Energy Management

Energy Management

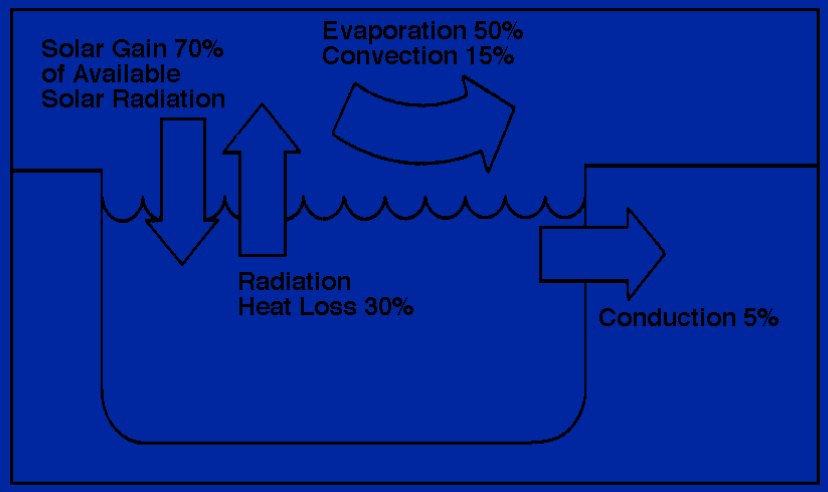
- Windbreaks
- Pool covers
- Solar & geothermal heating systems
- High efficiency pool water heaters
- Natatorium air quality
- Efficient pumps and motors
- Energy efficient lighting

Energy Management Plan

- Train personnel to conserve energy
- Establish energy reduction goals
- Develop energy maintenance procedures
- Coordinate use of equipment
- Conduct periodic energy audits
- U.S. Dept. of Energy's RSPEC! (Reduce Swimming Pool Energy Costs) program
  - For copies of software of fact sheets, call or write:
  - (202) 586-8034 or (800) DOE-EREC
  - Energy Efficiency and Renewable Energy Clearinghouse, P.O. Box 3048, Merrifield, VA 22116

Heat Loss

- Radiation
  - Heat lost to the surrounding cold still air
- Evaporation
  - Heat lost to water dissipation
- Conduction
  - Heat lost through contact with a cold
  - object
- Convection
  - Heat lost to moving air or water



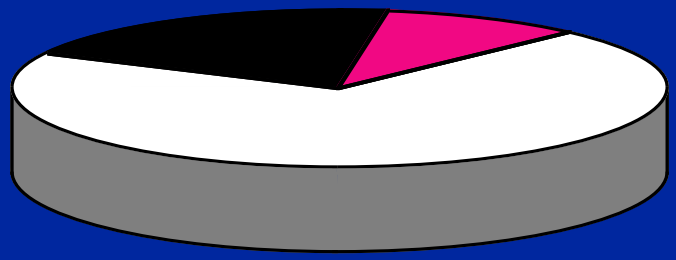
Factors Affecting Heat Loss

- Temperature difference between air and water
- Pool surface area
- Relative humidity
- Air velocity
- Geographic location

Energy Loss Characteristics

U.S. Department of Energy

- Outdoor Pools
  - 70% Evaporation
  - 20% Radiation
  - 10% Ground



- Indoor Pools
  - 70% Evaporation
  - 27% Ventilation
  - 3% Other

Evaporation

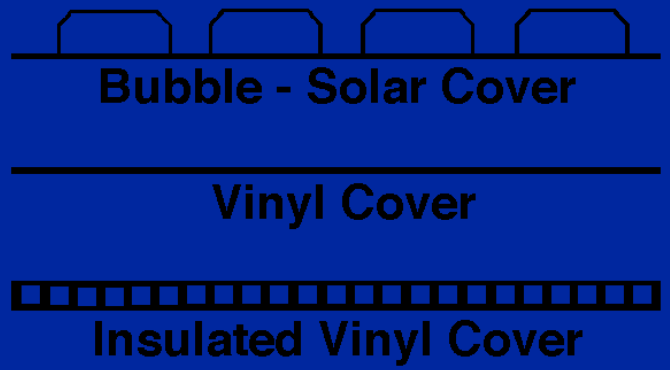
- Evaporation is the major source of energy loss from pools
- The higher the wind speed and water temperature, and the lower the humidity, the greater the evaporation rate
- 1 BTU is needed to raise 1 pound of water 1 degree
- For each pound of 80 degree water lost due to evaporation, 1,048 BTUs of heat are lost from the pool

