Form follows Function of Water, Air and Motion

The bubble of unaffected air

- What the Swim Facility Owners are looking for?
  - Chemical Control & Relation to Air Quality.
  - The Proper Components of the Complete Mechanical System.
  - Importance of a Design Team & It's Members.
  - Understanding the Moisture Load & Where It Comes From.
  - Evaporation - What to Consider.
  - The Proper Amount of Ventilation Air and How It Effects the Loa
  - Why Do I Need A Dehumidifier?
  - The Distribution System and the Bubble.
  - What is Needed After the Doors Open.

Introduction:

- Today's building environment is a scary place. Existing and revised Standards are shaping both building designs and legal environments.

- Individual interpretations of Standards are implicit in many design strategies, which can change as Standards are revised, adopted by code bodies and official interpretations are published.

- The occupied zone of a building is where the rubber meets the road. There are selection methods available to the engineer to make informed selections, in accordance with accepted practices (typically the ASHRAE Handbooks).

- In addition, there are new products, which allow for a more fail-safe design, allowing more design flexibility than conventional selections.

What the Swim Facility Owners are looking for?

- Healthy and safe environment for the many different user groups
- Protection of the Building Envelope and Equipment
- Energy Efficiency


Healthy and Safe Environment for the Many Different User Groups

Building Methods

- Brick & Mortar – Pre-engineered steel, concrete
- Fabric & Membrane
- Insulations – Air-tight energy savings, negative pressure, doors & windows, natural leakage

People's Lifestyles and Expectations

- Lifestyles are more demanding
- Expectations are higher
- Allergies more prevalent
- Perfection is relative and with no tolerance for the norm

Agencies

- All have regulations, some without consideration for the practical

Chemical Control & Relation to Air Quality

Relationship of Water to Air

- Prime Directive: The air can only be as good as the water!

What Has Changed in the Last 3 Decades?

- Everything:
  - Air
  - Source Water
  - Treatment Methods
  - Environment

Problems

- Causes?
- Cures?

Chemical Control & Relation to Air Quality

How We Treat Water

Chemically:

- Chlorine
- Bromine
- Biaguanides
- Ozone
- UV

<u>NOTE:</u> Chloramines = Bad Air

Physically:

