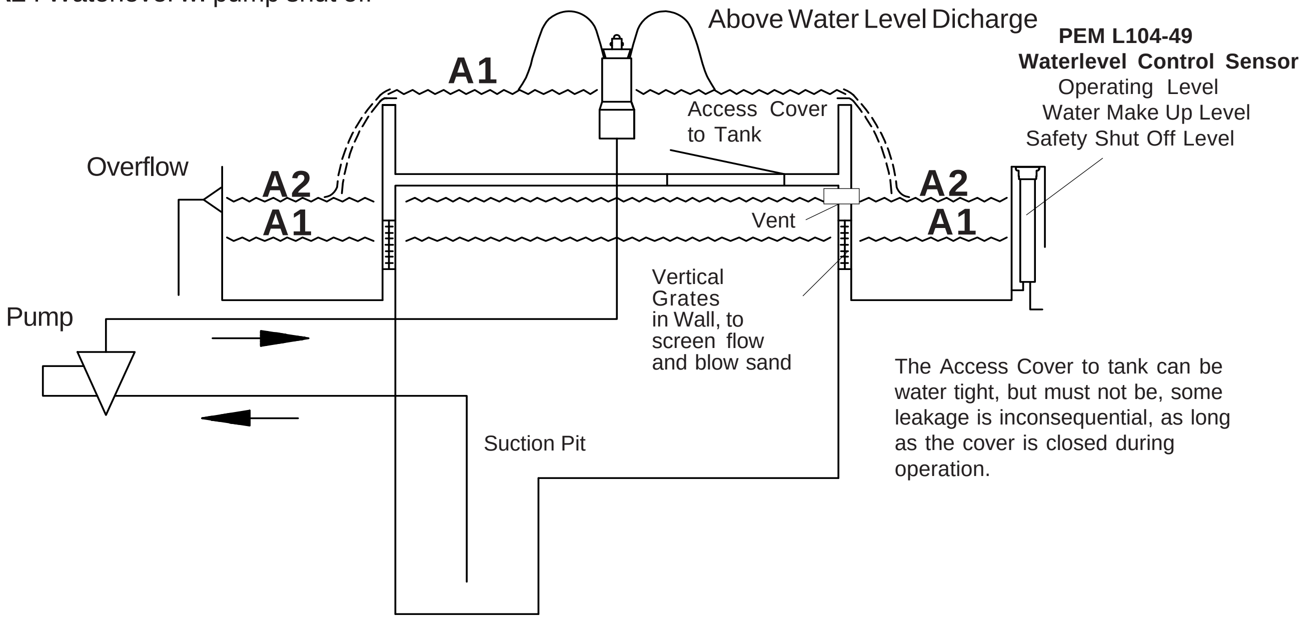
**Figure # 2** shows the decreased holding capacity of the storage tank due to the retention of content in pool(s) due to overflow stand pipe drains . Cross connection are possible but should be avoided of more than one elevation, each elevation to be separately drained into storage tank. In this figures, the water make up is discharged into the upper pool(s) filling same before filling storage tank.

Great care is to be taken not to have air lock(s) in drain pipe. (Air Locks, caused by air entrapped into pockets of pipe, that does not have a continuous upward slope/gradient . Air Locks can stop the gradient flow of water) - The storage tank to be vented to athmosphere.

