Seresco

SERESCO NE SERIES DEHUMIDIFIERS

NATATORIUM DESIGN MANUAL

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Your Natatorium Get What You Need (and Want)

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Natatorium: a facility that contains an indoor pool, whirlpool or spa ranging in size from a small residential installation to a large commercial indoor waterpark.

Seresco: (pronounced Sir-ES-co) Latin root meaning "to become dry".

Seresco's Natatorium Design Manual was developed by a team of industry experts with a lifetime of experience developed while working with many thousands of indoor pools. A natatorium has many critical design issues that must be fully understood and properly addressed to ensure years of comfortable and trouble free operation of the facility.

A NEW LEADER

Seresco Technologies Inc. was born from a team with over 50 years of collective industry experience and a desire to embrace technology and use it to produce products that set a new benchmark in the dehumidification and energy recycling industry. Use of new technologies and creative design advances combined with a solid engineering base in mechanical refrigeration, humidity control and manufacturing have together resulted in the launch of the first innovations seen in natatorium air quality control in the past 15 years.

The Seresco team is directly involved with the engineering community through ASHRAE (American Society of Heating, Refrigeration and Air Conditioning Engineers). Our expertise contributed to a major upgrade of ASHRAE natatorium design guidelines published in their 2003 Handbook of HVAC Applications.

This booklet contains valuable design guidelines based on Seresco's extensive knowledge and experience in solving humidity control problems in many thousands of indoor pool installations. Seresco Technologies Inc., manufacturer of the NE Series of natatorium air quality control systems is dedicated to providing state-of-the-art features and design, quality engineering and the most reliable products in the market.

GETTING WHAT YOU WANT

The environment in a natatorium should be the same as in any other room in a building: comfortable and healthy for the occupants and their activity, and provide good air quality. The space conditions in a natatorium need to be precisely maintained in order to maximize human comfort and health as well as preserve building integrity. Relative humidity, air temperature, water temperature and air quality are all key environmental aspects to control. High relative humidity levels are not only a problem to bather comfort and health, but can seriously damage the building structure possibly leading to building component failures. Revenues can also be affected in commercial facilities. Several hotel chains offer a full money-back guarantee should the hotel guest have any complaint regarding their stay.

Complaints impact the bottom line. Patrons want a clean, comfortable, healthy and odor free natatorium.

A properly designed and maintained natatorium delivers years of pleasure.The first step is to become familiar with the design challenges and to understand how to address them. A Natatorium's overall performance is inversely proportional to the amount of compromises and shortcuts taken in the design and construction of the natatorium.

A Successful Design - Understanding the Design Challenges

This section addresses issues related to occupant comfort, health and safety. A natatorium is one of the most notoriously difficult facilities to design because there are so many critical considerations that if overlooked develop into problems with the building structure or complaints for the occupants. The designer must take a complete system approach, from basic engineering issues to the more subtle details in the air distribution. Experience and a complete understanding of the design issues help the designer satisfy:

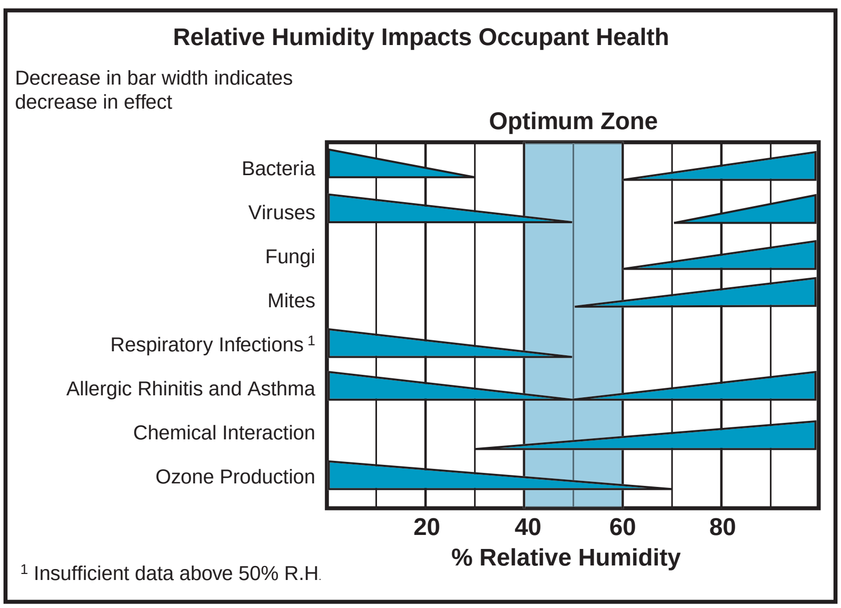
- Comfort and health
- Humidity control
- Indoor air quality
- Condensation control

Indoor pools are normally maintained between 50 and 60% RH for two reasons:

- Swimmers leaving the water feel chilly at lower relative humidity levels due to evaporation off the body, and
- It is considerably more expensive (and unnecessary) to maintain 40% RH instead of 50% RH.

2.1. COMFORT AND HEALTH

Human comfort levels are very sensitive to temperature and relative humidity. It is essential that both are controlled and stable. While temperature control is generally well understood and mastered by designers, it is important to recognize what temperature levels natatorium patrons want. The space temperatures in a natatorium are unique to each project and assumptions must never be made. Fluctuation of relative humidity levels can be an even greater concern because it has a direct effect on human comfort and health. Figure 1 shows that relative humidity levels outside the 40%- 60% range can result in increased human susceptibility to disease from bacteria, viruses, fungi and other contaminants that reduce air quality and potentially lead to respiratory problems.



Study by Theodore Sterling Ltd., A. Arundel Research Associates and Simon Fraser University.

FIGURE 1- RELATIVE HUMIDITY IMPACTS OCCUPANT HEALTH

Typical Natatorium Design Conditions		
Pool Type	**Air Temperature, °F**	**Water Temperature, °F**
Competition	75 to 85	76 to 82
Diving	80 to 85	84 to 88
Elderly Swimmers	84 to 85	85 to 90
Hotel	82 to 85	82 to 86
Physical Therapy	80 to 85	90 to 95
Recreational	82 to 85	80 to 85
Whirlpool/spa	80 to 85	102 to 104

Table 1 - Natatorium Design Conditions

The type of facility being designed dictates the space temperature.Table 1 helps target some typical conditions. It is critical to understand who will be using the facility in order to deliver the conditions most likely to satisfy them.

General Notes:

- Facilities with warmer water temperatures tend to have warmer space temperatures.
- Physical Therapy facilities will cater to therapist comfort rather than the patient because they are generally not in the space for more than an hour, whereas the therapist is there all day.The designer should consult local codes. Some States require a full purge of the room air with 100% outdoor air for every hour of occupancy.
- Elderly swimmers tend to prefer much warmer air and water temperatures.
- Maintain Relative Humidity between 50 & 60% RH

Operating conditions need to be discussed with the owner and documented.

2.2. HUMIDITY CONTROL

High relative humidity levels inside a building are well known for their destructive effects on building structure and can pose serious health concerns. Buildings with high humidity levels are prone to condensation problems that can destroy the building structure. They also facilitate the growth of mold and mildew, which in addition to being unsightly, can adversely impact the air quality. Controlling humidity requires that a total moisture load be accurately calculated. This amount of moisture must be removed from the space at the same rate it generated to maintain stable space conditions.

2.2.1 Load Calculation

Every building's moisture (latent) load is calculated in the same way. There are generally three sources of moisture that are considered:

- Internal load (evaporation rate)
- Occupants
- Outdoor air load

2.2.1.1 Evaporation rate

The internal load in a natatorium is the evaporation from the pool water and wet deck surfaces. In a natatorium this represents the majority of the total dehumidification load. Consequently, it is essential to accurately predict the pool evaporation.

There are 5 main variables used to calculate the evaporation rate:

- Pool water surface area
- Pool water temperature
- Room air temperature
- Room air relative humidity
- Pool water agitation and Activity Factor

The first four variables are straightforward and should be dictated by the owner. They are used to calculate the baseline (unoccupied) evaporation rate in the natatorium.

The Activity Factor is the fifth variable. It is a water agitation factor. The Activity Factor is used to evaluate how much water agitation and splashing is expected when the pool is in use and how that increases the evaporation from the baseline value. Chapter 4 of ASHRAE's 2003 HVAC Applications Handbook publishes an Activity Factor table (Table 2) based on years of empirical field and test data.

An active pool's evaporation rate can be two or three times as much as the baseline evaporation rate.

Evaporation Rate Equation:
Equation #2 in chapter 4 of ASHRAE's 2003 HVAC Applications Handbook calculates the evaporation rate in pounds of water per hour (lb/h) for air velocity over water @ 10-30 fpm. The Vapor Pressure values can be found in steam tables.

$$ER = 0.1 \times A \times AF\,(Pw - Pdp)$$

ER = evaporation Rate of water, lb/h
A = area of pool water surface, ft²
AF = Activity Factor (see Table 2)
Pw = saturation vapor pressure at water surface, in. Hg
Pdp = partial vapor pressure at room air dew point, in. Hg

It can be seen from the equation that the following factors increase the evaporation rate:

- Increasing water temperature
- Lowering air temperature
- Lowering air relative humidity
- High activity/agitation

Once equipment has been selected and installed, any change of the variables that increases the evaporation rate can result in equipment no longer being able to handle this new larger load.

It is critical the designer be provided with accurate operating data for a given facility.

Type of Pool	Activity Factor
Elderly swim	.065
Fitness club – Aquafit	0.65
Hotel	0.8
Institutional - School	0.8 – 1.0
Physical Therapy	0.65
Public / YMCA	1.0
Residential	0.5
Swim Meet	0.65
Wave Pool	1.5 – 2.0
Whirlpool	1.0

Table 2 - Activity Factors

2.2.1.2 Occupant Load
Swimmers are not usually considered occupants as they are submerged in the water. Swimmers and their water agitation are included in the Activity Factor. Spectators, especially in facilities that host swim meets can total several thousand, and add a significant moisture load, (see Table 3).

It is important to understand that when a facility is hosting a swim meet the Activity Factor of the water is considerably reduced. Typically there is only one swimmer per lane and while they agitate the water considerably, the overall agitation is much less than a densely occupied pool during a public swim.

Activity Level	Lb/h per Spectator
Quietly Seated	0.155
Moderate Activity	0.205
Enthusiastic	0.250
Highly Enthusiastic	0.530

Table 3 - Occupants Latent Load

To evaluate the dehumidification load during swim meets an Activity Factor of 0.65 is used to calculate the evaporation rate. The number of spectators are included in the load. Codes also generally require that each spectator be provided with 15 CFM of outdoor air. The load impact of the outdoor air must also be calculated.

Seresco recommends that facilities hosting swim meets size equipment based on the larger of the two main operating modes, normal operation load or swim meet load.

2.2.1.3 Outdoor Air

The introduction of outdoor air is essential to maintaining good air quality in any facility. The impact of outdoor air ventilation on a natatorium changes with the weather. Introducing outdoor air during the summer adds moisture to the space and in the winter removes moisture from the space. For maximum dehumidification load calculation the Summer Design conditions are considered.

Construction codes generally require that outdoor air be introduced into a commercial building during occupied hours. ASHRAE Standard 62-1999 recommends the introduction of outdoor air into a natatorium at the following rates:

- 0.5 CFM/ft² of pool and (wet) deck area
- 15 CFM per spectator.

Most designers use the larger of these two values.

Seresco suggests that only the wet deck (five to six foot perimeter) be considered in this calculation, as the purpose of this outdoor air is to help dilute chemicals off-gassed from water. A predictably dry portion of the deck will not factor into the IAQ issues. Additionally, outdoor air requires considerable heating in the winter. Exceeding code requirements is not recommended as it will increase the operating expenses and may upsize the dehumidifier.

2.2.2 Load estimation software

Seresco has developed software that calculates all moisture loads in a matter of minutes. Figure 2 gives a snapshot of the basic data that would generally need to be entered to calculate a load.

Natatorium Design Data		
	Main Pool	Spa
Pool Area:	2000 ft²	120 ft²
Water Temperature:	84°F	104°F
Activity Factor:	0.8	1.0
Pool & Deck Area:	3500 ft²	
Spectators:	0	
Pool Room Volume:	45000 ft³	
Indoor Air Design Conditions		
Room Design Temp.	84°F	
RH Design Unoccupied	50%	
RH Design Occupied	60%	
Outdoor Design Conditions		
City:	Your City data here	
Summer db	95°F	
Summer wb	75°F	

Figure 2 - Sample of Seresco's Load Estimating Software

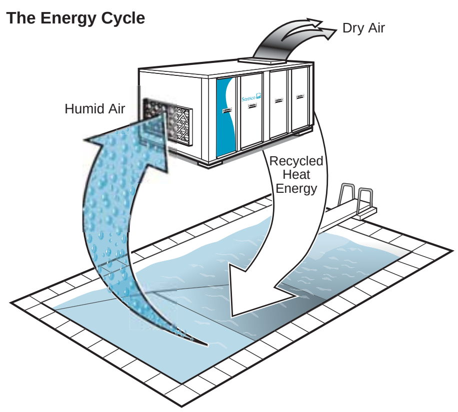
2.2.3 How to remove the moisture

There are three general approaches to humidity control in a natatorium. It is important to understand the capabilities and limitations of each approach in order to select the best system for the application:

1. Packaged mechanical refrigeration system
2. Central chilled water plant and air handler
3. 100% outdoor air ventilation

2.2.3.1 Packaged mechanical refrigeration systems

By far the most common and popular method of removing moisture from the space, these are packaged refrigeration units like those built by Seresco. The units are designed and developed specifically for dehumidifying indoor pools.