- Sand
- DE
- Cartridge
- UV
- Regenerative Systems

Chemical Control & Relation to Air Quality

Problems – Solutions

Filtration

- **Use the best that is allowed.**
  - **DE**
  - **Cartridge**
  - **Sand**

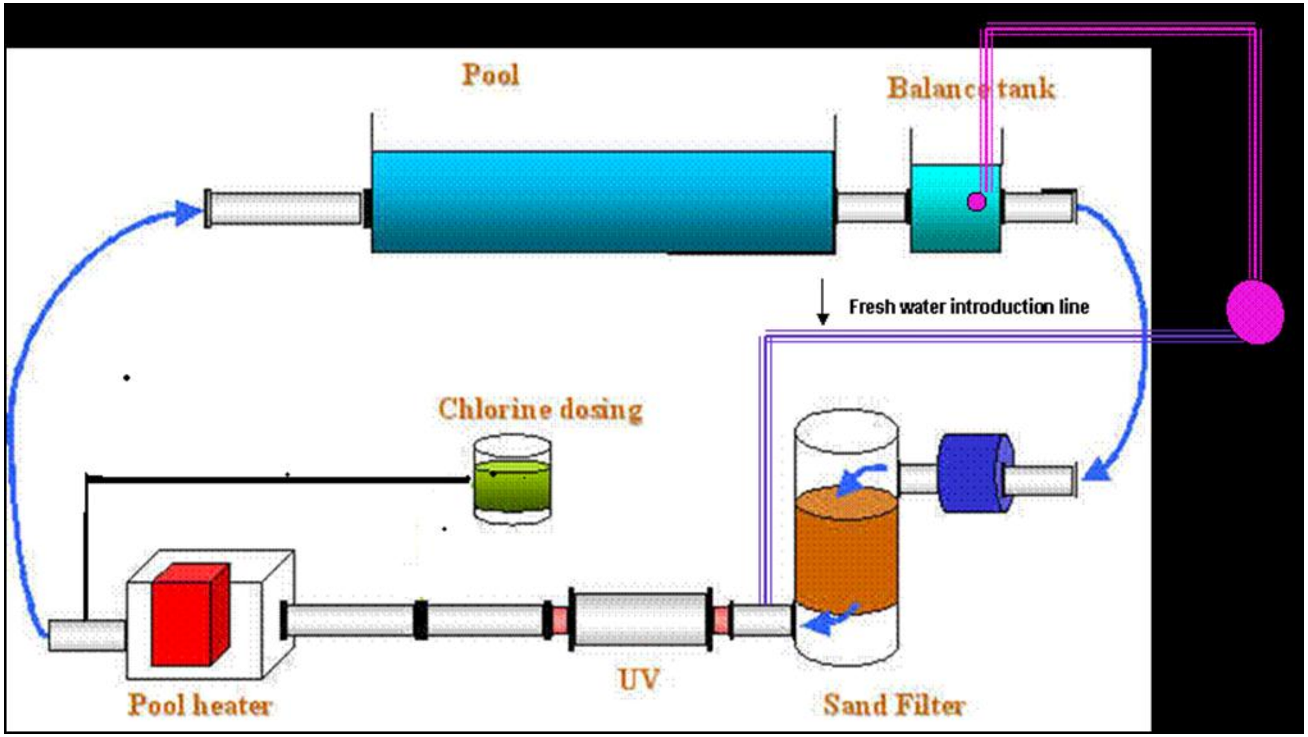
UV Is Paramount Indoors

Sanitization* – *Use the simplest system that is practical for your areas water quality.

Operations & Procedures* – *The car is only as good as its' driver. Record keeping & maintenance.

What to believe.

Chemical Control & Relation to Air Quality



Chemical Control & Relation to Air Quality

Systematic Problem Solving

No "canned" solutions, no assumptions.

Communications

Sharing the stories and being responsible to correct the errors rather than point fingers of fault.

Tracking Results

Every problem solved is a testimonial to proper design and planning, even if in hindsight.

Importance of a Design Team & Its Members

•Pools and pool spaces are engineering feats. Don't let architectural design drive this important issue.

•Form always follows function and especially for the pool space.

•If something goes wrong its YOUR fault

MYTHIC SPORTS

The Proper Components of the Complete Mechanical System

- Dehumidification System
- Auxiliary Space Heating System
- Pool Water Heating System
- UV Water Treatment System
- Proper Distribution System

ASHRAE Standards

A number of ASHRAE Standards cover the issues of proper space ventilation and occupant comfort. These include:

- Ventilation For Acceptable Indoor Air Quality
- Thermal Comfort Conditions for Human Occupancy
- Method of Test for Air Change Effectiveness
- Method Of Test for Room Air Distribution