# SUGGESTIONS FOR
# PIPING
# WITH STORAGE TANK UNDER FOUNTAIN

## FIGURE 1
**Fountain with external dry type pump**

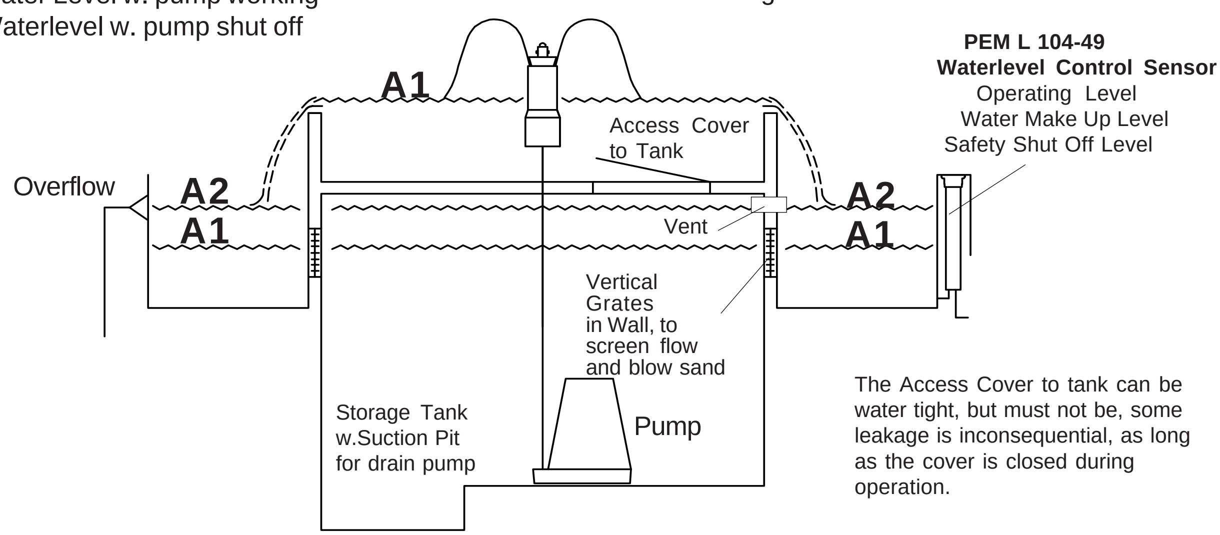
**A1** : Water Level w. pump working
**A2** : Waterlevel w. pump shut off




The Access Cover to tank can be water tight, but must not be, some leakage is inconsequential, as long as the cover is closed during operation.

## FIGURE 2
**Fountain with internal submersible pump**

**A1** : Water Level w. pump working
**A2** : Waterlevel w. pump shut off




The Access Cover to tank can be water tight, but must not be, some leakage is inconsequential, as long as the cover is closed during operation.

# SUGGESTIONS FOR PIPING
# FOR FOUNTAINS WITH REMOTE STORAGE TANK PIPING

**Fountain with Water Level Dependent Jets in**
**Multi Level ( Dry) Fountain with remote Storage Tank**
**& Bottom Drains in Pool.**
**Pump is off, fountain pools are dry**