Windbreaks

- Use trees, shrubs, fences, windscreens, walls... to shelter the pool surface from the wind
- A 7 mph wind blowing across the surface of the pool can increase energy consumption by as much as 300%
- Wind velocity affects rate of convection and evaporation losses

Pool Covers

- The most effective way to reduce pool heating costs is to cover the pool
- Reduced heating costs (50 - 70%)
- Conservation of make-up water (30 - 50%)



Pool Covers

- Prevents dirt and debris from entering pool
- Reduced maintenance time and costs
- Reduced chemical consumption
- Reduced need to ventilate indoor pools and pre treat outside air
- Reduced rusting and deterioration of structural components

Solar Heating Systems

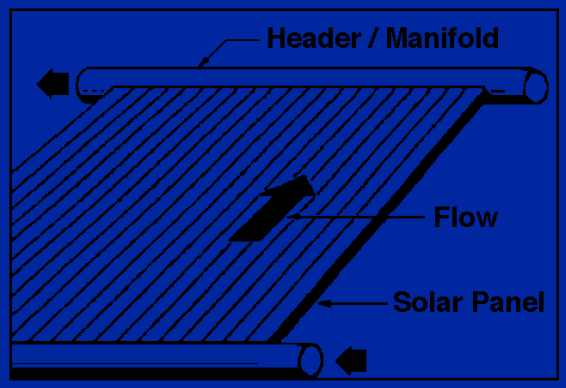
- Panels can be mounted on a roof, deck rack, or on the ground
- Ideally, panels should face due South -- but if within 15 degrees East or West of due South, there's little loss of performance
- Panel angle
  - Summer heating: Latitude minus 10 - 15 degrees
  - Winter heating: Latitude plus 10 - 15 degrees
  - Year 'round: Latitude

Solar Heating Systems - Glazed

- Black chrome-plated copper absorber plates with a low iron tempered glass covering
- Can operate year 'round in harsh climates
- Require transfer fluid and heat exchangers
- A booster pump to lift water to panels installed on a roof may also be needed

