



Armstrong International, Inc. is a leading supplier of hydro-pneumatic fogging systems used for both humidification and evaporative cooling. Its systems were first developed in response to industry needs for humidification systems that would be:

- Energy efficient
- Low maintenance
- Reliable
- Precisely controlled
- Clean

Cool Fog Systems, Inc. installed its first hydro-pneumatic humidification system in 1977. Since then, Armstrong-Cool Fog Systems has established itself with professional engineers and industry as a viable and desirable technology. Armstrong-Cool Fog has humidified over 100 million square feet of space including corporate occupancies, museums, hospitals, institutional facilities, **and semiconductor fabrication, and electronics manufacturing.**

Armstrong currently manufactures and markets the following systems for environmental control applications:

- **Cool Fog Systems (CF)** for use with potable or reverse osmosis purified water. All wetted parts are either stainless steel, brass, or copper. For general commercial and industrial application.
- **Pure Fog Systems (PF)** for use with de-ionized water. All wetted parts are stainless steel. For clean rooms, laboratories, semiconductor fabs, and other ultra clean environments.
- **Standard Proportional Systems (STD)** for air handler or duct applications. Available as CF or PF. For reduced evaporation distance requirements with medium to high compressed air consumption rates and 50:1 control modulation.
- **Variable Differential Control Systems (VDC)** for air handler or duct application. Available as CF or PF. For reduced compressed air consumption rates and 100:1 control modulation.

- **HumidiComp (HC), ON/OFF SYSTEMS** for air handler or duct applications. Available as CF or PF. For reduced cost compared to STD and VDC. Systems. Only recommended for fixed outside air rates and stable humidification loads.

- **Direct Area Discharge (DDF), ON/OFF SYSTEMS** for direct area discharge. Available as CF or PF.

Available from Armstrong Cool-Fog

Armstrong-Cool Fog Systems offers a complete package of products and services:

- Fogger assemblies with manifolds
- Control systems - standard & custom
- Precise engineering design and application assistance
- Detailed energy analysis and design
- Submittal drawings
- Installation Instructions
- Operating and maintenance manuals
- Full warranty
- Commissioning services
- Maintenance contracts
- Packaged systems
 - Humidification
 - Controls
 - Compressed air supply
 - RO water supply
- Water analysis

Designs, materials, weights and performance ratings are approximate and subject to change without notice. Visit armstronginternational.com for up-to-date information.

What is Fogging?

Armstrong-Cool Fog Systems are humidification systems that atomize water particles to produce a fog. When the fog is sprayed into a warm, dry air stream or space, the water readily evaporates without the addition of heat. The process is also referred to as evaporative humidification and follows the wet bulb line (i.e. constant enthalpy) on the psychrometric chart.

Armstrong-Cool Fog Systems may also be used for the purpose of air-cooling. Because no heat is added to evaporate the water, there is a cooling effect that is directly proportional to the amount of water evaporated. This is also referred to as adiabatic or constant enthalpy cooling and humidification.

How Foggers Operate

Armstrong-Cool Fog Systems use both compressed air and pressurized water to achieve atomization.

Pressurized water is injected into the discharge orifice of a compressed air stream. As the compressed air is discharged through an orifice, the air's potential energy is converted to kinetic energy, which is imparted to the injected water. In the process, the water is sheared into atomized water particles. In other words, the rapidly expanding air stream breaks up the water particles.

The mixture of atomized water and expanding air is discharged through an orifice and deflected off a resonator tip which further reduces the water particle size and spreads the atomized water and air mixture. The final product is fog.