A major benefit of this approach is that both the sensible and latent heat is combined with the heat generated by the compressor's power consumption and can be directed to wherever heat may be required in the natatorium. This process is unique in the HVAC industry as it uses both the cooling and heat rejection sides of the refrigeration cycle. The system can be simultaneously dehumidifying (cooling) the air and then reheating it (and/or the pool water) to deliver dehumidified and reheated air to the space, and warm water to the pool.

Figure 3 and 4 illustrate schematically how warm humid air passes through the dehumidifying coil and is cooled to below its dew point. As a result moisture condenses out of the air. Depending on the space temperature requirements the hot gas from the compressor can be used to reheat the air or be rejected to an outdoor condenser. Compressor hot gas can also be used to heat the pool water. Figure 4 shows an example of these components in a vertical unit.

This is the most energy efficient method of controlling humidity in a Natatorium.

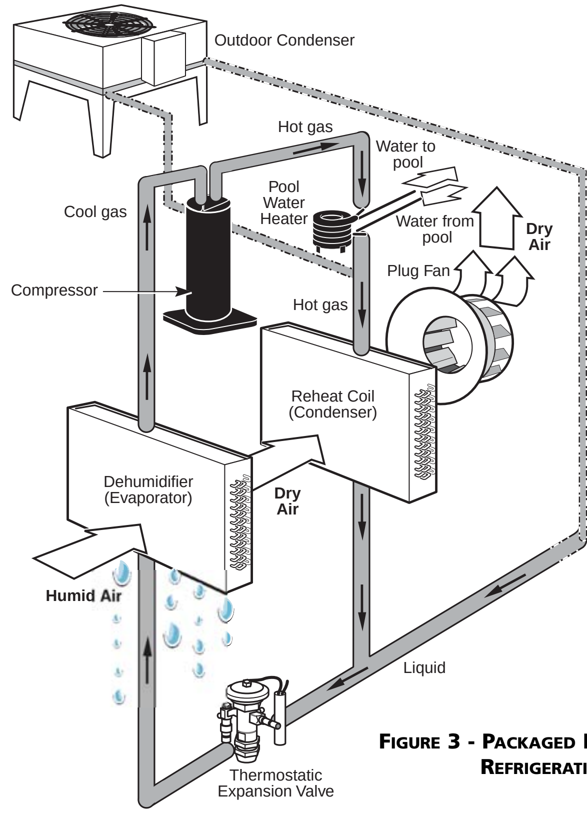


FIGURE 3 - PACKAGED MECHANICAL REFRIGERATION SYSTEMS

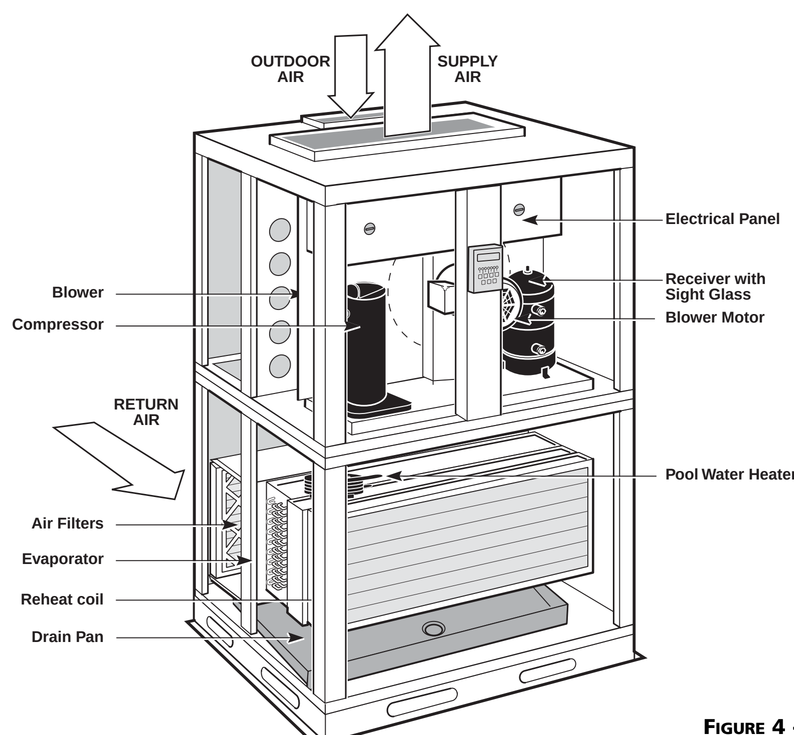


FIGURE 4 - VERTICAL DEHUMIDIFIER

2.2.3.2 Central chilled water plant and air handler

These units are found in larger campus or institutional applications that have a central chiller plant that delivers chilled water to the campus year round. The dehumidification aspect of these systems is essentially the same as a compressorized system. The chilled water supply temperature must be low enough (below 45°F) to cool the air below its dew point and condense moisture out of the air. These systems cannot usually reuse the captured heat for reheating air or pool water but are an effective means of year round humidity control.

	Packaged Mechanical	Chilled Water	100% Outdoor Air
First cost	Medium	Medium	Lowest
Year round humidity control	Yes	If 45°F water available year round	No
Dehumidification energy recovery	Yes	No	No
Heat recovery on Exhaust and Outdoor air	Option	Option	Option
Free Summertime AC	Yes	Yes	No
Free summertime pool water heating	Yes	No	No
System performance checked and guaranteed by manufacturer	Yes	No	No
Factory controls package	Yes	Option	Option
Cabinet and materials suitable for natatorium	Yes	Upgrade	Required only if system has recirculation.

Table 4 - System Comparison

2.2.3.3 100% outdoor air systems

This approach treats the space with a single pass of outdoor air. The outdoor air is introduced into the space and is then exhausted. This approach generally has lower first cost. Additionally the significantly elevated volume of outdoor air helps mask any chemical problems in the water as so much air continuously passes through the facility the airborne chemicals can never concentrate to appreciable levels. However when the dew point outdoors is above ~ 60°F this system will not maintain humidity levels below 60% RH.

100% Outdoor Air systems do not control humidity levels year round.

100% outdoor air systems also have significantly higher operating costs. In winter the outdoor air must be heated up to a minimum 80-85°F. Heat recovery helps reduce this but adds to the first cost.

In summer the space temperatures should not be allowed to exceed ASHRAE's human comfort threshold limit of 86°F. A supplemental cooling coil is required. This again adds to the first cost and to the operating costs. A 100% outdoor air system with heat recovery and a supplemental cooling coil has a first cost similar to a packaged mechanical system without the benefit of year round humidity control or reduced operating costs.

System comparisons and features are highlighted in Table 4.

2.3. INDOOR AIR QUALITY

A facility has only one chance to leave a first impression. If a patron is met at the natatorium door by a foul smelling pool odor, it is unlikely that this will leave a good impression. People also correctly associate poor air quality with problems in the facility. Indoor air quality is impacted by many problems: high humidity, mold, mildew, condensation, corrosion, poor water chemistry, inadequate outdoor air, air stagnation and poor air distribution.

Humidity control is covered in section 2.2 of this manual. Condensation is addressed in Section 2.4. Factors having a more direct impact on Indoor Air Quality (IAQ) are:

- Water chemistry
- Outdoor air ventilation
- Exhaust air
- Air change rate

2.3.1 Water Chemistry

Pool water quality affects not only human health and comfort but also space air quality and performance of the mechanical equipment.

Poor water chemistry is the single biggest source of indoor air pollution and corrosion problems in a Natatorium.

The owner/operator of the natatorium is responsible for maintaining proper pool water chemistry.

Failure to maintain proper pool water chemistry will result in several problems:

- **Air quality complaints**
- **Corrosion**
- **Frequent and costly maintenance**
- **Reduced equipment life**

Codes require that a separate, ventilated space MUST be provided to store pool chemicals.

DO NOT STORE POOL CHEMICALS IN THE MECHANICAL EQUIPMENT ROOM!

2.3.1.1 Foul Odors in the Pool Area

The powerful chlorine smell that is often associated with indoor pools is not actually the smell of excess chlorine in the water but of combined chlorines. Combined chlorines are a product of insufficient chlorine and can result in high levels of bacteria and algae in the pool water. Maintaining proper chlorine and constant pH levels will eliminate the foul odors. Airborne chloramines also have a strong affinity to pure water such as condensate. Consequently any condensation will become corrosive and further damage the structure.

The proper amount of outdoor air and exhaust air to and from the space is also crucial to ensuring chemical concentration levels are maintained within acceptable levels.

The powerful chlorine smell that is often associated with indoor pools is NOT the result of too much free chlorine in the water; it is TOO LITTLE free chlorine that is the culprit!

2.3.1.2 pH Levels

High pH levels (alkaline range) encourage scale formation, which reduces pool water heater efficiency. With low pH levels the water is acidic and corrosive.This may damage the metal parts in pump, water heaters and piping. Maintaining pH levels between 7.2 and 7.6 will ensure the longest life for the pool equipment.

2.3.1.3 Water Exchange Rates

Adequate water exchange rates are necessary to prevent the buildup of bio-wastes and their oxidized products. High concentrations of dissolved solids in water have been shown to directly contribute to high combined chlorine (chloramine) levels.

Pool water test kits must be able to accurately monitor (see Table 5):

- **pH Levels**
- **Alkalinity**
- **Free chlorine**
- **Combined chlorine**
- **Dissolved solids**
- **Total hardness**

2.3.1.4 Corrosion

Unbalanced pool water chemistry leads to excessive off-gassing, health problems and the deterioration of the pool building and equipment. Conversely, a balanced pool with proper water treatment and sufficient outdoor air/exhaust air dilution offers an environment that will not affect the health of the users or cause damage to mechanical equipment or the structure.

Pool Water Chemistry Parameters Recommended by NSPI		
	Pools	**Whirlpools**
	Desirable Range	Desirable Range
pH	7.4 – 7.6	7.4 – 7.6
Alkalinity	80 – 100 PPM	80 – 100 PPM
Free Chlorine	2.0 – 3.0 PPM	3.0 – 4.0 PPM
Combined Chlorine	0 PPM	0 PPM
Dissolved Solids	100 – 300 PPM	100 – 300 PPM
Total Hardness	225 – 250 PPM	175 – 275 PPM

Table 5 - National Spa and Pool Institute Recommended Levels for Water Quality

Although it stands to reason that pool operators do their utmost to create and maintain an optimum environment for patrons and equipment, mishaps do occur. Both swimmers and equipment should expect exposure to occasionally elevated levels as a result of inaccurate pool chemical treatment or chemical spills. Seresco has taken all possible commercially feasible precautions to protect the NE Series units against the corrosion caused by accidentally high chemical levels. The equipment, materials and paints are all resistant to occasional high levels of airborne chemicals.

2.3.2 Outdoor Air Ventilation

The amount of outdoor air to be introduced to the facility is generally determined by construction codes as outlined in Section 2.2.1.3 of this manual. Outdoor air is critical towards diluting airborne chemicals and maintaining good indoor air quality.

Experience has shown that facilities who introduce appropriate amounts of outdoor air have the best IAQ.

- Outdoor air requires a lot of heat in the winter and must be included in heat load calculations.
- Exceeding code amounts is not recommended, as it creates extremely high operating expenses.
- Locate outdoor air intakes away from sources of airborne contamination such as exhaust fans or plumbing vents.
- The outdoor air must be preheated to 65ºF - If more than 20% of the total airflow is outdoor air or if the winter design temperature is below 10ºF
- If outdoor air is introduced into the return air duct it must be preheated to space temperature.
- Where strict outdoor air code compliance is required, a certified air-balancing contractor must determine proper system airflow.

All Seresco units are equipped with an outdoor air connection, filter and balancing damper. Motorized dampers and time clocks are also available.

2.3.3 Exhaust Air

ASHRAE recommends the room be maintained at 0.05-0.15" WC negative pressure relative to surrounding spaces.

Ten percent more exhaust air than outdoor air is a good rule of thumb.

Figure 5 illustrates how the location of the exhaust fan can also significantly improve the air quality in the space. A spa or whirlpool should have the exhaust air intake grille located directly above it. This extracts the highest concentration of pollutants before they can diffuse into the space and negatively impact the room air quality.