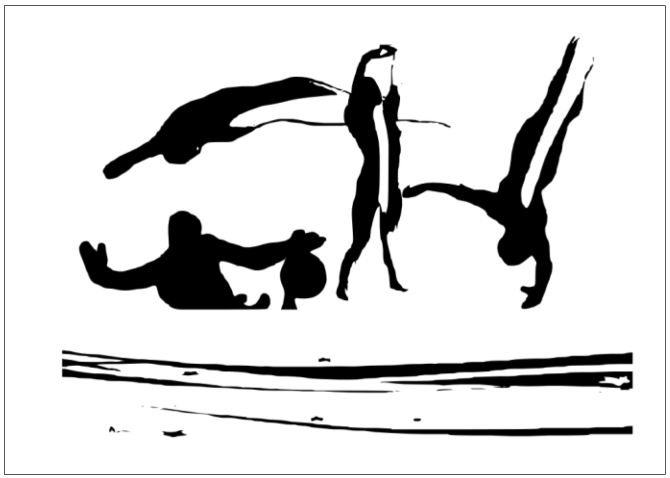
Understanding the Moisture Load

1. Water Surface Evaporation
    - Air & Water Temperatures
    - Humidity Levels
    - Activity Levels

2. Ventilation Air

3. People / Spectators

Water Evaporation



1. Water Surfaces in Square Feet
2. Activity Factors Suggested by ASHRAE

Unoccupied Pools --------	0.5
Residential -----------------	0.5
Condominium -------------	0.65
Therapy ---------------------	0.65
Hotel -------------------------	0.8
Public Schools ------------	1.0
Whirlpools -----------------	1.0
Wave Pools, Slides -------	1.5 (minimum)

Water Evaporation

Relation of Air Temperature & Water Temperature

- **Evaporation is at a minimum when the air temperature is above the water temperature**

- **Air Temperature should not be above 86°Fdb**

- **Keep humidity between 50% & 60%**
  - Minimizes evaporation
  - Helps prevent swimmer chill effect

Understanding the Moisture Load

Ventilation Air – ASHRAE 62.1 Standard

0.48 cfm / square foot of Pool & Deck

Spectator Area

7.50 cfm / person --- Plus

0.06 cfm / square foot of Bleacher Area

Understanding the Moisture Load

Notes:

1. Tabulated values are based on 75°F room dry-bulb temperature. For 80°F room dry bulb, the total heat remains the same, but the sensible heat values should be decreased by approximately 20%, and the latent heat values increased accordingly.

200 spectators

equals same evaporation as a 1,000 sq. ft. pool

Spectators

Table 1 Representative Rates at Which Heat and Moisture Are Given Off by Human Beings in Different States of Activity

Degree of Activity	Location	Total Heat, Btu/h: Adult Male	Total Heat, Btu/h: Adjusted, M/F[a]	Sensible Heat, Btu/h	Latent Heat, Btu/h	% Sensible Heat that is Radiant[b]: Low V	% Sensible Heat that is Radiant[b]: High V
Seated at theater	Theater, matinee	390	330	225	105		
Seated at theater, night	Theater, night	390	350	245	105	60	27
Seated, very light work	Offices, hotels, apartments	450	400	245	155		
Moderately active office work	Offices, hotels, apartments	475	450	250	200		
Standing, light work; walking	Department store; retail store	550	450	250	200	58	38
Walking, standing	Drug store, bank	550	500	250	250		
Sedentary work	Restaurant[c]	490	550	275	275		
Light bench work	Factory	800	750	275	475		
Moderate dancing	Dance hall	900	850	305	545	49	35
Walking 3 mph; light machine work	Factory	1000	1000	375	625		
Bowling[d]	Bowling alley	1500	1450	580	870		
Heavy work	Factory	1500	1450	580	870	54	19
Heavy machine work; lifting	Factory	1600	1600	635	965		
Athletics	Gymnasium	2000	1800	710	1090		

Notes:

1. Tabulated values are based on 75°F room dry-bulb temperature. For 80°F room dry bulb, the total heat remains the same, but the sensible heat values should be decreased by approximately 20%, and the latent heat values increased accordingly.
2. Also refer to Table 4, Chapter 8, for additional rates of metabolic heat generation.
3. All values are rounded to nearest 5 Btu/h.

[a] Adjusted heat gain is based on normal percentage of men, women, and children for the application listed, with the postulate that the gain from an adult female is 85% of that for an adult male, and that the gain from a child is 75% of that for an adult male.

[b] Values approximated from data in Table 6, Chapter 8, where V is air velocity with limits shown in that table.