Figure 157-2. Fogger Head

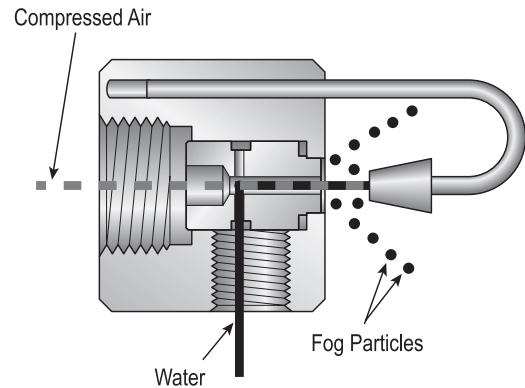
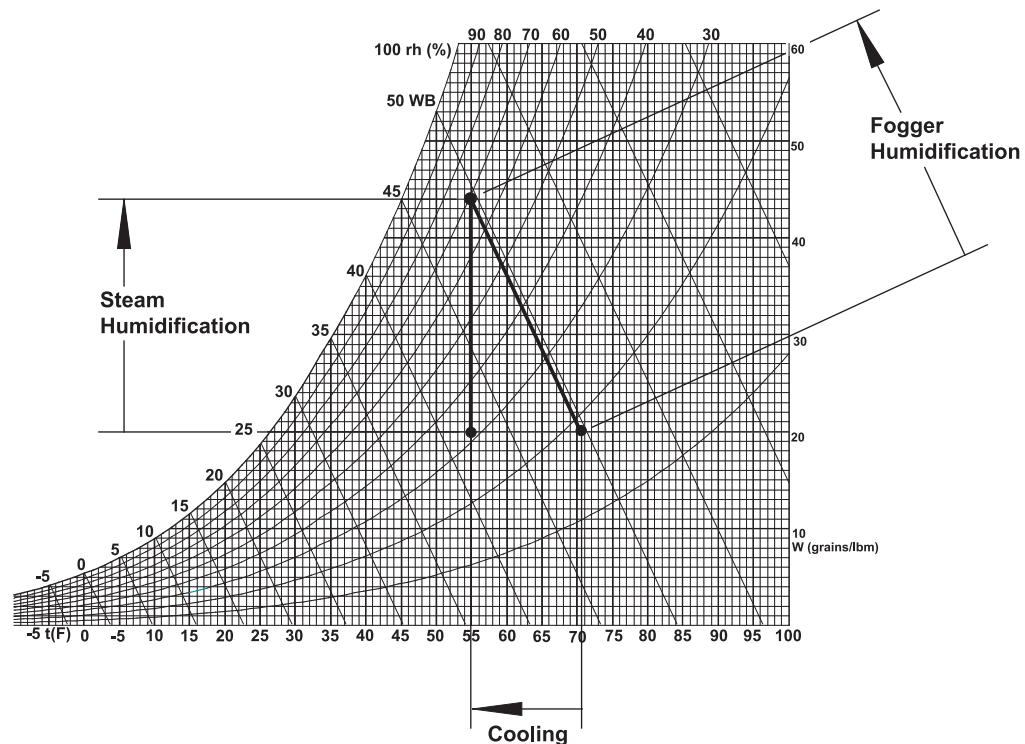


Figure 157-1.



Note: Psychrometric chart representations do not include fan heat gains, duct losses, infiltration losses or cooling coil dehumidification.

Humidification Reduces Heating Costs

All forms of humidification provide a variety of benefits, not the least of which is a reduction in heating load for human comfort. Studies indicate people are generally most comfortable when relative humidity is maintained between 35% and 55%. When air is dry, moisture evaporates more readily from the skin, producing a feeling of chilliness even with temperatures of 75°F or more. Because human perception of RH is often sensed as temperature differential, it's possible to achieve comfortable conditions with proper humidity control at lower temperatures. The savings in heating costs are typically very significant over the course of just a single heating season.

Efficient use of internal heat gain and waste heat can yield up to a 90% reduction of energy costs compared to steam humidification.

Large commercial offices and manufacturing facilities can have an extended cooling season or year round cooling load. In such situations, a mixed air economizer system can be employed to exhaust warmer return air and replace it with cooler outside air.

Although free cooling is achieved, the dryer outside air actually increases the humidification load and humidification energy consumption.

Instead of exhausting the warmer return air, foggers use the warm return air to evaporate water. Humidification is achieved without the energy required to boil water and economizer cooling is still achieved without mechanical refrigeration.

50-60% reduction of economizer humidification load and associated energy costs.

Because of the cooling experienced with fogging systems, economizer systems can run at higher mixed air temperatures which means less outside air is required. Therefore, the humidification load is greatly reduced compared to the conventional steam humidification load.

Efficient use of warm, dry outside air reduces cooling costs.

Some outdoor climates require both cooling and humidification to achieve the desired indoor design conditions. Obviously, economizers cannot deliver free cooling when the outside air is warmer than the desired zone temperature.