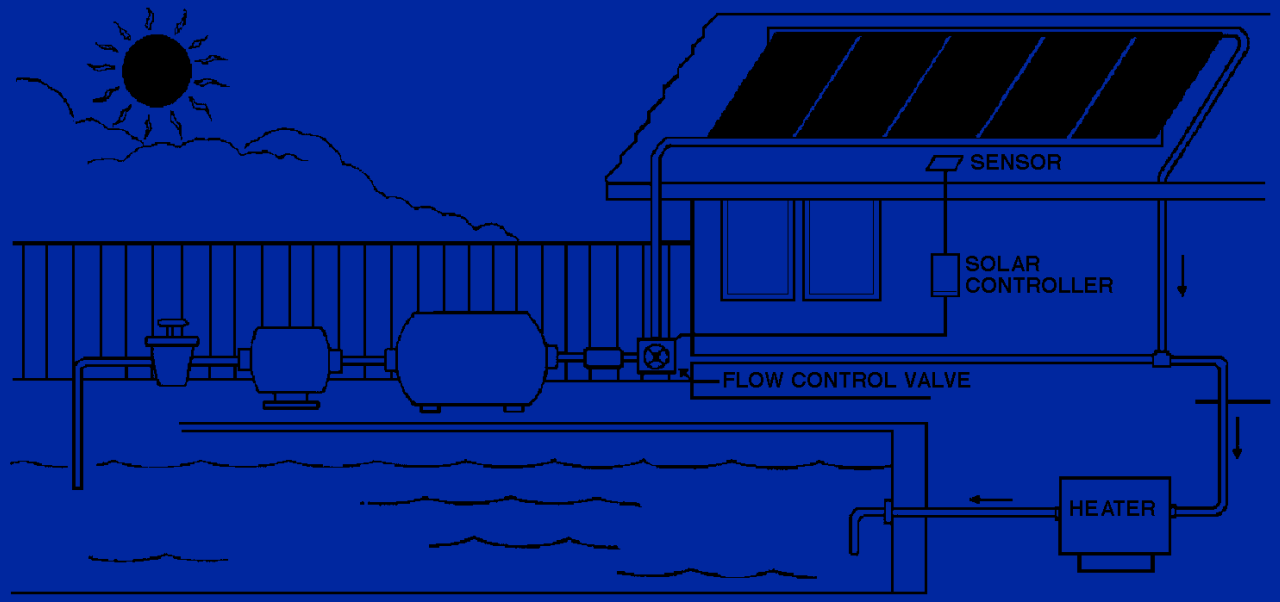
Solar Heating Systems - Unglazed

- Inexpensive for use in warm climates and outdoor seasonal pools
- Water circulates directly through collectors, using the pool pump, and 2 heat sensors connected to a solar controller
  - One sensor measures pool temperature
  - The other measures temperature at the controller surface
  - If temperature differential is significant, the controller sends a signal to a motorized valve that closes and directs water through the collectors



Solar Heating Systems - Unglazed

- Black thermoplastic rubber or polypropylene absorber plates

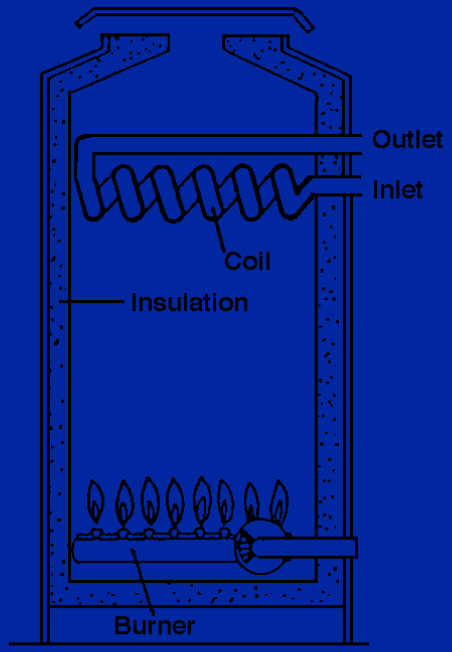


Geothermal Heat

- Use of natural hot springs to heat pools
- Mixing and cooling reservoirs
- Availability based on geographic location
- Potential problems: sulfur odors, high mineral content, aggressive water

Pool & Spa Heaters

- Fossil fuel heaters
  - Direct fired
  - Electric immersion element
  - Indirect fired
  - Heat pump
- Alternative energy sources
  - Solar
  - Geothermal



Heating Methods

- Temperature maintenance:
  Size is calculated using surface area

- Intermittent or spot heating:
  Size is calculated using volume

Heater Ignition Systems

- Millivolt Heaters
  - Continuous pilot light to ignite burner
  - Banned in some states (CA, NY) on new pool installations
  - Energy waste
- Intermittent Ignition Systems
  - AKA: spark ignition, electronic ignition, or pilotless ignition
  - Require electrical hook-up or line voltage

Heater Efficiency

- Heater Efficiency = Heater Output ÷ Heater Input
- Output = Input x Heater Efficiency
- Efficiency ratings:
  - Pool gas heaters 75 - 97%
  - Heat pumps 400%
  - Electric heaters 100%

Water Column (WC)

- Unit for expressing pressure
- 1 inch water column = 0.0578 ounces per square inch
- 1/30 of 1 psi
- 28 inches water column= 1 psi

Intermittent Heating

419,415 BTUs per 1,000 ft^2 for 15° rise in 24 hours

559,220 BTUs per 1,000 ft^2 for 20° rise in 24 hours

699,025 BTUs per 1,000 ft^2 for 25° rise in 24 hours

838,830 BTUs per 1,000 ft^2 for 30° rise in 24 hours

_____ BTU output

x _____ (1,000 ft^2)

÷ _____ % E rating

= _____ BTUs input

Temperature Maintenance

157,500 BTUs per 1,000 ft^2 for 15° temperature rise
210,000 BTUs per 1,000 ft^2 for 20° temperature rise
263,000 BTUs per 1,000 ft^2 for 25° temperature rise
315,000 BTUs per 1,000 ft^2 for 30° temperature rise

_____ BTU output
x _____ (1,000 ft^2)]
÷ _____ % E rating
= _____ BTUs input

Pool Heater Sizing Example

Fuel:	Natural gas
Heat method:	Temperature maintenance
Dimensions:	75' x 48'
Surface area:	3,600 square feet
Desired temperature:	85°
Max. temperature rise:	25°
Efficiency rating:	97%
Heater output:	1,000 ft^2/25° rise = 263,000 3.6 x 263,000 = 946,800 BTU
Required heater input:	946,800 ÷ .97 = 976,082 BTU