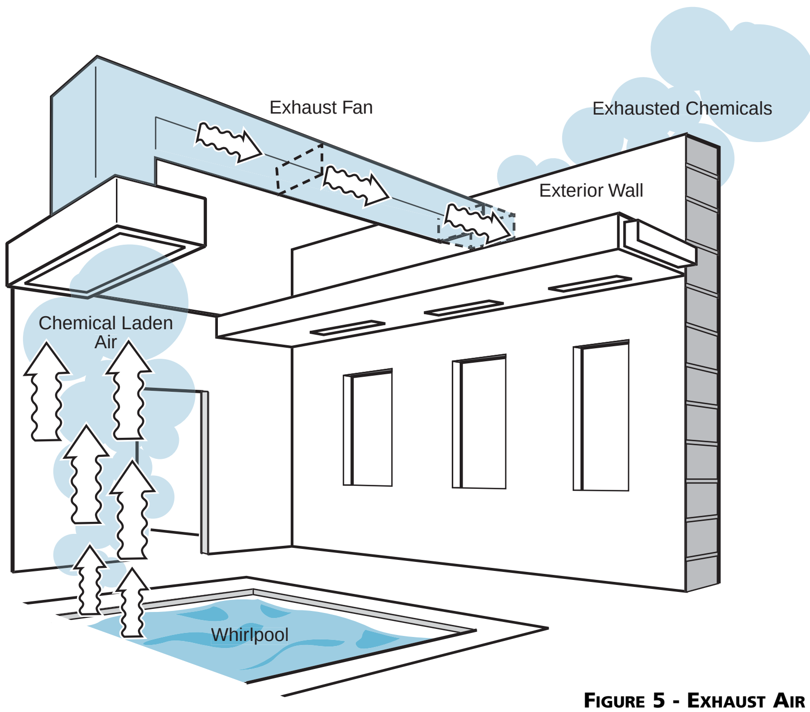


Figure 5 - Exhaust Air

2.3.4 Air Change rate

ASHRAE recommendations for proper volumetric air changes per hour are important to ensuring that an entire room will see air movement. Stagnant areas must be avoided, as they will be prone to condensation and air quality problems.

Short circuiting between supply and return air must also be avoided as it significantly reduces the actual air changes within the space.

ASHRAE recommends:

- 4-6 volumetric air changes per hour in a regular natatorium.
- 6-8 volumetric air changes per hour in facilities with spectators

A quick calculation will determine the supply air requirement.

- Supply air required (CFM) = room volume (ft^3) x desired air changes / 60

2.4. CONDENSATION CONTROL

You only have to enjoy a cold drink on a summer day to experience condensation. Condensation occurs whenever a surface temperature is below the ambient dew point temperature.

Condensation is a major concern for all types of building construction. It must be avoided at all costs. Condensation triggers a destruction process and allows mold and mildew to grow. If allowed to occur inside the building walls or roof, condensation will cause deterioration and can devastate the structure by freezing in winter.

Condensation in a Natatorium must be avoided at all costs.

The architect, engineer and contractor must coordinate with each other to make certain the building design and construction is appropriate to house an indoor pool. Suitable materials and construction techniques are crucial to ensuring the building envelope will perform properly. The pool enclosure must be suitable for year round operation at 50% to 60% relative humidity and built as per the latest building codes.

All building elements that create thermal bridges must be avoided. All building elements with a low R-value must be blanketed with warm supply air to prevent condensation. Window frames and emergency exit doors are especially likely to have to thermal bridging.

2.4.1 Dew Point Temperature

The first step in condensation control is to establish the space dew point temperature based on the owners desired space conditions. Once done, the designer can establish potential condensation spots in the building. These are building elements that will have an inside surface temperature below the dew point at winter design condition. Most importantly, it must be determined where to locate the vapor retarder in the wall. Figure 6 shows that a typical pool design of 82°F 50% RH has a dew point of 62°F. Therefore, any surface with a temperature BELOW 62°F will condense moisture.

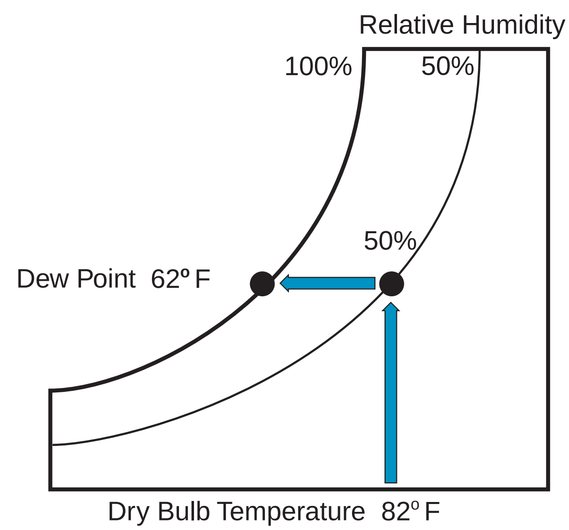


Figure 6 - Dew point temperature

2.4.2 Vapor Retarder

The purpose of a vapor retarder is to block moisture from penetrating into a wall or ceiling where it will encounter a temperature below the dew point temperature and condense. The vapor retarder is the most important component in protecting a building structure from moisture damage. Figure 7 illustrates how failure to install the vapor retarder in the proper location will result in condensation forming within the structure. Condensation can cause decay and lead to catastrophic structural failure. The vapor retarder must be sealed (taped) at all the seams. Electrical outlets should be avoided on exterior walls.

Ensure the pool enclosure design (exterior walls and ceilings) has a vapor retarder in the correct location.

The vapor retarder is the most important component in protecting a building structure from moisture damage.

Figure 8 is an example of a wall detail with its temperature gradient. This exercise allows the designer to identify the dew point temperature in the wall and where the vapor retarder must be installed.

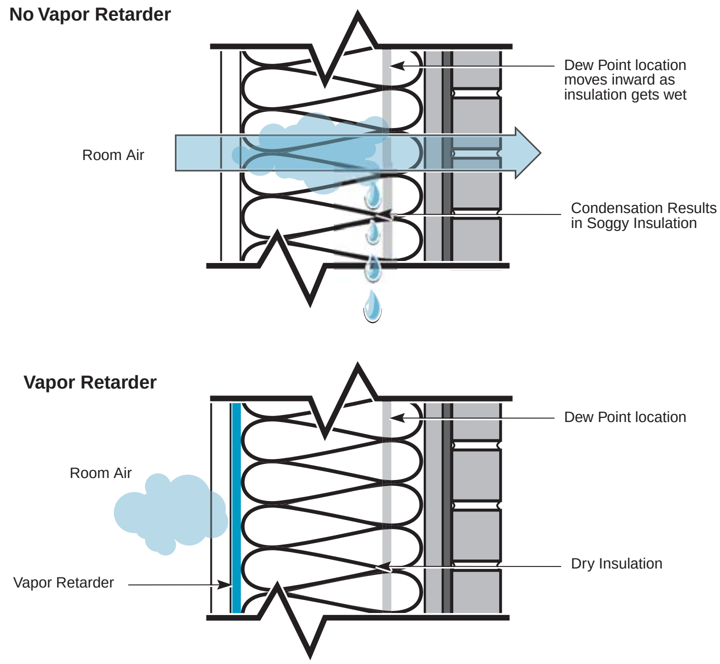


FIGURE 7 - DO NOT BUILD AN INDOOR POOL WITHOUT A VAPOR RETARDER

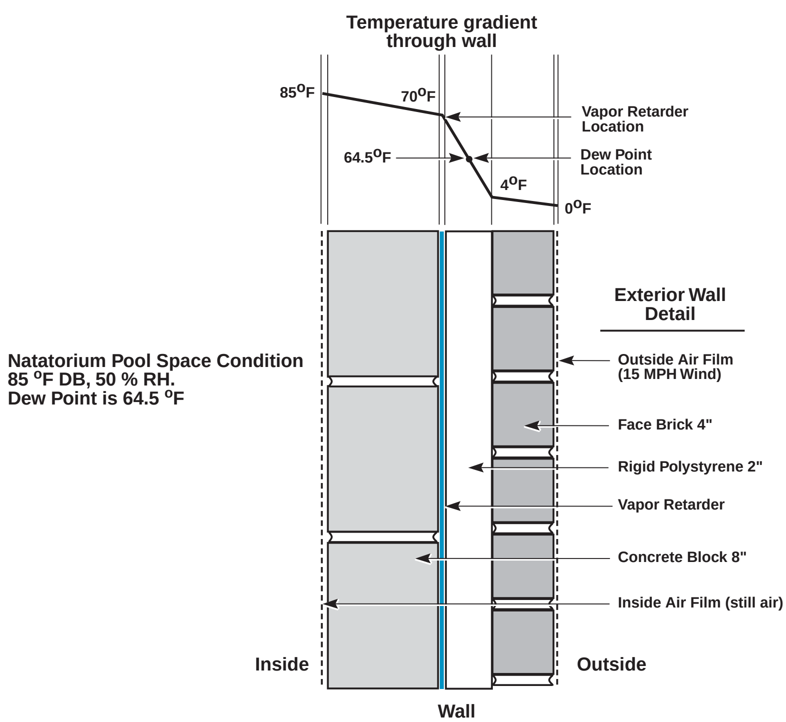


FIGURE 8 - INSTALL VAPOR RETARDER ON THE WARM SIDE OF THE DEW POINT LOCATION

2.4.3 Window Design

Special attention should also be paid to exterior glass components such as windows and patio doors. Due to their low insulation values, windows are usually the building element with the lowest inside surface temperature. Even a triple pane window can have an inside surface temperature below the room's dew point.

All exterior glass surfaces must be fully blanketed with supply air to avoid condensation.

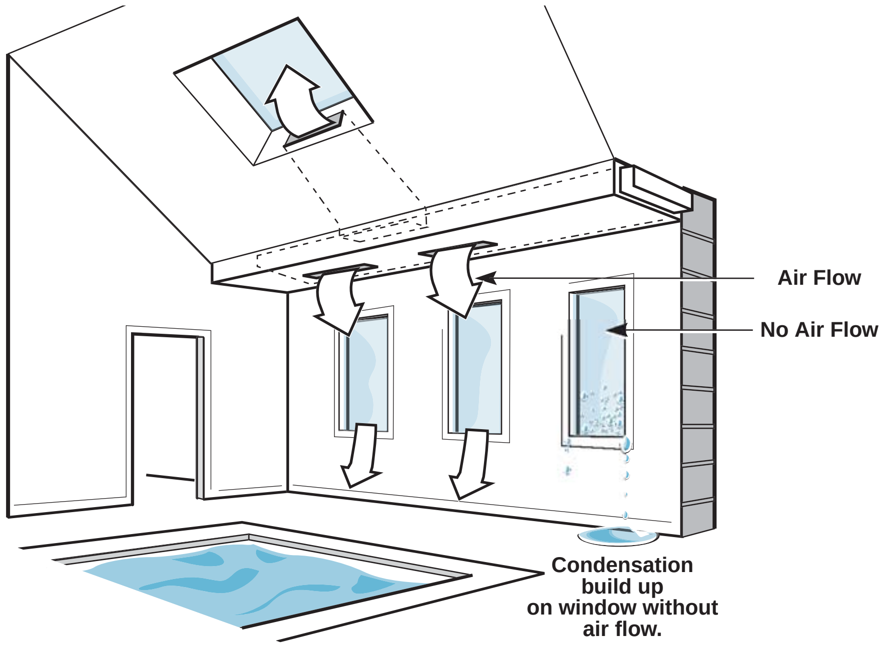


Figure 9 - Window design

2.4.4 Air Distribution

Since windows are a primary condensation concern it is extremely important that the supply air is focused on these building elements. The warm air from the dehumidifier will keep the window surface temperature above the dew point temperature and this in turn ensures the windows and exterior doors remain condensation free.

There are five basic steps to laying out the ductwork:

1. Supply air to exterior windows and doors
2. Supply air to the remainder of the room to ensuring there are no stagnant areas
3. Supply air to the deck level
4. Locate the return duct where it will optimize the entire airflow pattern.
5. Prevent air short-circuiting by avoiding supply air diffusers near the return grille.