However, if the humidity levels are low, such as in the Western High Plains of the United States, significant free cooling may be achieved with an evaporative humidification system. This is true for both mixed air and 100% make-up air systems.

If fact, many non-desert climates experience significant cooling and humidification hours each year.

Ultra clean humidification source.

Armstrong-Cool Fog's Pure Fog (PF) systems are currently installed in many of the world's highest technology electronics and semiconductor manufacturing facilities. De-ionized water is used for an ultra-pure source of humidification to maintain a non-contaminated environment.

Highest Kinetic Energy.

Armstrong-Cool Fog Systems use the highest air pressures of all high capacity atomizer systems. The result is the highest kinetic energy imparted to the water particles. Because Armstrong-Cool Fog Systems produce the highest energy particle, we have the highest evaporation efficiency. In other words, we evaporate more water per unit volume of water sprayed.

This translates directly into the highest energy savings. This also results in less waste of purified water which, if not evaporated, goes down the drain.

Highest kinetic energy also means the driest running system.

Because Armstrong-Cool Fog Systems produce the highest energy particle, we have the shortest evaporation distances **and have the driest running system** of all high capacity atomizer systems.

Energy savings with clean rooms.

Clean room humidification typically requires ultra-pure (i.e. de-ionized or reverse osmosis filtered) water as a humidification source. As ultra-pure water is considered corrosive at elevated temperatures, all stainless steel components would be required for steam service.

In many applications, a stainless steel re-boiler would be used to accomplish clean room humidification with ultra-pure water. Due to the inefficiencies of the heat exchange process, a Cool Fog system could be more energy efficient . . . even if 100% outside air is used.

Reduced maintenance cost with no boiler or steam distribution system.

Steam injection humidification, while similar to Cool Fog Systems in reliability and accuracy, can require more maintenance in the following areas:

- blowdown
- leaks
- traps
- scale
- carbonic acid
- chemical treatment

Reduced maintenance and improved reliability over other evaporative systems.

Traditional evaporative systems and other atomizing systems have many maintenance requirements that are not a concern with Armstrong-Cool Fog Systems.

- Swamp coolers require replacement of pads, cleaning & chemicals.
- Air washers require cleaning & chemicals.
- Low pressure air/water atomizers have moving parts in their nozzles that break.
- High pressure water atomizers (no compressed air) are prone to clogging of the orifice.
- Cool Fog manifolds come completely assembled, so less installation time is required.

Instant and Precise Control Response.

- 50:1 turndown with standard proportional control
- 100:1 turndown with variable differential control
- no staging
- fast pneumatic response
- patented feedback system

Quick and Easy Installation.

- simple design
- pre-assembled manifolds

Highest Mechanical Integrity.

As with everything Armstrong makes, quality is not compromised in order to produce a low priced system. Armstrong-Cool Fog Systems are made with both the sturdiest materials and design.

Potential Energy Savings Opportunities with Armstrong-Cool Fog Systems



Due to the dry bulb cooling effect of evaporative humidification systems, substantial energy saving opportunities present themselves when compared to the cost of using steam for humidification. These opportunities are easily quantified using bin weather data. The estimated energy saving may be used to estimate the payback period for an investment in an Armstrong-Cool Fog System.

Mixed Air System with Dry Bulb Economizer

During the fall, winter, and spring economizer seasons, typical commercial air conditioning systems supply air to conditioned spaces at 55°F. If the minimum outside air percentage is low enough, return air and outside air can be mixed to 55°F, or higher, during most, or all, of the season without pre-heating.

The typical maximum humidification load conditions occur when the outside air is 55°F. At such conditions, 100% outside air is used for the free cooling effect.

When the outside air temperature is between the supply air temperature and the building design temperature, 100% outside air is cooled to the supply air temperature.

When the outside air temperature is above the building design temperature, outside air is reduced to the minimum percentage to minimize the cooling load.