Commercial Pool Heater Sizing

- Pool surface area (ft^2)
- x 15--a constant that represents the BTUs required to raise water temperature one degree per square foot of surface area
- x Desired increase in water temperature over ambient air temperature
- Example:
  ($6{,}150\ ft^2$) x (15) x (25°) = 2,306,250 BTU

Heater Installation

- Establish adequate clearances
  - Oxygen is needed for combustion to occur
- Install on a level, non-combustible base
- Minimize the effects of wind
- Compensate for altitude
  - For each 1,000 feet in altitude above sea level, increase heater size by 4%
- Insure an adequate supply of fuel--natural gas 5-10 WC, LP gas 11-14 WC
  - Anything that restricts the flow of gas may cause problems
  - Incorrect gas volume will cause over or under firing of heater
- Correctly size the heater

Heater Installation

- Correctly size the hydraulic system
  - Water flow can erode heater piping and components
- Install a thermostat and high temperature limit switch
- Install a flow or pressure switch
- Install a gas pressure regulator
- Locate the heater away from combustible materials
- Keep pool chemicals away from the heater
  - Corrosive fumes will damage the heater
- Bond and ground the heater to prevent hazards of electrical shock
- Install the heater downstream of the pump and filter, and upstream of chemical injection equipment

Heater Installation

- Install a fireman's switch
  - If a timer is installed, a separate low voltage fireman's switch should also be installed to deactivate the heater several minutes before pump is turned off
- Maintain proper water balance
  - Calcification or corrosion and early destruction of heater elements will result if water is not balanced
- Install heater close to the pool to minimize heat loss
- Install a copper, stainless steel or CPVC heat sink between the heater and piping
- Install check valves in line between the filter and heater, and between the heater and chemical injection equipment

Heater Installation

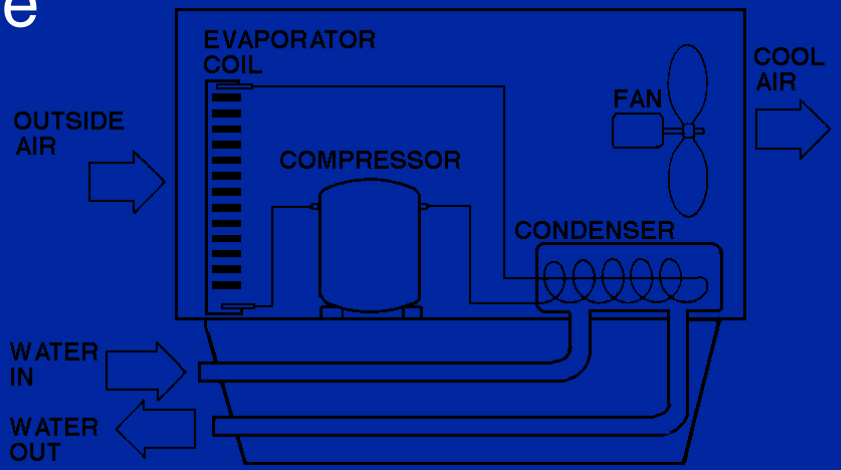
- Properly vent to insure combustion and adequate exhaustion
- Install in compliance with codes and regulations:
  - ANSI Z223.1-1984: National Fuel Gas Code
  - ANSI Z21.56 Gas Fired Pool & Spa Heaters
  - American Gas Association
  - Underwriters Laboratories
- Read the instruction and maintenance manual provided by the manufacturer
- To avoid accidents:
  - Only look at the pilot light with a mirror
  - Relight the pilot with long matches or a lighting tool
  - Use dish soap to test for leaks -- don't use matches

Heat Pumps

- Energy efficient method of reclaiming and recycling energy
- Generate heat by using energy taken from surrounding air and transferring it to pool water
- Fan assembly draws air through the evaporator
- Evaporator collects heat from the air and warms the refrigerant gas
  - Usually freon, a non chlorine fluorocarbon
  - When gas is compressed temperature increases
  - Higher the ambient air temperature, the faster and better heat pumps work

Heat Pumps

- Compressor compresses the warmed refrigerant
- Heat exchanger transfers heat absorbed by refrigerant in the compressor to the water flowing through adjacent piping