**A1** : Water Level w. pump working
**A2** : Water Level w. pump shut off

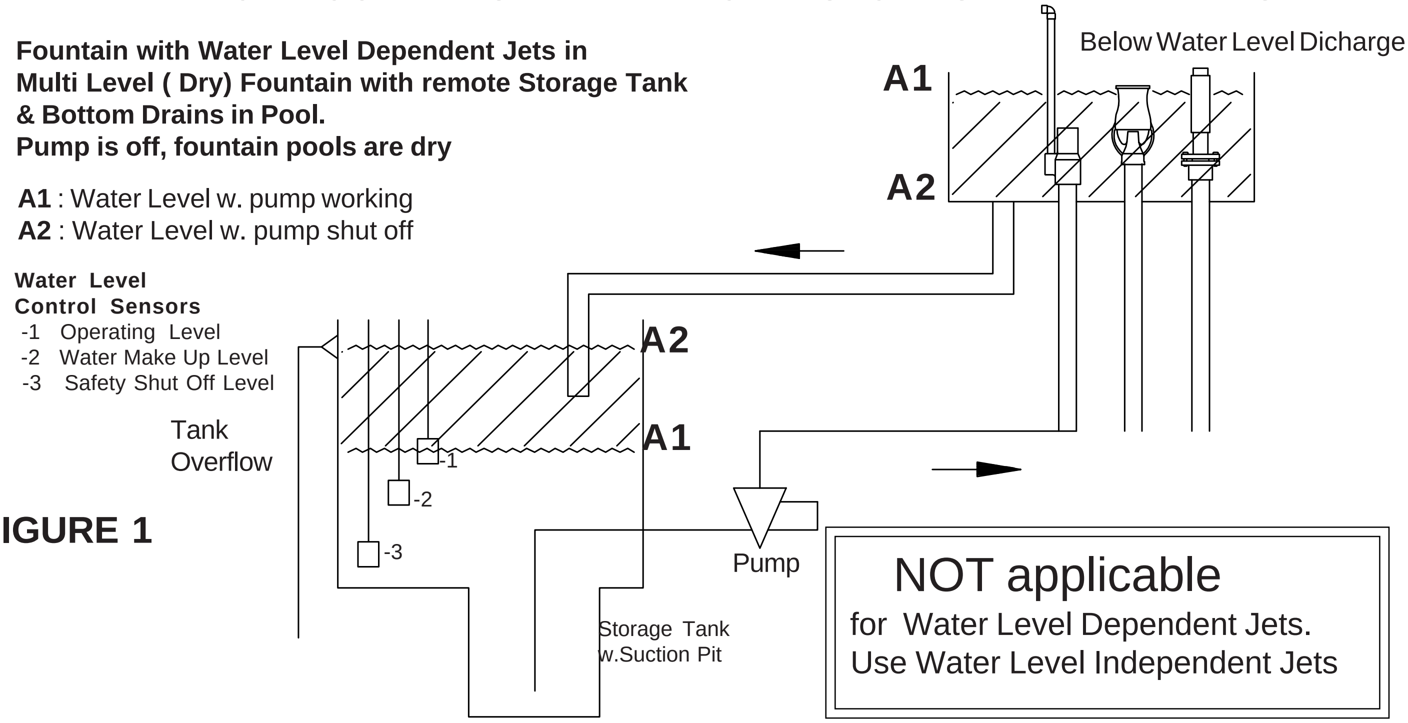



**FIGURE 1**

**Fountain with Water Level Dependent Jets in**
**Multi Level Fountain with remote Storage Tank**
**& Overflow Stand Pipe Drains in Pool.**
**Pump off: Fountain pools remain filled to overflow level**

**A1** : Water Level w. pump working
**A2** : Water Level w. pump shut off
**A3** : Water Level w. Pump shut off
and Check Valve not sealing
**A4** : Check Valve in Pump Discharge