The following sample duct diagrams illustrate good air distribution practices:

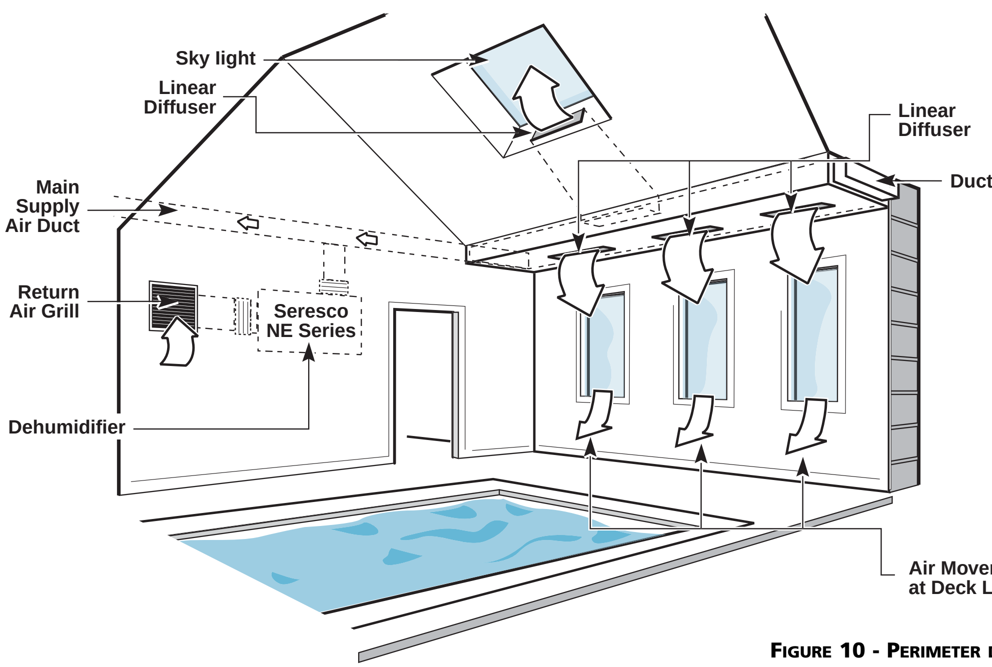


Figure 10 - Perimeter duct layout

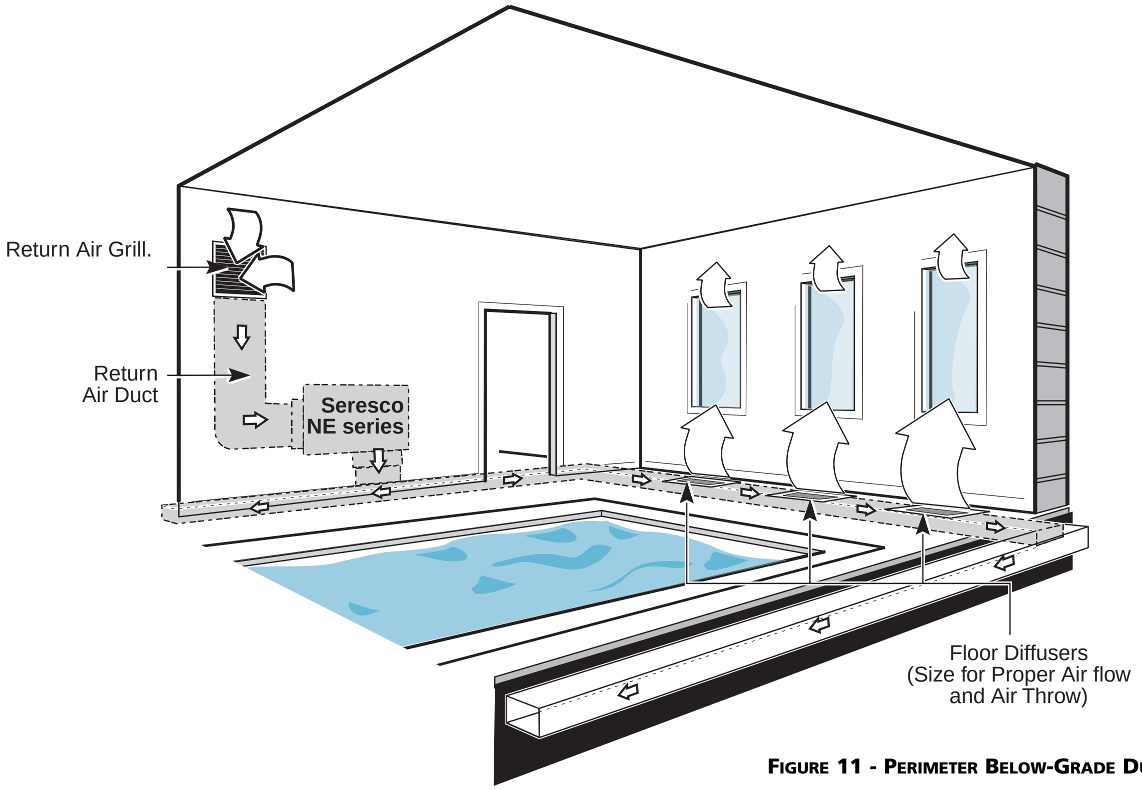


Figure 11 - Perimeter Below-Grade Duct Layout

All air distribution systems should:

- Supply at least 4-6 volumetric air changes per hour.
- Blanket exterior windows, exterior surfaces and other areas prone to condensation with supply air. A good rule of thumb is 3 - 5 CFM per ft² of exterior glass.
- Locate the return grille to enhance the overall air pattern within the room.
- Select grilles, registers and diffusers that deliver the required throw distance, and the specified CFM rating.
- Introduced outdoor air per local codes and/or ASHRAE Standard 62-1999.
- Maintain a negative pressure in the space with an exhaust fan.

General Recommendations:

- Galvanized sheet metal ducts are acceptable in most installations. A below-grade duct system should use PVC or plastic-coated galvanized spiral pipe to avoid deterioration.
- Ductwork that passes through an unconditioned area should be insulated on the exterior.
- When applicable, locate exhaust fan air intakes as close to the whirlpool as possible.
- To prevent excessive vibration noise, install neoprene flex connectors when attaching ductwork to the dehumidifier.
- Skylights require significant airflow to avoid condensation on their surfaces.

2.5. SYSTEM DESIGN CHECKLIST

Ensuring that all critical system design aspects have been addressed is paramount to obtaining a safe and healthy pool environment. Seresco's name is a useful checklist:

S ystem duct design and air pattern
E vaporation rate and latent loads
R equired access space
E xhaust air
S upply air flow
C ooling and heating loads
O utdoor air

Energy Consumption Considerations

A designer must determine and discuss the energy consumption and performance implications based on the owner's choice of operating conditions and building envelope. An all glass structure, for example, is going to be expensive to heat and difficult to keep condensation free in a northern climate.

A natatorium has 5 major areas of energy consumption:

1. Pool water heating
2. Dehumidification
3. Air heating
4. Air cooling
5. Outdoor air heating and cooling.

The owner should have an estimate of their annual energy expense.

3.1 OPERATING CONDITIONS

Pool water heating and dehumidification costs are always interrelated because over 90% of a pool water's annual heating costs originate from pool surface evaporation losses.

- Every pound of moisture evaporated represents ~1000 Btu of heat lost from the pool.
- The warmer the pool water, the higher the evaporation rate.
- The lower the room dew point, the higher the evaporation rate.

At the same water temperature a pool in a room at 78°F 50% RH will evaporate 15% more than that same pool in an 82°F 50% RH room.

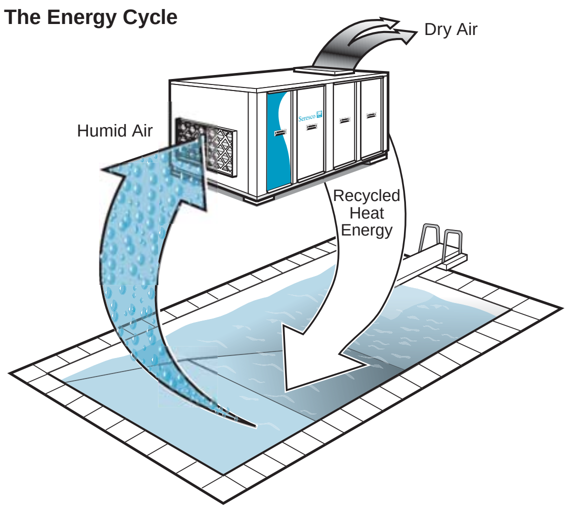
For energy conservation purposes, it is recommended that the air temperature be maintained 2 - 4°F above the pool water temperature.

3.2 WATER HEATING AND DEHUMIDIFICATION

The dehumidification process captures the latent heat in the evaporator coil. This latent heat represents a significant portion of the annual pool's water heating requirement. As discussed in section 2.2.3.1, a Seresco dehumidifier with water heating option has an enormous potential for energy savings.

Closed Loop Energy Recycling occurs when the energy lost through evaporation is returned back to the pool water by the Seresco dehumidifier.

The Energy Cycle



The Seresco unit captures 100% of this heat as a by-product of the dehumidification process and can return this energy back to the pool, thereby greatly reducing pool water heating cost. During the cooling season the dehumidifier is capable of providing 100% of the pool's water-heating requirement.

Annual Savings from Pool Water Heating Option									
Cooling Season	Heat Source	Average Pool Evaporation (lb/h)							
		20	**30**	**40**	**50**	**100**	**150**	**200**	**300**
4000 hours	Gas	$640	$960	$1280	$1600	$3200	$4800	$6400	$9600
	Electricity	$1880	$2820	$3760	$4700	$9400	$14100	$18800	$28200
2000 hours	Gas	$320	$480	$640	$800	$1600	$2400	$3200	$4800
	Electricity	$940	$1410	$1880	**$2350**	$4700	$7050	$9400	$14100

Table 6 - Annual Water Heating Savings from Pool Heating Option

Adding the water heating option to your dehumidifier typically has a payback of less than one year.

Table 6 shows the annual contribution towards water heating from the dehumidifier while operating in cooling mode. A pool with a 50 lb/h evaporation rate and cooling season of 2000 hours would realize an annual savings of $2,350 if the primary source of pool water heating was an electric heater.

Calculations based on: 1000 Btu/lb latent heat of vaporization. Gas: $0.60 per 100,000 Btu, efficiency = 75%. Electricity: 8¢ per kWh

All systems require auxiliary pool water heaters. The Seresco unit will control their operation when it is not able to provide full water heating.

3.3 SPACE HEATING

All buildings should have cooling and heating load calculations done to determine their specific requirements. The room air temperature of an indoor pool facility is generally 10-15 °F warmer than a typical occupied space. Therefore, the heating requirement is larger than a traditional room and the cooling needs are less.

- Rules of thumb do not apply. This is a unique space that requires accurate load calculations.
- Outdoor air must be included in load calculations as it often represents up to 50% of the heating load.

3.4 SPACE COOLING

Even though the space is generally 10-15 °F warmer than a typical room, it is important to maintain the same conditions year round. Space cooling is a free byproduct from packaged dehumidifiers and chilled water systems.

As discussed in sections 2.2.3.1 & 2.2.3.2, these systems dehumidify by cooling the air below its dew point. The compressor heat of the mechanical refrigeration system can be used to heat the pool water during this time or merely sent outdoors to a condenser as is done with traditional air conditioning systems. If the cooling load exceeds the standard output of a dehumidification unit, a larger unit with compressor staging is often specified.

Packaged Refrigeration or Chilled Water dehumidifiers provide summertime space comfort with no additional operating cost to the owner.

3.5 OUTDOOR AIR AND ENERGY RECOVERY

Outdoor air ventilation is essential for maintaining good IAQ and is usually a code requirement. The outdoor air must be conditioned: cooled in the summer and heated in the winter. Outdoor air has a significant impact on the space-heating load in winter.

In winter outdoor air may be required to be heated by up to 100°F.

The designer has several issues to consider:

- Introducing more outdoor air than codes require will increase operating costs.
- Warm energy-rich air is required to be exhausted from the space to maintain negative pressure.

Energy recovery from exhaust air to outdoor air should be considered.

Air-to-air heat exchangers are available for both sensible heat recovery and total energy recovery. Sensible only devices are generally used in Natatoriums because there are very few instances where you actually want to recover some of the humidity being exhausted. All sensible recovery devices are effective, figure 13 shows two examples. There are several considerations to determining the feasibility of heat recovery:

- Can the outdoor air and exhaust air streams be located in close proximity to each other?
- Are the winter conditions cold enough to warrant heat recovery?
- Is it more cost effective to install a stand-alone heat recovery device or have it pre-packaged in the Seresco dehumidifier?
- What are the cost savings from the reduced space-heating requirement?

Heat recovery is generally packaged as part of a dehumidifier when outdoor or rooftop installations are specified. Figure 12 shows a schematic of a typical system offered by Seresco. For indoor installations, space limitations within a mechanical room will dictate if the heat recovery option can be packaged within the dehumidifier or remotely installed in the ductwork.