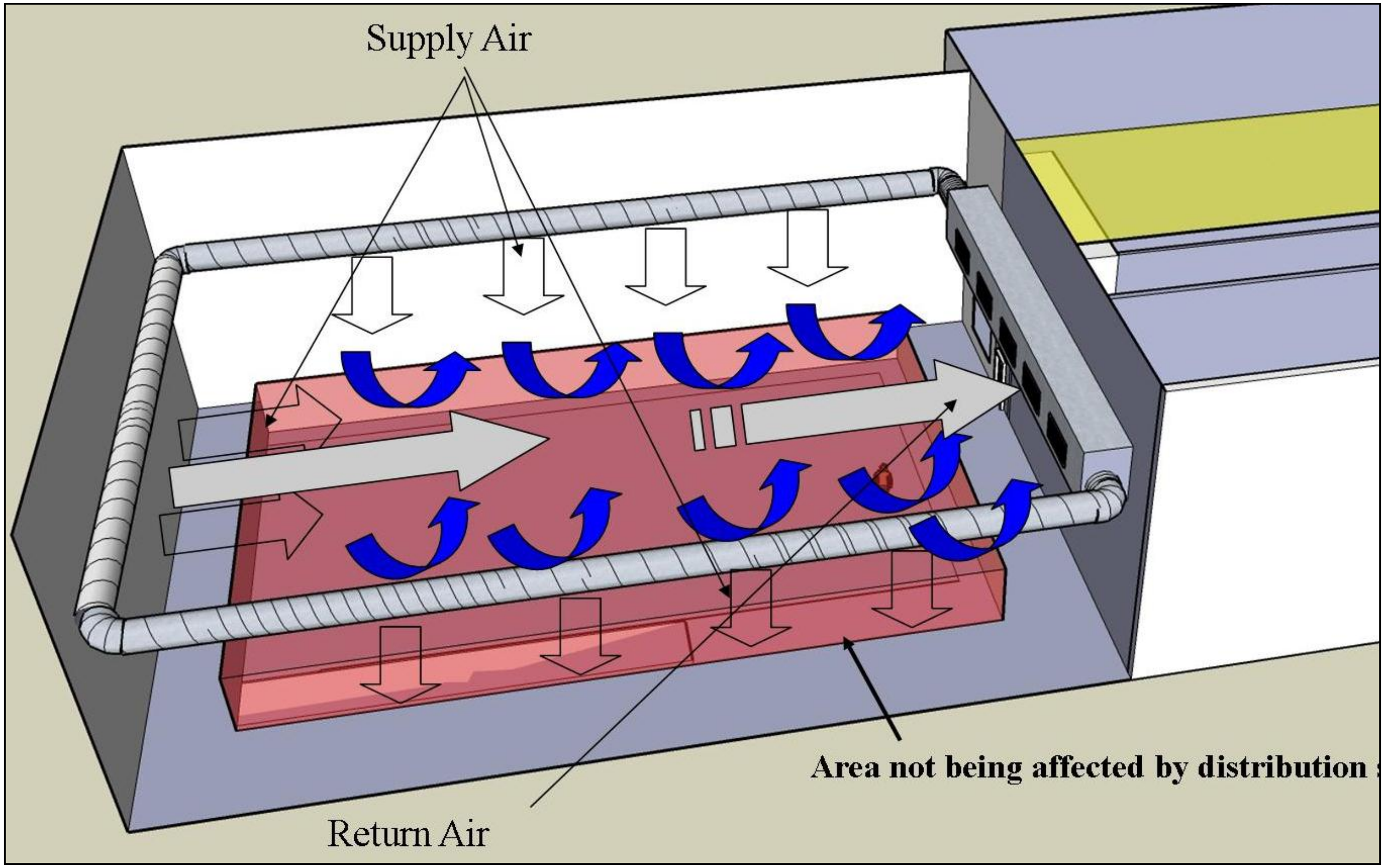
[c] Adjusted heat gain includes 60 Btu/h for food per individual (30 Btu/h sensible and 30 Btu/h latent).