Energy savings potential may be realized in three ways with mixed air systems using a dry bulb economizer:

1. Latent Heat Recovery from Return Air.

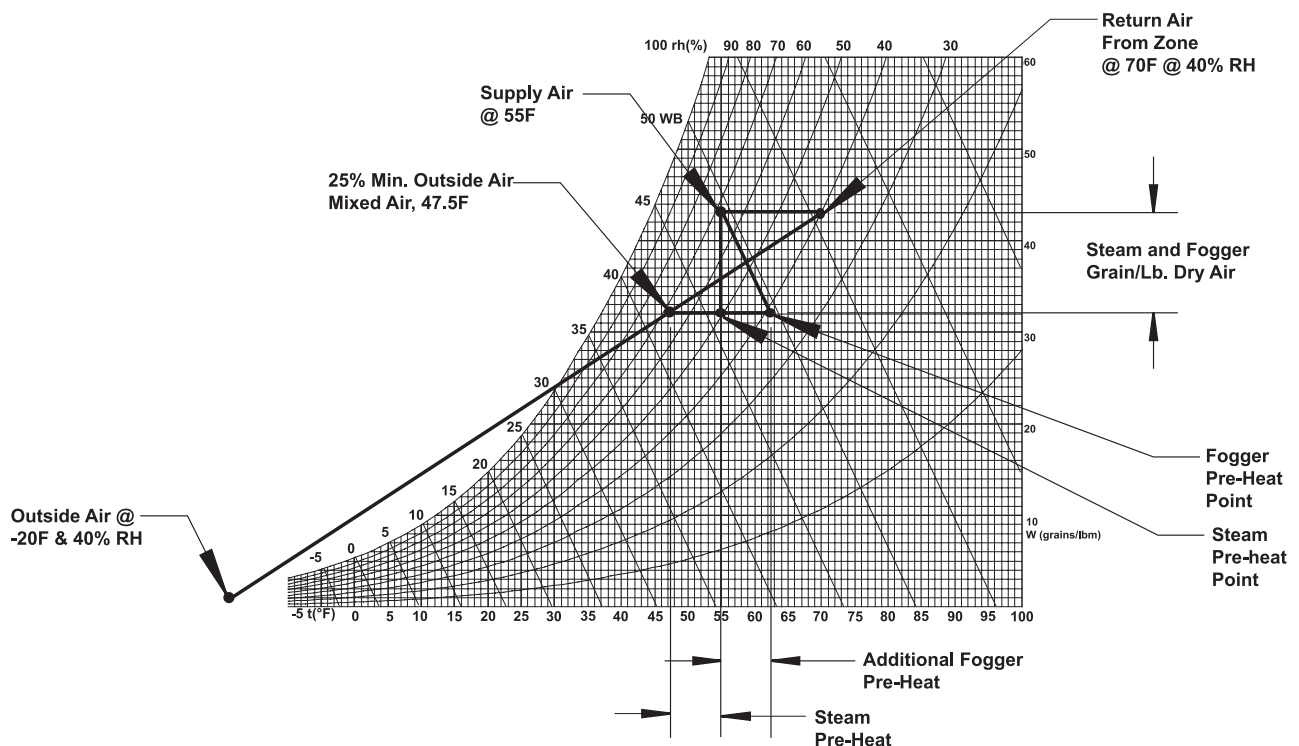
Due to the typical internal heat gain of commercial offices and manufacturing facilities, outside air and return air can be mixed to the required temperature for evaporative humidification without pre-heating. However, if minimum outside air requirements are high enough, pre-heating of the mixed air could be required on the coldest days.

Therefore the energy savings for each temperature bin may be calculated as follows:

$$\begin{aligned}
 &+ \text{Cost of Steam} \\
 &- \text{Additional Cost of Preheat (if any)} \\
 &- \text{Cost of Air Compressor with Armstrong-Cool Fog} \\
 &= \text{Latent Energy Savings}
 \end{aligned}$$

The psychrometric representation of the process looks like this: (see Figure 159-1.)

Figure 159-1. Latent Heat Recovery from Return Air



Note: Psychrometric chart representations do not include fan heat gains, duct losses, infiltration losses or cooling coil dehumidification.

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Potential Energy Savings Opportunities with Armstrong Cool-Fog Systems, continued...

2. Reduction in Humidification Load

Due to their dry bulb cooling effect, Armstrong-Cool Fog Systems require that outside and return air are mixed to the wet bulb temperature of the supply air. Whereas, steam humidification systems require that outside air and return air are mixed to the dry bulb temperature of the supply air.