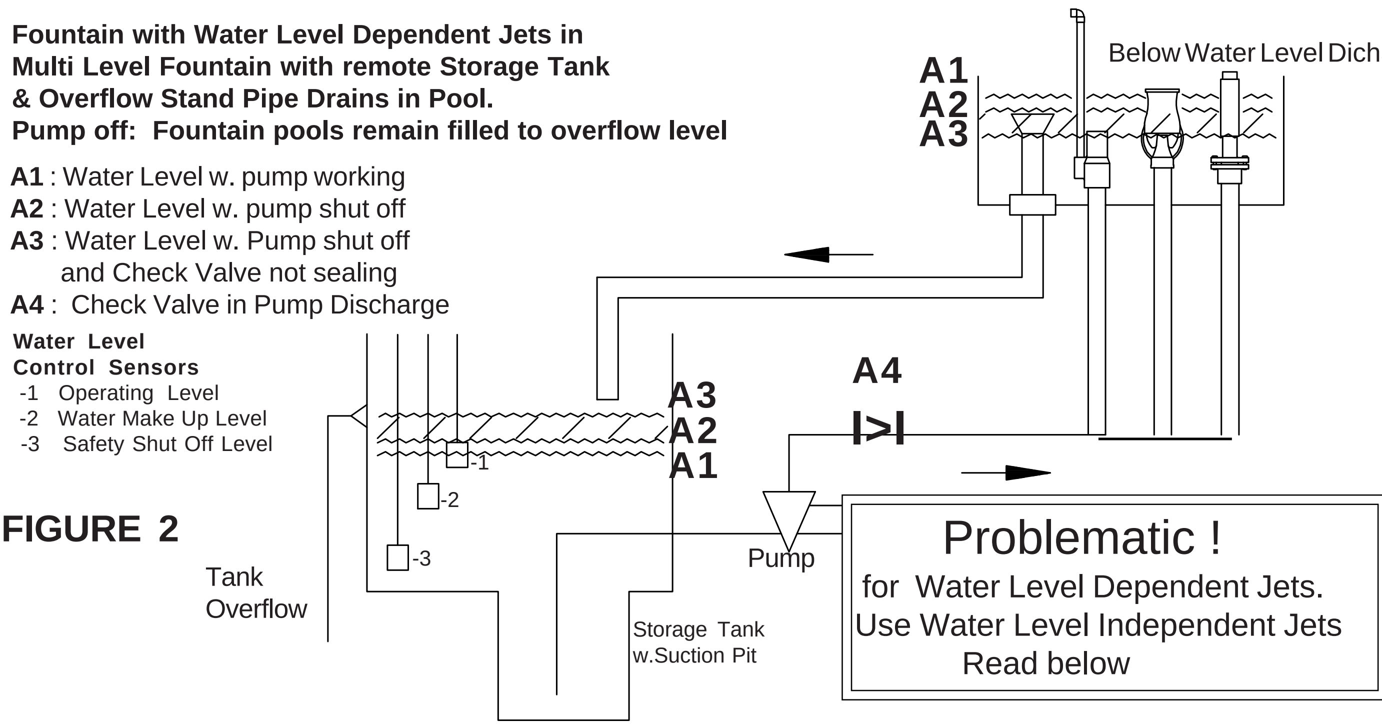


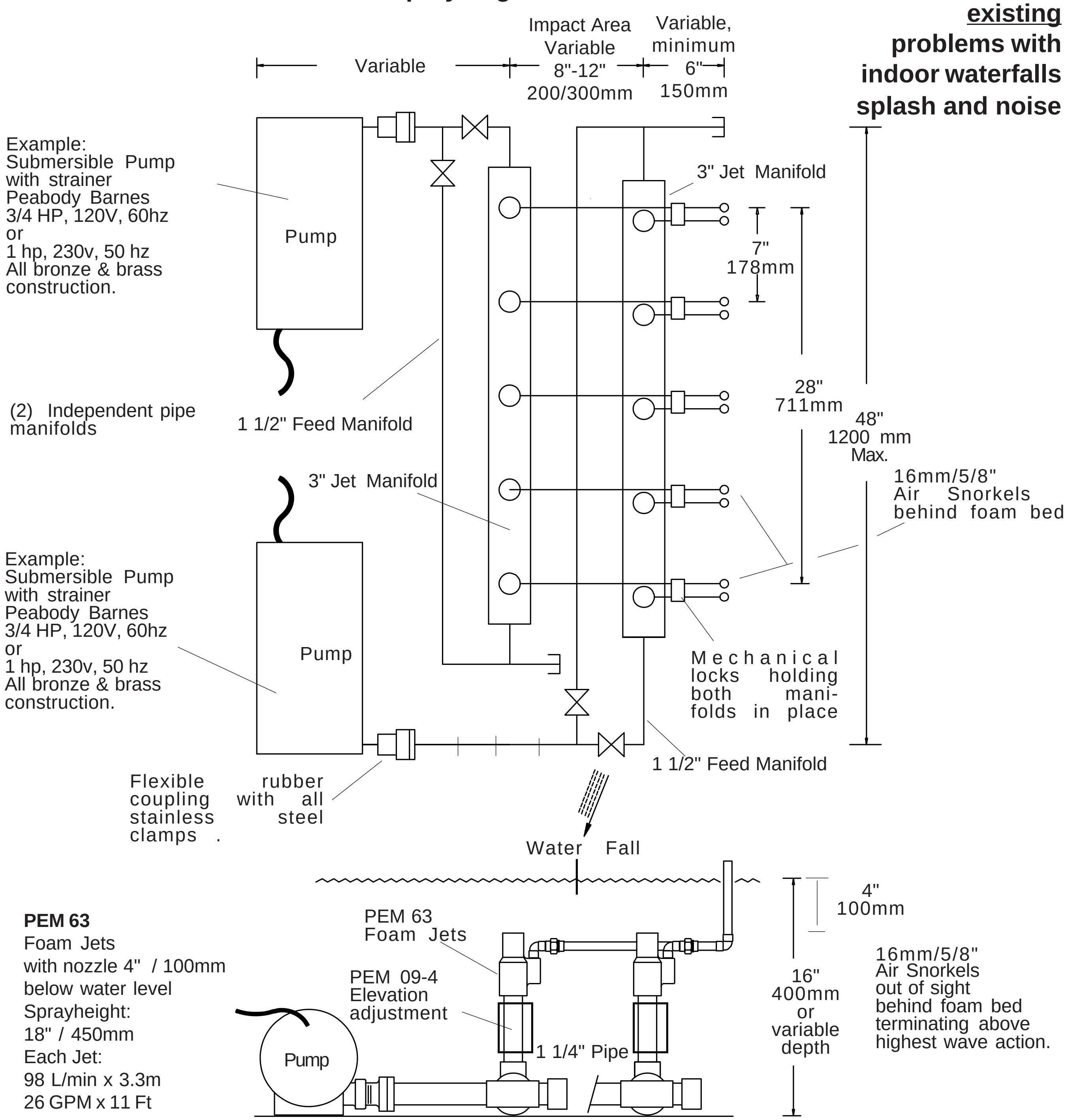

**FIGURE 2**

**COMMENT:**
**Figure # 1** shows water level dependant jets fully exposed with pump shut off , the jets might not be able to refill the pool as the sprays will be too high and not fall back into the pool, filling same. A common design fault, use water level independent jets!
**Figure # 2** shows a design that depends on the perfect sealing of the check (No Return) valve in the pump discharge to maintain the water level for the water level dependent jets after pump is shut off. If the check valve leaks, the water level dependent jet pressure nozzles might be fully exposed and not be able to refill the pool as the sprays will be too high and might not fall back into pool. A common problem, only solved by a secondary pump (water filter) system that is working all the time, refilling the leakage from the pool through the check valve, or by using water level indepent jets.**Most check valves require more back pressure to seal than available with a fountain elevation differential pressure.**
In both figures, the water make up is discharged into the upper pool(s) filling same before storage tank.
- The storage tank must be vented to atmospere, to prevent air lock.

# WATERFALL FOAM BED

**No Splash, reduced noise FOAM BED for 24" / 0.6M WIDE WATERFALL 15 Feet , 4.5m Height, Indoors. Double manifold with customized PEM 63 Foam Jets 18" - 400mm Sprayheight**

**A quick cure suggestion to overcome <u>existing</u> problems with indoor waterfalls splash and noise**




The foam bed assembly consist of 2 separate 5 jet manifolds, one in front of falling water, the other behind, final placement must be made under falling water which is to fall exactly into the center between the rows of jets placed as close as possible together.

If the waterfall and pool has other dimensions, adopt the above solution - it just might work.

For aestetic reasons, paint all equipment same color as color of pool, to make it not so noticeable. - If the problems also include failure of air conditioning due to water evaporation, get and install a water chiller to keep the water temperature below that of the ambient air temperature surrounding the water display.