[d] Figure one person per alley actually bowling, and all others as sitting (400 Btu/h) or standing or walking slowly (550 Btu/h).

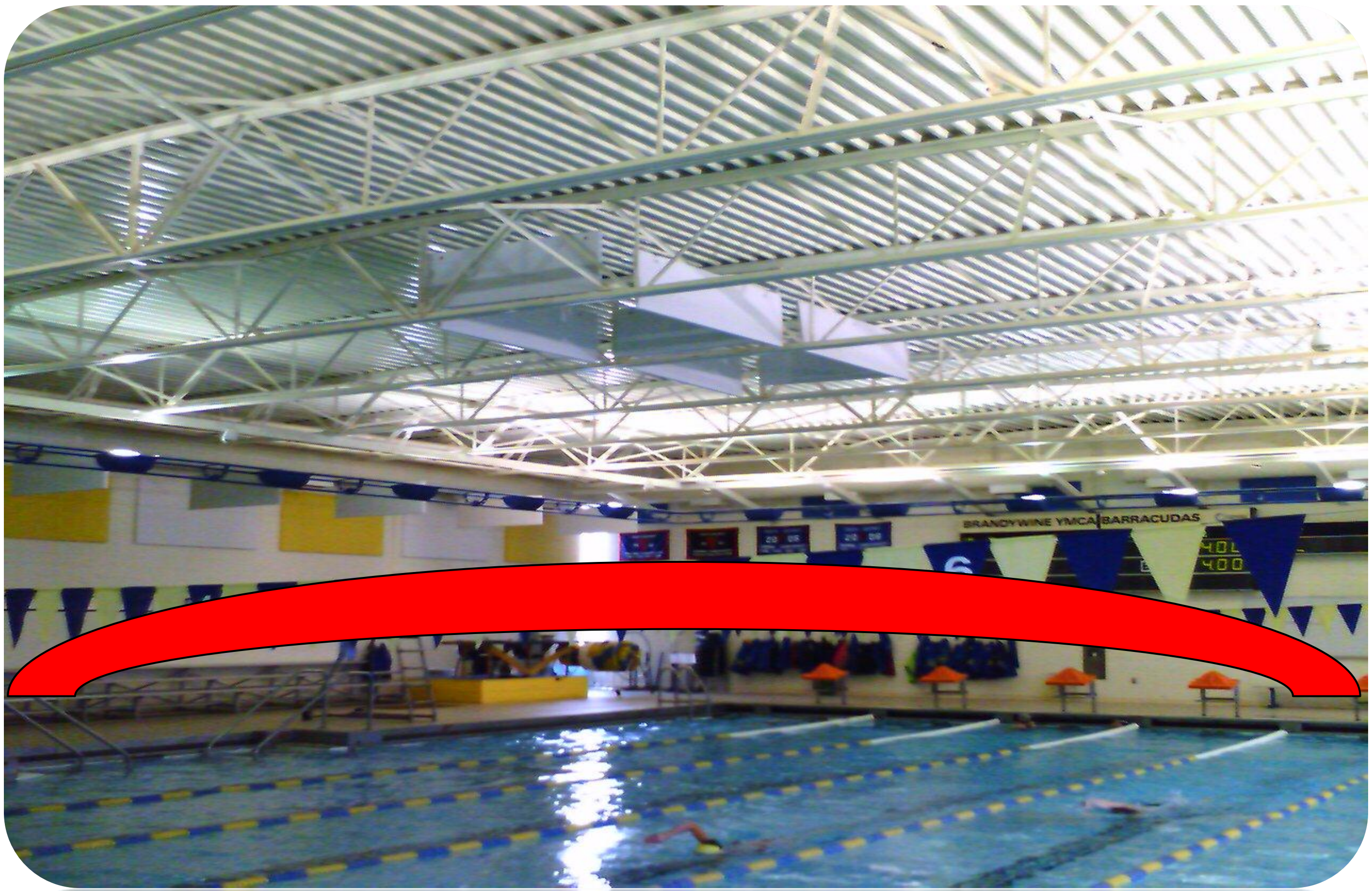
Air Distribution

Breaking the Bubble

Is it a combination of more ventilation air and air movement across the water surface?