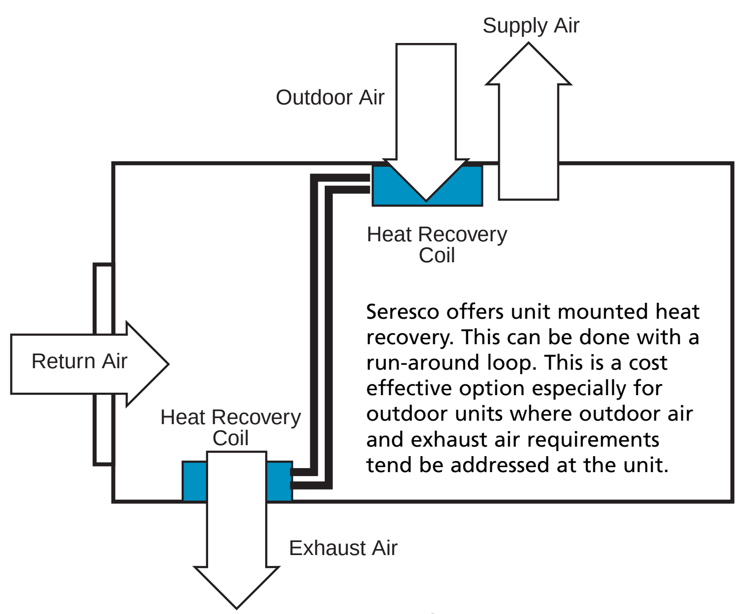


FIGURE 12 - PACKAGED HEAT RECOVERY

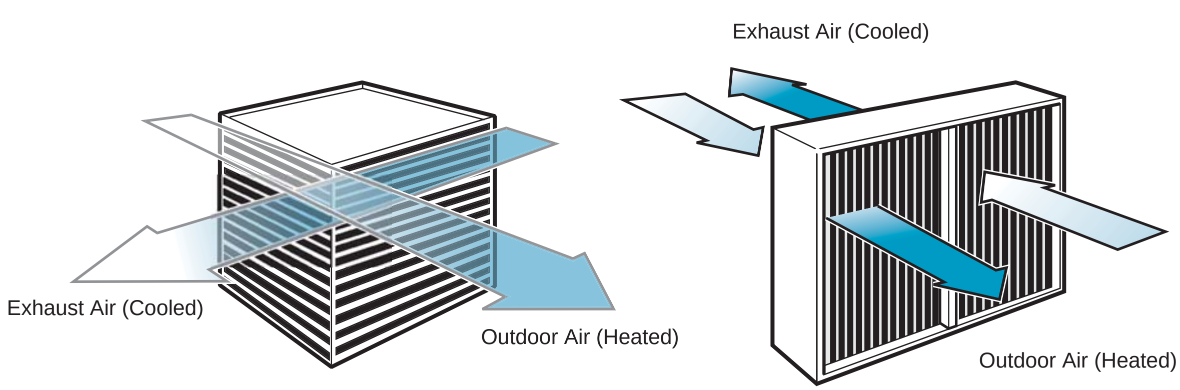


PLATE HEAT EXCHANGER **HEAT PIPE**

FIGURE 13 - HEAT EXCHANGERS

Seresco has developed a very quick calculation to determine the energy recovered and energy savings possible from a sensible heat recovery device.

It is important to note the heat recovery is viable even for a mild climate like Atlanta. The savings are noteworthy. Since outdoor air and exhaust air are required by code, the added cost of a heat recovery device generally pays itself back in less than two years.

Conclusion:

1. Maintaining a warmer space temperature reduces evaporation from the pool.
2. Pool water heating from a packaged refrigeration dehumidifier is free when the compressor is running for other duties.
3. Summer time cooling from a packaged refrigeration or chilled water dehumidifier is a free byproduct of dehumidification.
4. Energy recovery between outdoor air and exhaust air should be considered.

Weather Data		
City	Average ° F T1	Winter °F T2
Atlanta	61	17
Boston	51	6
Buffalo	43	2
Chicago	51	-8
Dallas	65	18
Denver	50	-5
Detroit	49	3
Minneapolis	45	-16
Indianapolis	52	-2
Nashville	60	9
New York	54	11
Oklahoma City	60	9
Pittsburgh	50	3
Portland, OR	53	17
Salt Lake City	52	3
Seattle	51	20
St-Louis	55	2
Toronto	46	-5

Table 7 - Weather Data

Heat Recovery Savings (Q) Analysis			
	Pool Location	Atlanta	
T1	Average Outdoor Temperature	61	°F
T2	Winter Design Temperature	17	°F
T3	Indoor Design Temperature	84	°F
V	Outdoor Air Volume	3500	CFM
N	Occupied hours	12	Hours
ER	Electric Rate:	0.06	$/kW
GR	Gas Rate:	0.65	$/CCF
GE	Gas Heating system efficiency:	60	%
	Space Heating by:	GAS	
HE	Heat Recovery Efficiency	50	%
Q	**{T3-T1} x 1.08 x V x {8760*N/24} x GE**	190400	MBH
Annual savings from heat recovery device			
$	**{Q x $/CCF} / HE**	**$2,062**	
Reduction in peak heating			
Q1	**{T3-T2} x 1.08 x V x HE**	**126,600**	Btu/h

Table 8 - Energy Recovery Calculation

Finalizing the System Design

This design guide has presented many important aspects to consider for a successful natatorium system design. Putting it all together properly becomes a daunting task. Every facility has different needs and jobsite limitations. The Seresco team has worked on thousands of indoor pools and understands that product flexibility is essential to allow the designer to work around project-specific issues while not compromising their design. The overall performance of a Natatorium will be directly proportional to the number of deviations and compromises taken in its design.

Seresco's NE Series was designed with this in mind. We suggest a step-by-step approach to the overall design to evaluate what parts of the system the designer would like packaged within the dehumidifier and what should be a separate part of the system. There is no right or wrong answer to this approach. Every project has unique characteristics that will dictate the final system design.

At the core of every unit is a dehumidifier capable of removing a calculated moisture load. Every unit has a compressor, evaporator coil, reheat (condenser) coil, blower and sophisticated electronic controls. Units are almost always configured with the means to deliver air conditioning via heat rejection to an outdoor air-cooled condenser or to a fluid loop.

The remainder of the system design can be incorporated in the Seresco dehumidifier or handled remotely. Unit mounted heating coils, exhaust fans, heat recovery packages, weatherproof outdoor cabinets and heat rejection to cooling towers/dry-coolers/outdoor condensers are some of the configurations available from Seresco. The project specific details generally dictate what is the most appropriate. The checklist below was developed to help the designer decide how they want to proceed.

4.1 DESIGN PROCESS CHECKLIST

Table 9 on page 21 is a handy design process checklist.

Step 1:
Calculate the total dehumidification load to select the basic dehumidification unit. Once this has been calculated the designer can start considering air handler configurations. Seresco offers two basic cabinet configurations, horizontal and vertical.

Step 2:
Calculate the supply air requirement and select the appropriate cabinet. This is the simplest calculation and one of the most important. The air handler must be able to deliver the required CFM. Seresco has the flexibility to install multiple dehumidification capacities in different cabinets. This allows the design to always provide the required airflow.

Step 3:
Determine the best unit configuration based on the airflow requirement and installation location. Seresco manufactures vertical and horizontal units with 1", 2" and 4" insulation. This allows the designer the choice of indoor or outdoor installation with a cabinet appropriate for the climate.

- In considering location the designer must provide adequate space for proper duct connections and access to the unit. No access = No service or maintenance

Step 4:
Select the location where outdoor air will be introduced into the system. The majority of installations will see the outdoor air introduced at the factory provided opening in the unit. In cases where that is simply not possible, the following criteria must be followed:

- Outdoor air must be filtered.
- Install a balancing damper and ensure it is properly adjusted during the initial system air balance.
- Preheat the outdoor air to 65°F to avoid condensation problems.
- Thermally insulate the exterior of the duct.

Design Issue	Calculated Requirement	Design issue addressed:	
		In NE Series Dehumidifier	Remotely
Step 1:Total Dehumidification Load			
Step 2: Supply Air CFM & AC/h			
Step 3: Location of the Dehumidifier			
Step 4: Outdoor Air - CFM			
Step 5: Exhaust Air - CFM			
Step 6: Heating Load and Heating Coil			
Step 7: Cooling Load Economizer			
Step 8: Pool Water Heating			
Step 9: Heat Recovery			
Step 10: Condensate Return			
System Design Issues			
	Verified	Installed per Seresco recommendations	
Air Distribution			
Vapor Retarder			

TABLE 9 - DESIGN PROCESS CHECKLIST

Step 5:
Select the exhaust fan location. The exhaust fan should be sized to remove 110% of the outdoor air CFM. A well-located exhaust fan can significantly improve the air quality in the space. If the space has a spa or whirlpool, the exhaust air intake grille should be located directly above it. This extracts the most contaminant-laden air before it can diffuse into the space and negatively impact the room air quality.

- The exhaust fan can be installed remotely or within the Seresco unit.
- Never recover heat from whirlpool exhaust air.

Step 6:
Select the space heating coil location. The majority of installations will see the heating coil inside the dehumidifier. Seresco offers a full range of control valves as well.

- Specify which trade is to provide the controller.
- Care must be taken when considering gas heating. If chlorine from the natatorium is allowed to mix with combustion gases, hydrochloric acid (HCl) forms and is very corrosive.

Step 7:
Confirm that the cooling output from the dehumidifier is adequate for the facility. The NE Series dehumidifier has a limited sensible cooling capacity. If the unit's sensible cooling falls short of the calculated requirement, a larger unit can be selected or a supplementary cooling coil could be added to the supply duct.

- Never supply a lower air temperature than the space dew point, as condensation will occur on ductwork, grilles and diffusers.
- whenever possible configufre the controls to allow compressor staging.

Step 8:
Evaluate if the dehumidifier's pool water heating option is feasible. As discussed in section 3.1 this option has a very attractive payback period. If it is chosen ensure that the pool water circuit is designed to allow water to be delivered to the unit reliably.

- Provide a separate circulating pump.
- Use the controls provided in the unit to control the auxiliary water heater operation.
- Install the auxiliary pool water heater downstream of the dehumidifier for backup heating.
- Ensure the pool water chemicals are introduced downstream of all heaters and pumps.

Step 9:
Select the type and location of any heat recovery device. As outlined in Section 3.5, this accessory can significantly reduce building heating costs. If the payback analysis shows this to be an attractive investment, then the designer has to decide what heat recovery device to use and where to locate it.

- The heat recovery device should be suitably protected from corrosion and freezing.

Step 10:
Verify with local codes whether condensate return to the pool is allowed. If allowed this will save the equivalent of one entire pool fill annually.

4.2 POPULAR CONFIGURATIONS AND SYSTEM DESIGNS

Since the late 1990's, the industry has gravitated towards 2 basic designs because of their overall features, first cost and system performance:

- Hotel and Therapy system layout
- Purge - Economizer system layout

4.2.1 Hotel and Therapy Pool layout

This configuration has a basic unit installed with most system design issues handled external to the unit. They tend to be vertical units installed in the pump room. The air conditioning heat rejection is to an outdoor condenser. The space-heating coil is generally duct mounted, electric and 2 stages.

The vertical configuration is very popular in hotel and residential applications because of their compact footprint and 2-side service access. These PV and NV models are available with or without pool water heating. The maximum size is limited to 100 lb/h capacity.