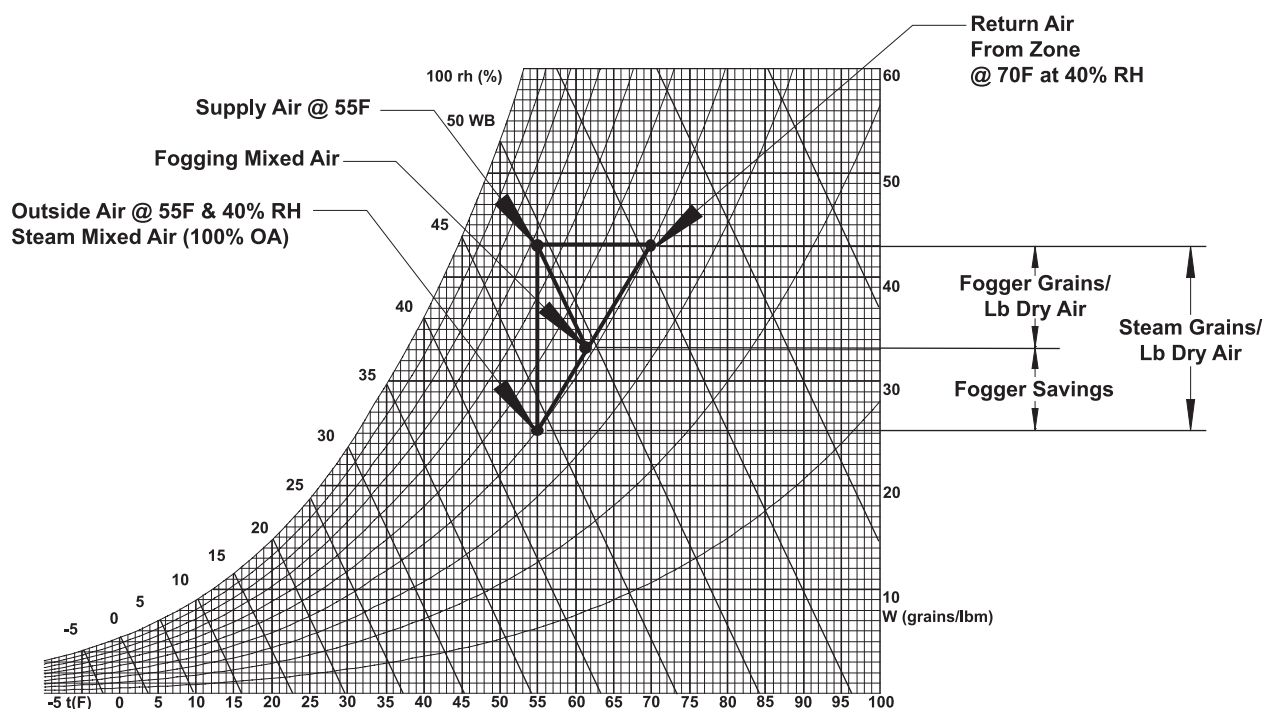
The result is that less outside air is used with evaporative humidification, and therefore, the humidification load is also reduced.

Therefore the energy savings for each temperature bin may be calculated as follows:

Cost of Differential Increase in Humidification Load with Steam = Economizer Energy Savings

The psychrometric process of the reduced humidification load is as follows: (see Figure 160-1.)

Figure 160-1. Reduction in Humidification Load



Note: Psychrometric chart representations do not include fan heat gains, duct losses, infiltration losses or cooling coil dehumidification.