Supply Air
Area not being affected by distribution
Return Air

MYTHIC SPORTS



Effective Ventilation Rates

The ratio of outside air which enters the HVAC system, that is delivered to the occupants

- air mixing (and potential short-circuiting) in the HVAC air handler
- duct leakage
- duct air distribution and mixing
- internal air handler short-circuiting between supply and exhaust

Air Change Effectiveness

Air Change Effectiveness (ACE) is defined by ASHRAE Standard 129 as the ratio of air entering a space to that in the occupied zone.

- % of outside air introduced by the diffuser into a room which makes it to the 'breathing' or occupied zone and is available to provide 'fresh' air and to dilute occupant generated contaminants.
- Studies indicate that ACE is almost always 100% when diffusers are supplying cold air. In heating, however, rates as low as 65% have been observed

Ventilation Air

Use the ASHRAE "Dehumidification Weather Data"

	Lb/hr	Gallons/hr
Los Angeles, CA	20.0	2.4
Atlanta, GA	15.9	1.9
Chicago, IL	15.0	1.8
St. Louis, MO	13.8	1.7
Dallas, TX	25.0	3.0
New York City	17.3	2.0

Difference per 1,000 cfm of ventilation air @ 1% values

Air Movement Over Water Surface

- Basic ASHRAE formula allows for 25 fpm of air movement over surface of the water
- Typical supply grill discharges at over 125 fpm
- At 125 fpm over the water surface, the evaporation increases by approximately 35%

Air Distribution

Breaking the Bubble

Protecting the Building – Protecting Coaches & Swimmers

- All surfaces subject to condensation must be kept above dew point (typically 62°F)
- Return air must be split between ceiling area & floor area

Air Distribution for Large Spaces

The distribution of air into large spaces has both good news and bad news.

- **The good news is that since the spaces are so large, air distribution is spread out over a large area and localized problems are unlikely.**
- **The bad news is that because the spaces are large, diffusers can't be located everywhere.**

Most of the selection process is one of experience and jet mapping. HUH!

Avoid Stratifications
Avoid Short Circuiting
Supply and Return both High and Low

Basic Principles

Basic principles in analyzing airflows in large (or any) spaces.

- Newton’s gravitational observations: Hot air rises and cold air falls. The question is, of course, how much?

- Air which is in the form of a free jet, as opposed to one that is constrained along a surface, acts pretty much independent of the supply outlet isovel (or air pattern), following some basic rules of jet theory.

Return Air Locations

In most cases the location of a return is of little concern. In large spaces, however, returns can assist in controlling stratification.

- Returns should be placed in the occupied zone
- The influence of the return air device on air movement is very subtle.
- You can't suck out a match - returns have little direct influence on air patterns.

speedo
Radisson
DOROTHY L. SHEPPARD
POOL
MINNESOTA
GOLD
MINNESOTA

Ventilation Air

Do we need more than the ASHRAE recommendations?

Probably but how much more?

Why Do I Need a Dehumidifier?

Ventilation Air Alone Will Not Maintain Proper Conditions Year Round

Hours Above 78°F & 50% RH

Location	Hours	Days	% Year
Los Angeles, CA	2924	121.8	33%
Atlanta, GA	3763	156.8	43%
Boston, MA	1747	72.8	20%
Kansas City, MO	2860	119.2	33%
Portland, ME	1519	63.3	18%
Colorado Springs, CO	541	22.5	6%

Why Do I Need a Dehumidifier?