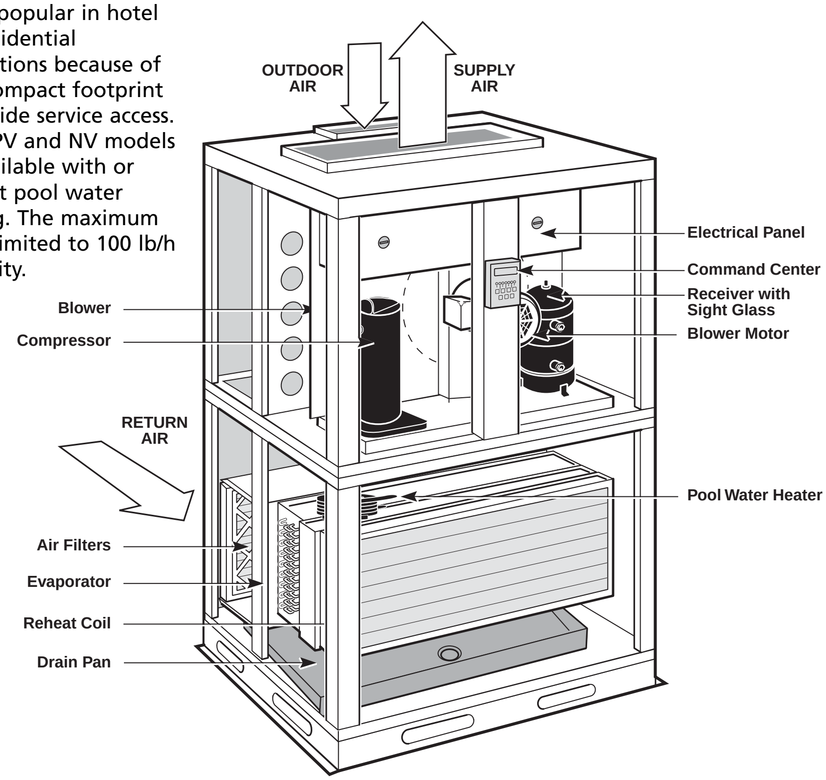


FIGURE 14 - VERTICAL UNIT CONFIGURATION

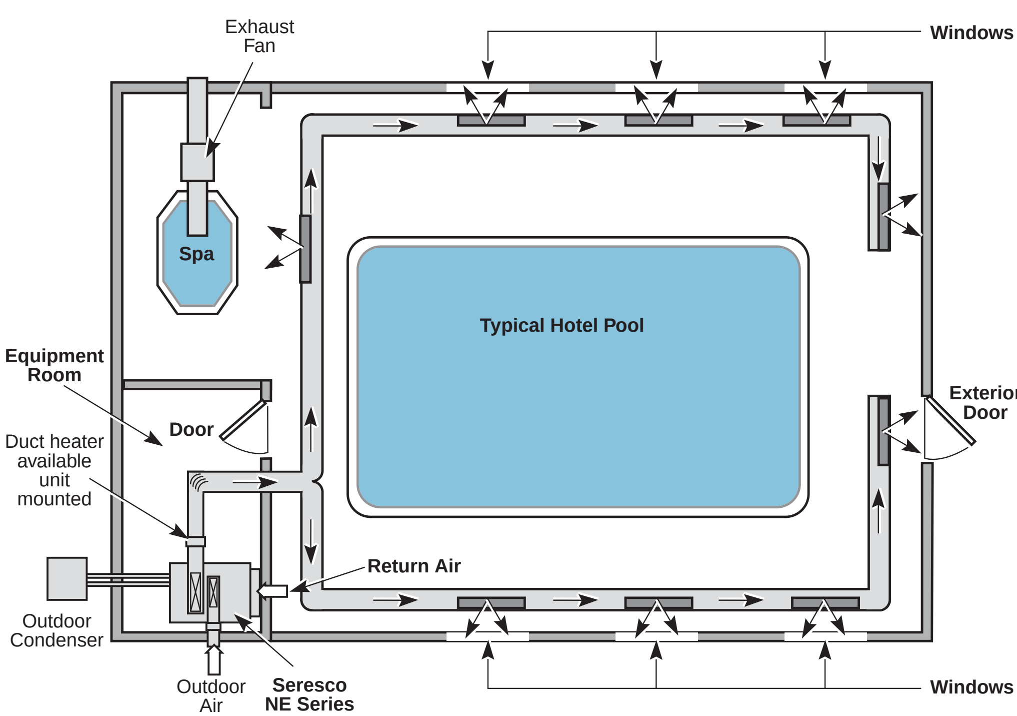


FIGURE 15 - TYPICAL HOTEL AND THERAPY POOL LAYOUT

4.2.2 Purge - Economizer layout

This configuration has enhanced air quality control capabilities and reduces economizer unit operating costs. These systems are designed with a second exhaust fan (EF2) sized to allow for full evacuation of the space with a 100% outdoor air mode. Figure 16 shows a unit in "Normal Operation" where EFI maintains the room's negative pressure by exhausting 10% more room air than is introduced to the space as outdoor air. EFI can be unit mounted or remotely installed with it's intake located above the whirlpool whenever appropriate. EF2 is normally off and operates only when a purge or economizer demand exists.

Figure 17 shows a unit in "Purge-Economizer mode". There are three significant benefits to this configuration:

1. 100% air purge capability available at any time. The operator can super-chlorinate (shock) the pool, then ventilate the space with 100% outdoor air to quickly clear out any airborne chemicals. It also allows for a means to deliver a complete air change of the space should it require a quick purge.

2. Built-in economizer operation. All controls and mechanical equipment are in place to operate in economizer cooling and dehumidification modes whenever the outdoor air conditions are suitable. This offers the operator the most economical year round system operation.

3. This configuration consumes significantly less energy than traditional economizer/purge systems with a mixing box and two full sized fans. EF2 operates only when called upon or when the outdoor conditions are suitable for economizer operation whereas the traditional approach has 2 full sized fans operating year round.

These system features can be designed into the ductwork or incorporated into the unit as a complete package.

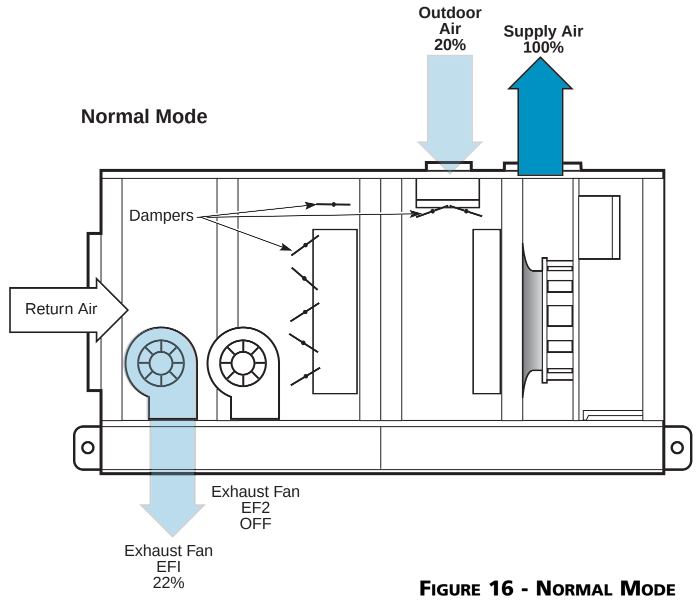


Figure 16 - Normal Mode

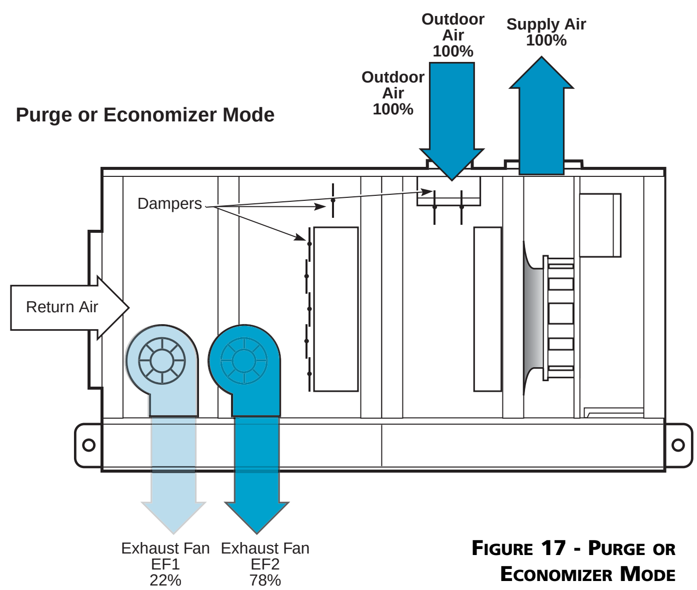


Figure 17 - Purge or Economizer Mode

Exhaust Fan Operating Sequence Example			
	Exhaust Fan **EF1**	Exhaust Fan **EF2**	Outdoor Air
Normal Operation	ON	OFF	Minimum required by code
Purge -Economizer Mode	ON	ON	100%

Table 10 - Exhaust Fan Operation

4.3 ITEMS TO SPECIFY

In order to ensure the system performs as expected and that the equipment is suitable for an indoor pool environment, there are several items to look for in a quality product. The materials and components used must have adequate corrosion protection. Seresco has taken all possible commercially feasible precautions to protect the units against the corrosion caused by even accidentally high chemical levels. For example, the sheet metal galvanizing used is automotive grade intended to withstand road salt. There are other less obvious items to specify as well.

1. **Microprocessor Control**
   The dehumidification system controls all aspects of the Natatorium environment. Control and information are vital to the building operator. Seresco units have a micro controller system CommandCenter (see figure 18) with an LCD display and keypad. All units have a web browser based remote interface tool for monitoring and controlling NE systems from anywhere around the world via the internet. There are a full range of unit mounted sensors and remote sensors that can be accessed. Information regarding the conditions in the space and system operation is accessible via the operator panel of the controller.

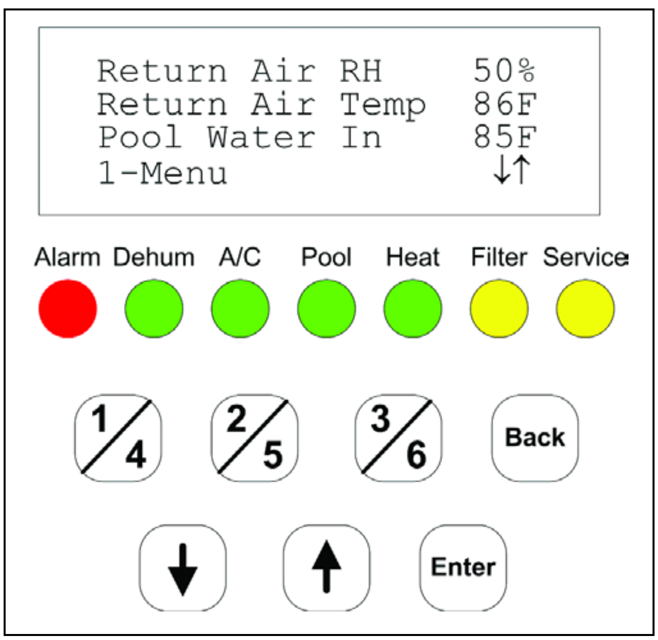


FIGURE 18 - COMMAND CENTER

2. **Quality Control and Factory Performance Testing**
   This ensures that the unit delivered to the facility has already shown it performs to specifications.

Seresco offers ground-breaking technology with the "Virtual witness test". Watch via a webcam and simultaneously access the unit over the Internet through WebSentry while it is in Seresco's QC and environmental testing chamber. An industry first!

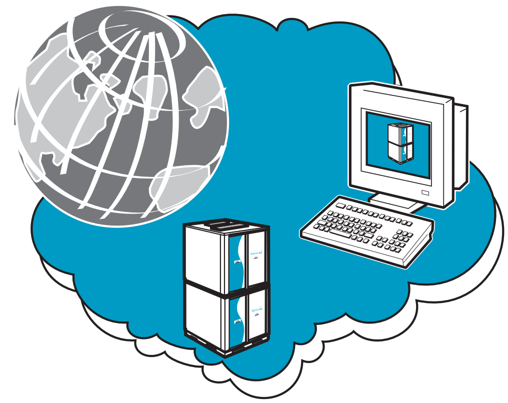
Seresco tests every dehumidifier under full load conditions to ensure all modes perform as specified. During this time, the end user can tie into their unit via the internet and witness in real time how their unit is performing.

3. **Refrigerant Pressure Transducers**
   Unit mounted pressure transducers allow the user or serviceman to access the vital refrigerant pressures through the operator panel of the microprocessor (or remotely via the internet) rather than having to connect a set of refrigerant manifold gauges. This is the most important operation and diagnostic information for any refrigeration system and the ability to access this information at any time is a significant benefit. This eliminates the need for service gauge attachment, preventing non-condensibles from entering the system and loss of refrigerant.

4. **Refrigerant and Total System Charges**
   There is no "drop in" replacement for the industry's refrigerant of choice (R-22) today. As R-22 production begins to reduce, prices will climb. Alternative refrigerants are available but penalize system performance up to 25%. This is significant enough that few systems today are built with refrigerants other than R-22. There are steps the designer can take today to ensure the owners refrigerant costs in the future are minimized:

   - Specify the maximum total allowable system` charge.
   - Keep outdoor air-cooled condensers as close to the dehumidifier as possible.
   - Water-cooled or closed circuit fluid cooler unit configurations have the smallest charges. These units come with a complete factory charge and require no onsite refrigeration piping or charging.

Select systems with the smallest possible refrigerant charges.



5. **Receiver Refrigerant Level Indicators**
   Sight glasses mounted on the receiver allow for easy refrigerant charge adjustment without the expense of evacuation and weigh-in techniques.

6. **Dehumidifier Evaporator Coil Design**
   A latent cooling coil must be 6 rows deep or more. A coil with fewer rows will penalize compressor performance. In order for a 3-row deep coil to deliver the same leaving air temperature as a 6 row deep coil, the compressor must run significantly colder. This penalizes compressor and system output up to 20% and may cause coil freeze-ups.

7. **Warranty**
   Five (5) year extended parts only warranties on compressors and airside heat exchangers are generally a good investment. Some manufacturers' 10-year warranties are very restrictive and conditional such that they may not be enforceable.

8. **Commissioning**
   The final performance review of a dehumidifier can only be completed once the natatorium is operating at design conditions. Often the initial start up is done with a cold pool. These facilities require a follow up visit once the water has reached design conditions. Specify that a factory trained/certified service company perform the start up and commissioning. *This may not be the installing contractor.*

9. **First Year Labor**
   If the installing contractor is not doing the unit start up, specify who should be responsible for the first year labor warranty.