3. Mixed Air Cooling Savings

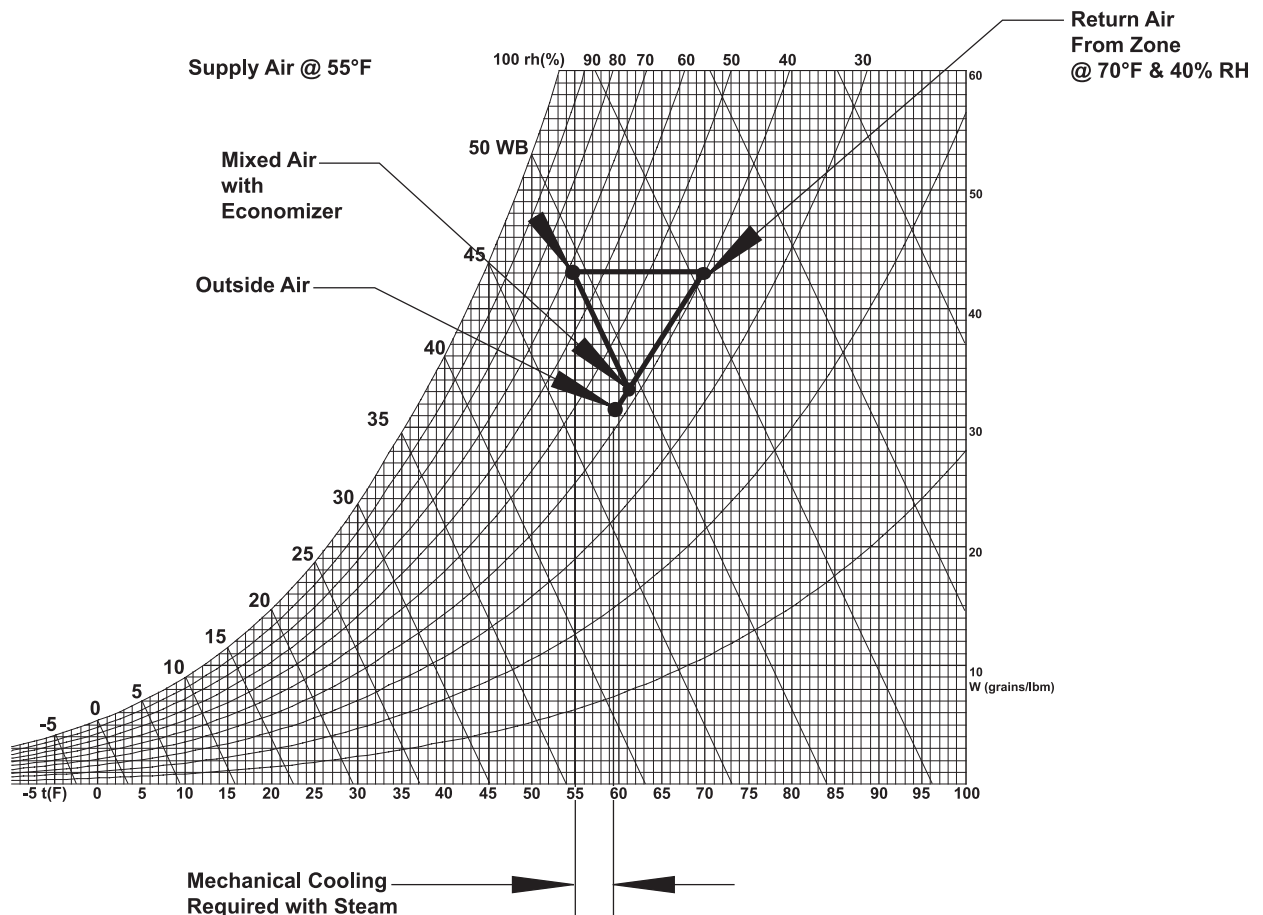
Anytime the outside air temperature is both above the dry bulb temperature and below the dew point of the supply air, cooling savings may be realized.

Therefore the energy savings **for each temperature bin** may be calculated as follows:

$$\begin{aligned}
 &+ \text{Cost of Differential Increase in Mechanical Cooling with Steam} \\
 &- \text{Cost of Air Compressor with Armstrong-Cool Fog} \\
 &= \text{Cooling Energy Savings}
 \end{aligned}$$

The psychrometric representation of mixed air cooling savings is as follows. (see Figure 161-1, 162-1 and 163-1)

Figure 161-1. Mixed Air Cooling Savings
Spring/Fall Economizer—Mixed Air



Note: Psychrometric chart representations do not include fan heat gains, duct losses, infiltration losses or cooling coil dehumidification.