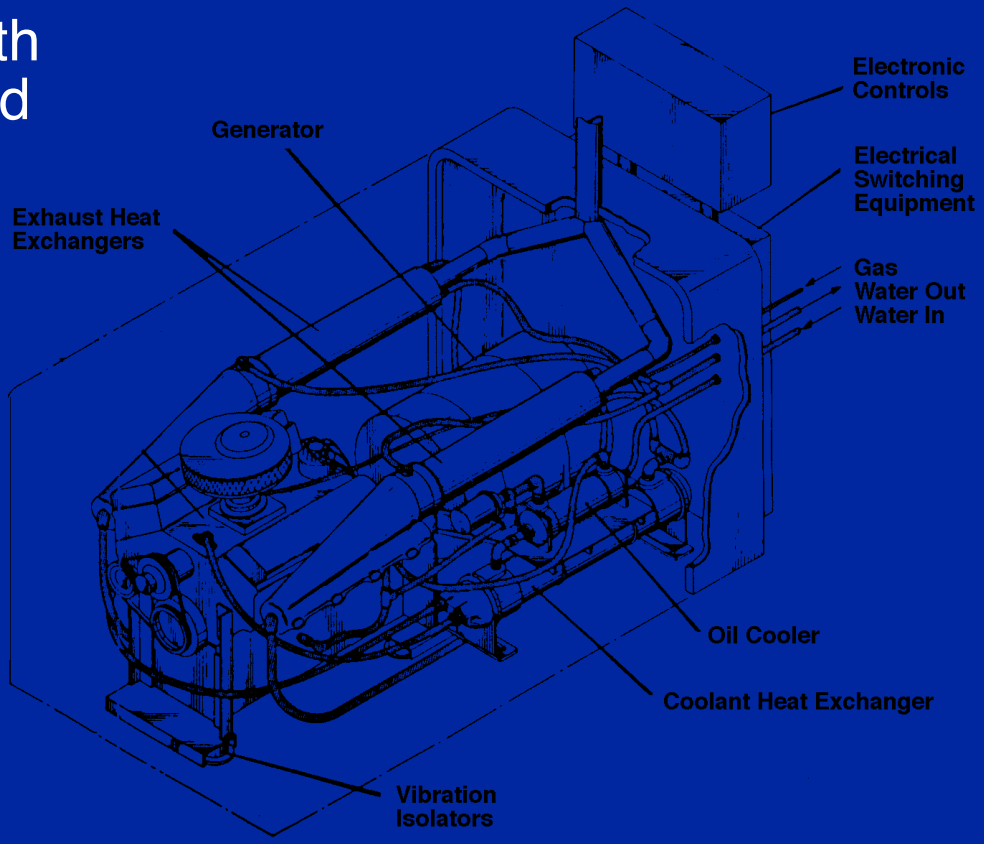


Heat Pumps

- Gas cools from coming into contact with water, and is the re compressed and reheated
- Heat pumps are rated in tons like air conditioners, rather than like heaters
  - 1 ton equals the amount of energy needed to keep 1 ton of ice frozen at 32° for 24 hours
  - 1 ton equals approximately 15,000 BTUs

Co-generation

- Generation of both electric power and heat on-site
- Energy efficient and economic heating method



Co-generation

- Pool acts as the heat sink to transfer the heat by-product created by the (oil, natural gas or diesel) engine, electrical generator, radiator, and exhaust equipment
- Engine turns a generator which produces electric power (kilowatts)
- Utilize heat exchangers
- Problems:
  - Initial cost of equipment
  - Space requirements
  - High maintenance and downtime
  - Noise

Energy Cost of Operating a Pool Circulation Pump

(Motor amps _____ x Voltage _____) ÷ 1,000

= _____ kwh

x _____ cost per kwh (from electric bill)

x _____ hours per day pump is operated

x _____ days per year pump is operated

= _____ average cost to operate pump per year

Illumination Levels

- Minimum wattage: 3.5 - 5.0 watts per square foot of water surface area (incandescent)
- Illuminating Engineering Society, NCAA and U.S. Swimming recommend that pool lighting be based on illumination levels (luminous output) rather than wattage (energy input)
- Indoor pools: 100 footcandles
- Outdoor pools: 60 footcandles
- Pools used for elite level competition: 150 - 200 fc
- Test using a light meter or photometer