4.4 INTERNET MONITORING

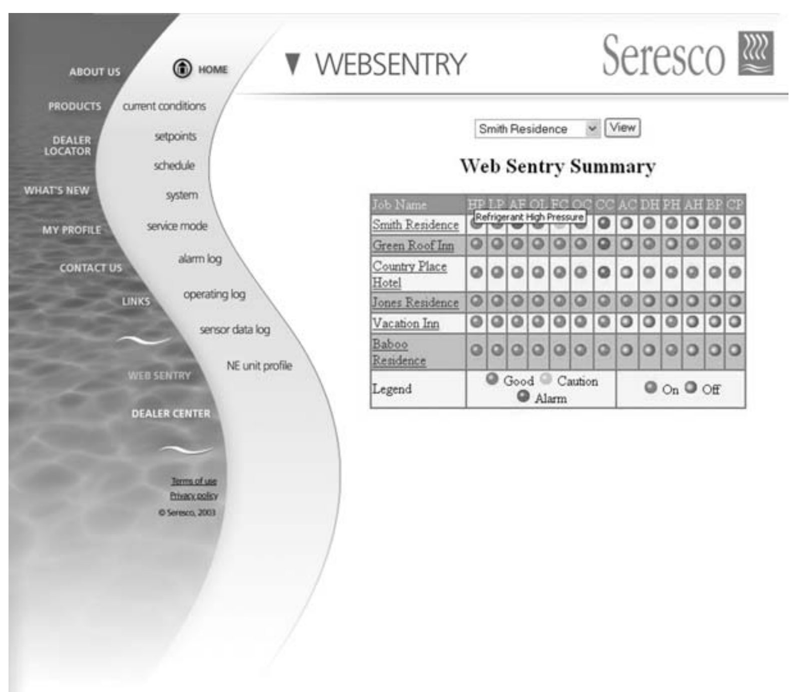
Seresco's electronic controls are all supplied with Ethernet connections. This allows all units to be accessed over the internet. This technology offers the owner very inexpensive 24-7 monitoring abilities.

Seresco units have a multitude of unit mounted sensors as well as refrigerant pressure transducers. The service technician can access all necessary information regarding unit operation and performance from their remote computer. Set points can be adjusted, sensors can be recalibrated, new programs can be downloaded and unit performance can be fine-tuned.

Factory certified service companies can now offer pool operators 24-hour monitoring.

The facility owner, especially those in more remote locations, will have a much more affordable means of ensuring their units are monitored and serviced by experienced factory trained service companies.

This is the new standard in customer satisfaction and unit reliability



5 Frequently Asked Questions

DUCT MATERIAL
What duct material is recommended?

For most installations standard galvanized sheet metal is adequate. Aluminum, 316-grade stainless steel or fabric duct are also suitable. Painted galvanized spiral ductwork is popular when the duct is exposed. If a below-grade duct system is used, non-metallic or PVC-coated round metal ductwork should be used.

FABRIC DUCT
Is this duct material recommended?

There are many benefits to fabric duct. It is inexpensive, easy to install, lightweight, won't corrode and can be ordered in virtually any color. However - special care must be taken when using fabric duct to ensure the diffusers are sewn in where they will deliver air as required for the space and that they have suitable throw.

WAVE POOLS AND WATER PARK FEATURES.
What are some of the design challenges?

Calculating the evaporation rate and IAQ. These facilities have high dehumidification loads as a consequence of their heavy bather loading and also require more outdoor air than a traditional natatorium. Contact your local Seresco representative for additional design assistance.

POOL COVERS
I have one. Do I still need a dehumidifier?

Yes. The dehumidifier is sized for the load presented by the pool when in use. Experience shows that unless a pool cover is automatic, it will not be routinely used. A pool cover is important to have at a facility in the event of a power failure. Pool covers do not completely stop evaporation, but they do reduce it. Consequently use of a pool cover will reduce the run time of the dehumidifier.

WET DECK
Why use wet deck area in lieu of total deck area to calculate the outdoor air requirement?

The purpose of outdoor air is to dilute the chemicals evaporating from the pool water. A section of deck that will never get wet does not contribute to air quality issues. As outdoor air is expensive to heat, cool and dehumidify, designing the outdoor air requirement to match the wet areas is a means of reducing the operating costs of the facility. Facilities may also have lounges and exercise areas that should not be considered a part of the pool operation area.

SUSPENDED CEILINGS
Why are suspended ceilings not recommended?

They create an unconditioned space that is prone to condensation and corrosion problems. If a facility has a suspended ceiling, it must be conditioned as would the rest of the pool space.

SKYLIGHTS
Are skylights recommended?
No. They are prone to condensation problems in colder weather. The large quantity of supply air required for condensation control is often a problem because ductwork is required and this can cause concerns about aesthetics with the owner.

SWIM MEETS

How does this impact dehumidifier selection?

A pool that will host swim meets has essentially two modes of operation: normal mode and swim meet mode. A swim meet generally has a very large spectator load while the pool swimmer density is less than during normal operations. Section 2.2.1.2 addresses this issue in more detail.

CONDENSATE

Can I return condensate from the Seresco dehumidifier back to my pool?

Check your local health codes. The condensate from our coated coils is drinking-water quality and can be returned to the pool where local codes permit. The amount of condensate recovered in a year is equivalent to one entire pool fill. It is usually reintroduced upstream of the filter or into the skimmer.

COOLING

Can I upsize my Seresco dehumidifier for more cooling?

Yes. If the model initially selected has a sensible cooling capacity less than what is required, a larger unit is usually the most cost effective solution. Two compressor systems can also be staged to help deliver only as much cooling as is required at any given time.

AIR DIRECTION

Should there be air movement at the water surface?

Yes. The U.S. Olympic Committee (USOC) does recommend some air movement at the water surface for its facilities to dilute a higher concentration of chemicals where the swimmers breathe. Significant air movement at the water surface (above 10-30 fpm as per ASHRAE) is not recommended however, as it increases the evaporation rate and affects bather comfort.

RETURN AIR

Should the return air inlet be near the spa?

No, put the exhaust air inlet there instead. The air around the spa has the highest concentration of pollutants and is the most corrosive air in the space.

DUCT INSULATION

Is it required?

Yes, when ductwork passes through unconditioned areas it should be insulated with duct wrap on the *outside*. This will prevent condensation and heat gain/loss.

SMALL POOLS/ROOMS

What is recommended for a small room with only a therapy pool or whirlpool?

These smaller rooms are common in hotels and physical therapy clinics. They still need to be designed as you would a larger facility.

ALL GLASS STRUCTURES

What are some of the design challenges?

Condensation is an obvious issue. The entire structure is essentially a window and must be blanketed with air. The heating and cooling requirements of the space must be addressed. Significant amounts of glass also contribute to glare on the water surface. This becomes a safety issue because the lifeguard my not be able to see below the water surface as a result.

6 Design and Installation Details

The designer should address the following issues to ensure the unit is properly installed and can be serviced and maintained.

6.1 ACCESS SPACE

No Access = no service or maintenance. All NE series dehumidifiers have been designed to require access on only two sides. Allow a minimum of 36 inches of clearance on the sides indicated for piping and service access. Mirror access units are also available.

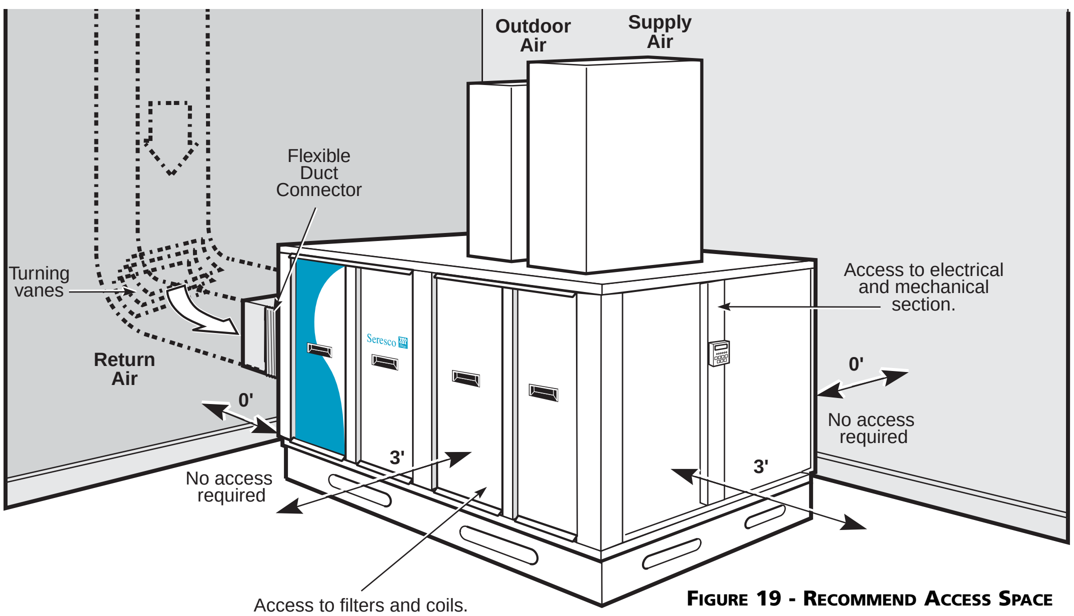


FIGURE 19 - RECOMMEND ACCESS SPACE

6.2 POOL WATER HEATING (OPTION)

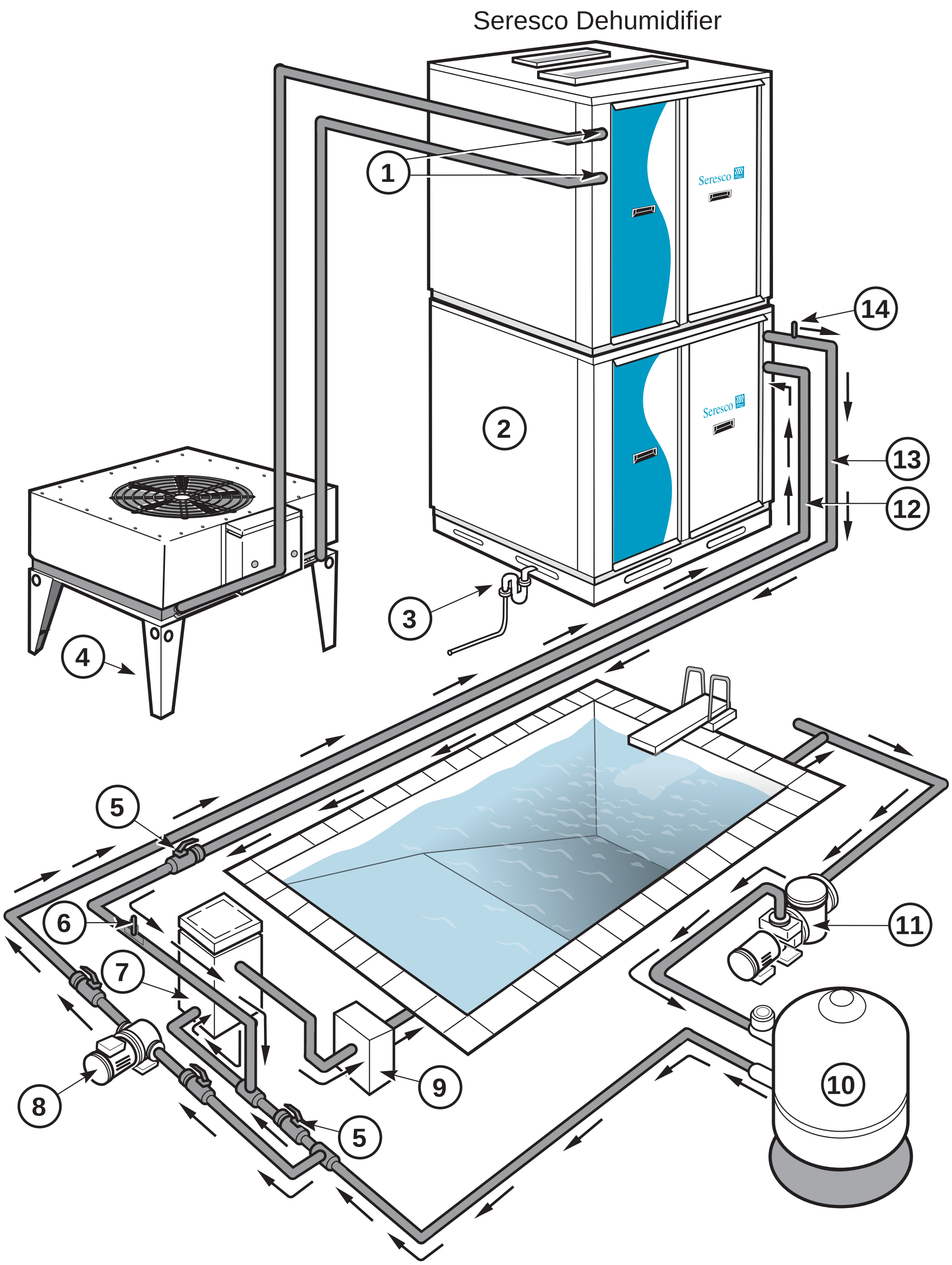
Seresco has developed the simplest and most reliable water heating configuration in the industry. NE Series dehumidifiers can be equipped with water heating capabilities. The annual energy savings realized as a result of the water heating capabilities makes this unit configuration one of the most energy efficient units in all of the HVAC industry.

The NE unit requires only a fraction of the total water being circulated by the main filter system.