3A. Mixed Air Cooling Savings

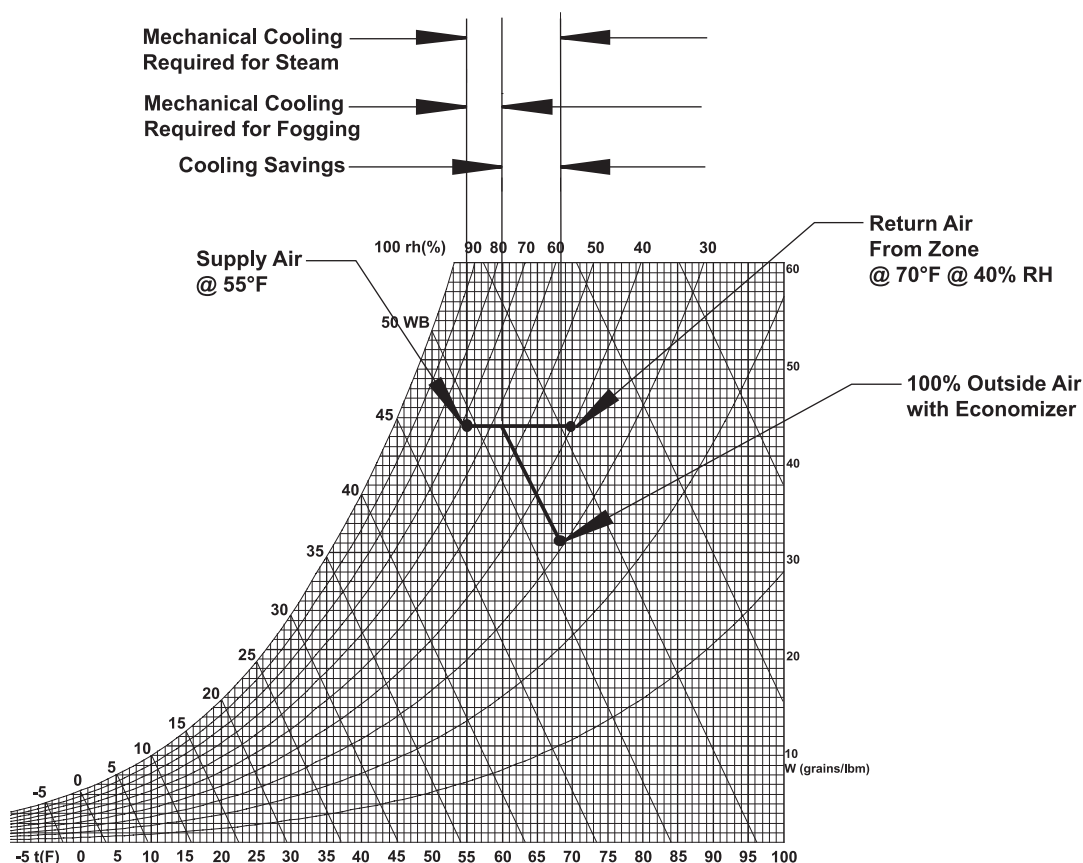
Anytime the outside air temperature is both above the dry bulb temperature, and below the dew point of the supply air, cooling savings may be realized.

Therefore the energy savings **for each temperature bin** may be calculated as follows:

$$\begin{aligned} &+ \text{Cost of Differential Increase in Mechanical Cooling with Steam} \\ &- \text{Cost of Air Compressor with Armstrong-Cool Fog} \\ &= \text{Cooling Energy Savings} \end{aligned}$$

The psychrometric representation of mixed air cooling savings is as follows. (see Figure 161-1, 162-1 and 163-1)

Figure 162-1. Mixed Air Cooling Savings
Spring/Fall Economizer—100% Outside Air



Note: Psychrometric chart representations do not include fan heat gains, duct losses, infiltration losses or cooling coil dehumidification.