Over-drying (lower than 50% RH)

- Will cause chilling effect to swimmers
- Increases evaporation
- Requires more make-up water
- Requires more chemical use

What is Needed After the Doors Open?

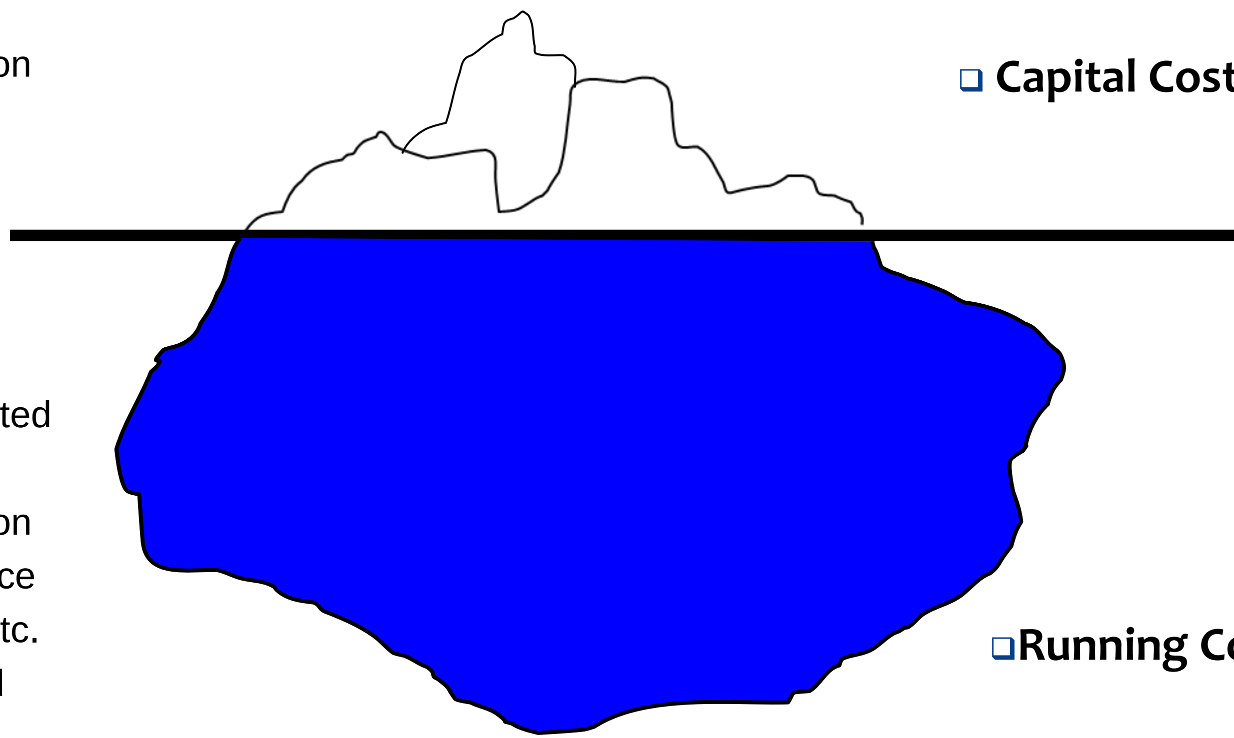
The Maintenance Contract

Proper Training

What is Needed After the Doors Open?

Iceberg Theory!!!!

- Land
- Studies
- Design
- Construction
- Furniture
- Fixtures



- **Capital Costs 30%**

- Staff Oriented
- Energy
- Depreciation
- Maintenance
- Cleaning etc.
- Contracted

- **Running Costs 70%**

Legal Issues

Many legal issues surround the IAQ question.

It is becoming apparent that the legal standard may be defined in court under the clause “acceptable standard of care”.

ASHRAE Standards have been used in litigation, even though not a part of the local code.

The concern is that even the draft standards may fall under this concept (explaining the level of concern over what is written in an unapproved public review draft.)

MAHC