Natatorium Lighting

- Cost of light bulb
- Fixture
- Wattage and lumens/watt
- Bulb replacement (frequency, life expectancy, labor costs)
- Color
  - Incandescent — White
  - Low pressure sodium — Bug light yellow
  - High pressure sodium — Pinkish-yellow
  - Mercury vapor — Greenish-yellow
- Glare potential
- Efficiency (cost of operation)
- Start-up or re-strike requirements (warm-up or instant light)

Lighting

- Incandescent
- Halogen
- Fluorescent
- High intensity discharge
  - Metal halide
  - Mercury vapor
  - High pressure sodium
  - Low pressure sodium
- Fiberoptics
- Sulfur (experimental, don't burn out, 3 = 94 mercury vapor bulbs)

Light Comparison

- Color
  - \+ Metal halide, fluorescent, incandescent
  - \- Low pressure sodium, mercury vapor, high pressure sodium
- Glare
  - \+ Fluorescent, metal halide
  - \- High pressure sodium (alternate with amber lights), Incandescent
- Candlepower (lumens/watt)
  - \+ Metal halide
  - \- Fluorescent

Light Comparison

- Instant light
  - \+ Fluorescent
  - \- Mercury vapor, metal halide, high pressure sodium
- Life expectancy
  - \+ Fluorescent, metal halide
  - \- Incandescent
- Energy efficiency
  - \+ Fluorescent
  - \- Incandescent, mercury vapor

Fluorescent Bulbs

Compact fluorescent bulbs use 75% less electricity and last 10 times longer than conventional incandescent bulbs. Over its lifetime, one compact fluorescent bulb will save enough energy to cut 600 pounds of carbon emissions from a typical coal-fired electric plant.

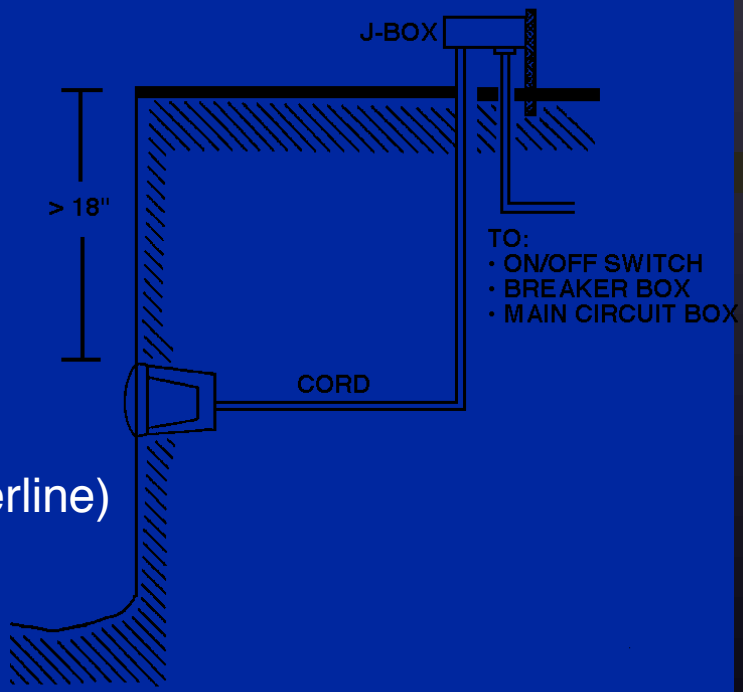
Smithsonian display - Museum of Natural History

Lights

- Deck and area lighting
- Underwater lights
- Security lights
- Exit lights
- Natural light
- Exterior building lights, parking lot lighting

Wet Niche Underwater Pool Lights

- Typical pool lighting circuit:
  - Light bulb
  - Lamp assembly
    (lens, gasket, face plate,
    set screw, washer)
  - Recessed niche
  - Cord, conduit
  - Ground wire
  - J-box or transformer
    (4’ from pool and 8” above waterline)
  - On/off switch, breaker box
    (fuses, breakers, GFCI)
  - Main circuit box



Wet Niche Underwater Pool Lights

- Mounted in pool wall 18” below the water surface
- Sealed, water-tight fixture
- Cooled by surrounding water

Dry Niche Underwater Pool Lights

- Mounted in niches that extend through the pool wall and are separated from the water by a glass lens
- Serviced from behind the pool wall from an access tunnel
- Air and water cooled
- Housing, lens, lamp assembly, junction box