- The water circuit should tap off the main pool water line downstream of the main filter and upstream of the auxiliary pool water heater and chemical feeder. (See figure 20)
- An auxiliary water pump to deliver the unit's required water flow rate is recommended. This is an open system and the pool's main circulating pump can rarely accommodate additional system pressure.

Model	GPM	PSI
003	6	5
004	8	3
006	12	2.5
008	16	3.5
010	18	4.5
015	28	4.5
020	36	4.5

TABLE 11 - WATER FLOW RATES (GPM) & PRESSURE DROP (PSI)



Legend

1. Refrigerant Piping to Outdoor condenser
2. Seresco Dehumidifier
3. P-Trap
4. Outdoor Condenser
5. Ball Valve
6. Flow Meter
7. Auxiliary Pool Heater
8. Auxiliary Pump
9. Automatic Chemical Feeder
10. Pool Filter
11. Main Pool Pump
12. Water Inlet
13. Water Outlet
14. Air Vent

Figure 20 - Proper Pool Water Piping Installation

6.3 OUTDOOR AIR COOLED CONDENSER INSTALLATION

This condenser is used in air conditioning mode where it rejects unneeded heat from the space to outdoors. Proper installation is essential to ensure it can function as intended. Proper airflow and refrigerant piping are paramount.

- Ensure an appropriate maximum ambient air temperature has been specified.
- Ensure the unit has proper airflow. A perimeter of free area equal to its width must be provided.
- Use line sizes as specified by Seresco.
- To avoid potential seasonal system charge problems, ensure the installed line lengths are never longer than indicated on the plans and specifications.
- If the condenser is installed above the dehumidifier, ensure the hot gas line has proper oil traps.
- Contact Seresco if the condenser is installed more than eight (8) feet below the dehumidifier.

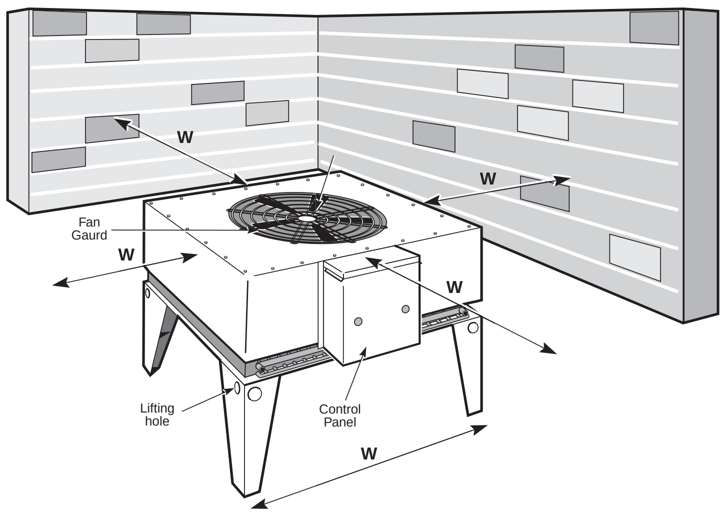


FIGURE 21 - TYPICAL OUTDOOR CONDENSER INSTALLATION

- Specify the lines be nitrogen purged while being brazed to help avoid scaling inside the pipe.

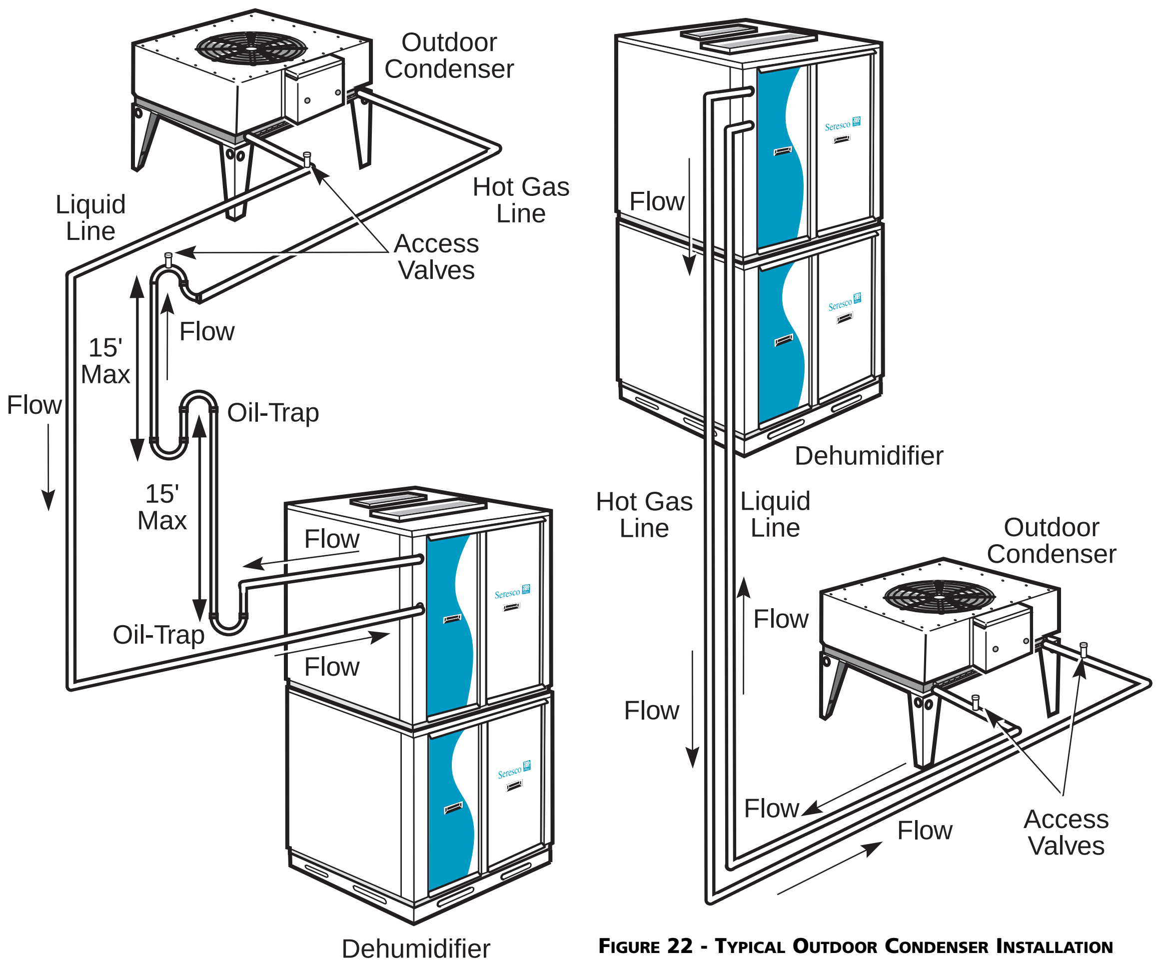


FIGURE 22 - TYPICAL OUTDOOR CONDENSER INSTALLATION

6.4 CONTROL WIRING

The NE Series dehumidifiers have all necessary sensors unit mounted and set points pre-programmed at the factory. Remote duct heaters, outdoor air-cooled condensers, auxiliary pool water heaters and remote exhaust fans all require interfacing with the dehumidifier. The microprocessor has been programmed to control their operation. An Ethernet connection to the Internet allows all functions to be monitored by trained professionals with Seresco's WebSentry. It is the final step to ensure the facility operates trouble free.

Unit mounted sensors, all accessible via the Internet include:

- Refrigerant high pressure
- Refrigerant low pressure
- Return air temperature
- Return air relative humidity
- Pool water temperature (in and out)
- Outdoor air temperature
- Supply air temperature
- Evaporator air temperature
- Compressor superheat temperature
- Mechanical compartment temperature
- Filter condition
- Airflow
- Bypass damper setting

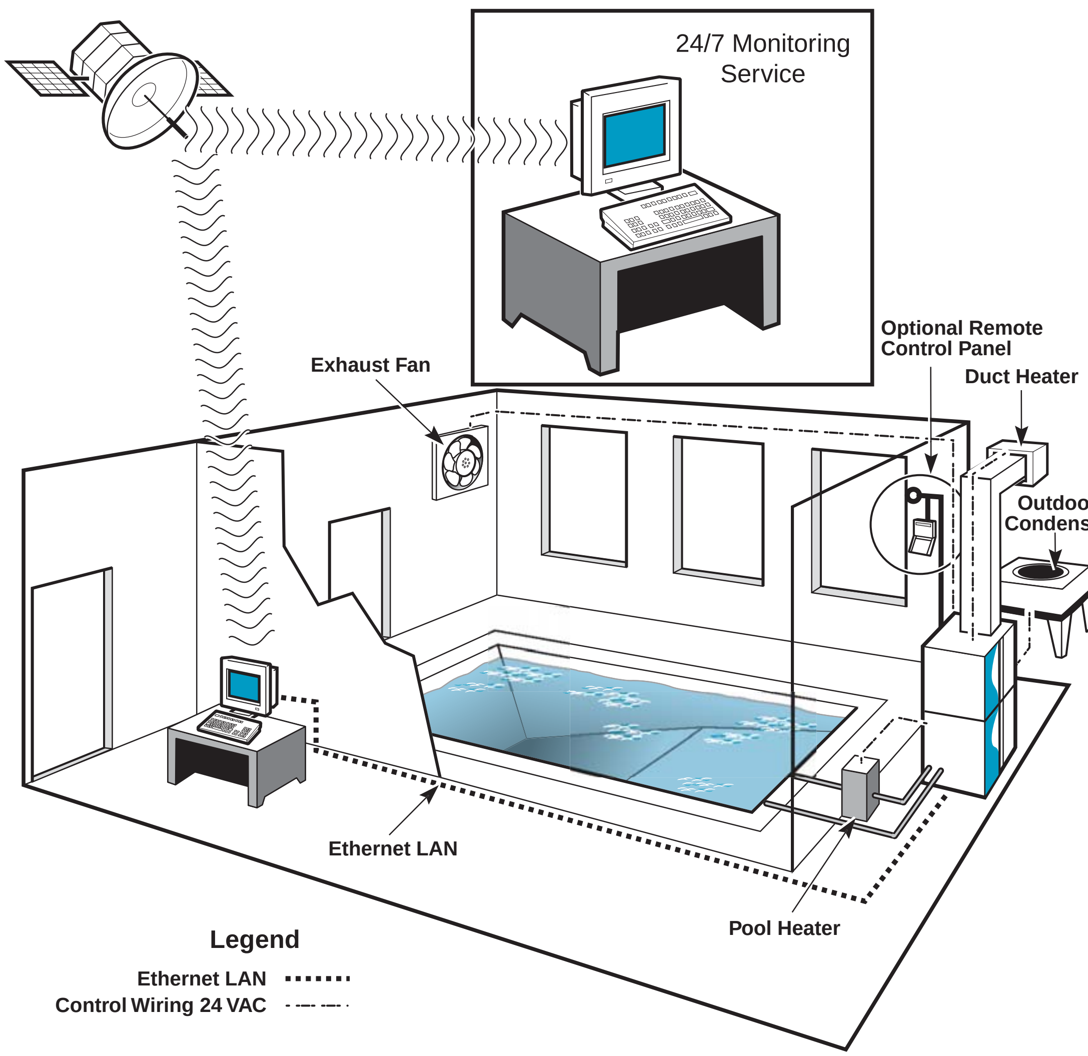


FIGURE 23 - CONTROL WIRING

Your local Seresco representative:

System design and air flow pattern
Evaporation rate and latent loads
Required Access Space
Exhaust Air
Supply Air
Cooling and Heating loads
Outdoor Air

Design Checklist

Project: ______________________________

Reviewed by: ______________________________

System design and air flow pattern

- ☐ All exterior windows, doors and skylights are fully blanketed with supply air.
- ☐ No stagnant areas including the water surface.
- ☐ Vapor retarder is installed on the warm side of the dew point in the roof and walls.

Evaporation rate and latent loads

- ☐ Pool load calculated.
- ☐ Outdoor Air load calculated.
- ☐ Water features reviewed with factory.
- ☐ Spectators and swim meet mode calculated.

Required Access Space

- ☐ Unit is accessible.
- ☐ Unit has adequate service clearance.
- ☐ Suspended unit has unobstructed access.

Exhaust Air

- ☐ Exhaust fan identified on the plans.
- ☐ Exhaust Air is minimum 110% the outdoor air CFM.
- ☐ Exhaust air drawn from the whirlpool or any other warm or highly active water area.

Supply Air

- ☐ System delivers 4 air changes per hour or greater.
- ☐ Supply air is delivered to the deck area.
- ☐ No short-circuiting of supply air to the return duct.

Cooling and Heating loads

- ☐ Sensible cooling load has been calculated for the space design temperature.
- ☐ Heating load has been calculated for the space design temperature.
- ☐ Outdoor air has been included in all load calculations.

Outdoor Air

- ☐ 1.0 CFM/ft^2 of water and wet deck for pool with water features.
- ☐ 0.5 CFM/ft^2 of water and wet deck for regular pool.
- ☐ 15 CFM per spectator.

Comments:

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1-888-Seresco (737-3726)
For more information visit www.seresco.net

Seresco