3B. Mixed Air Cooling Savings

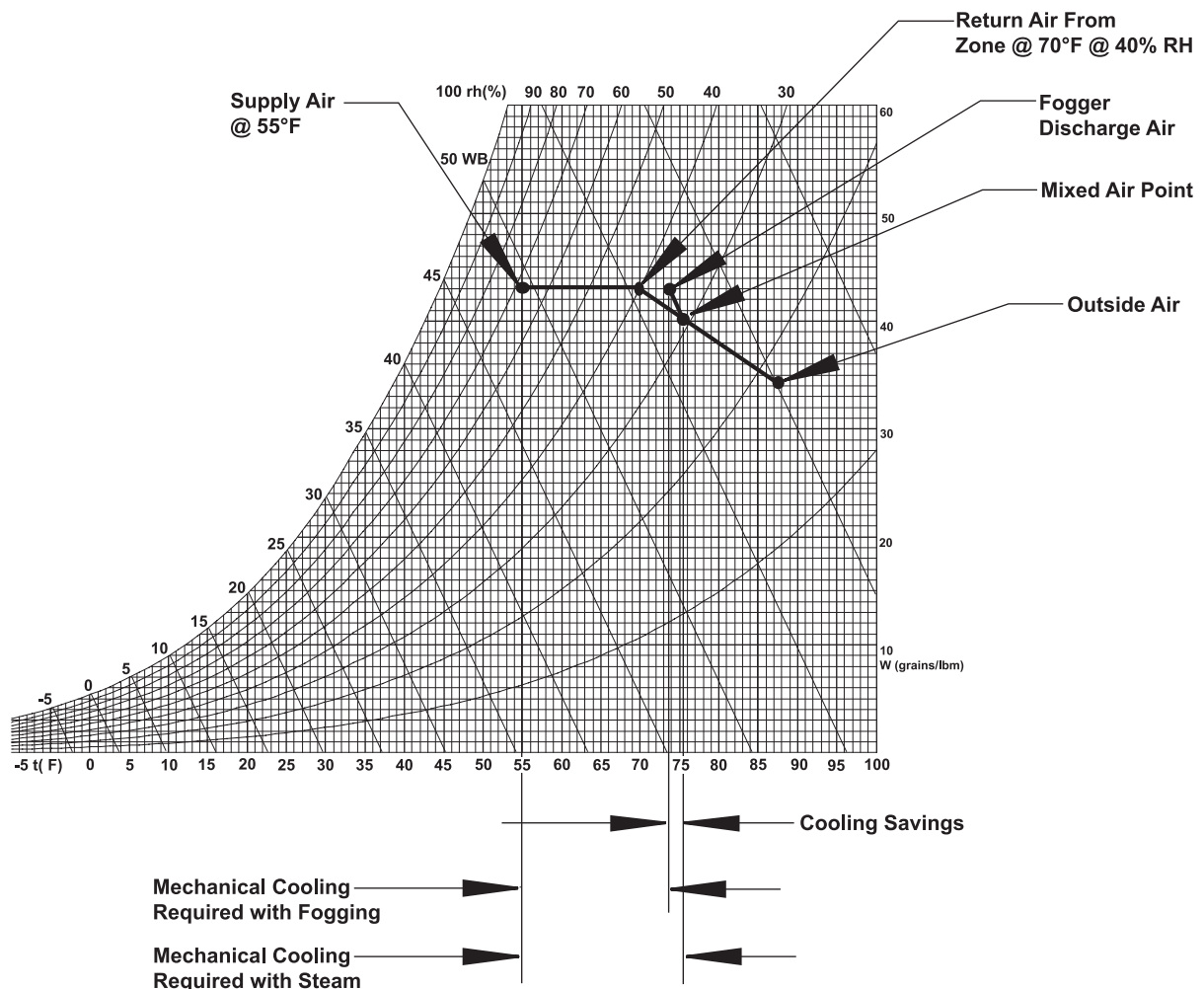
Anytime the outside air temperature is both above the dry bulb temperature, and below the dew point of the supply air, cooling savings may be realized.

Therefore the energy savings **for each temperature bin** may be calculated as follows:

$$\begin{aligned}
 &+ \text{Cost of Differential Increase in Mechanical Cooling with Steam} \\
 &- \text{Cost of Air Compressor with Armstrong-Cool Fog} \\
 &= \text{Cooling Energy Savings}
 \end{aligned}$$

The psychrometric representation of mixed air cooling savings is as follows. (see Figure 161-1, 162-1 and 163-1)

Figure 163-1. Mixed Air Cooling Savings
Summer Cooling
Minimum Outside Air



Note: Psychrometric chart representations do not include fan heat gains, duct losses, infiltration losses or cooling coil dehumidification.



Potential Energy Savings Opportunities with Armstrong-Cool Fog Systems, continued...

4. 100% Make-up Air Cooling Savings

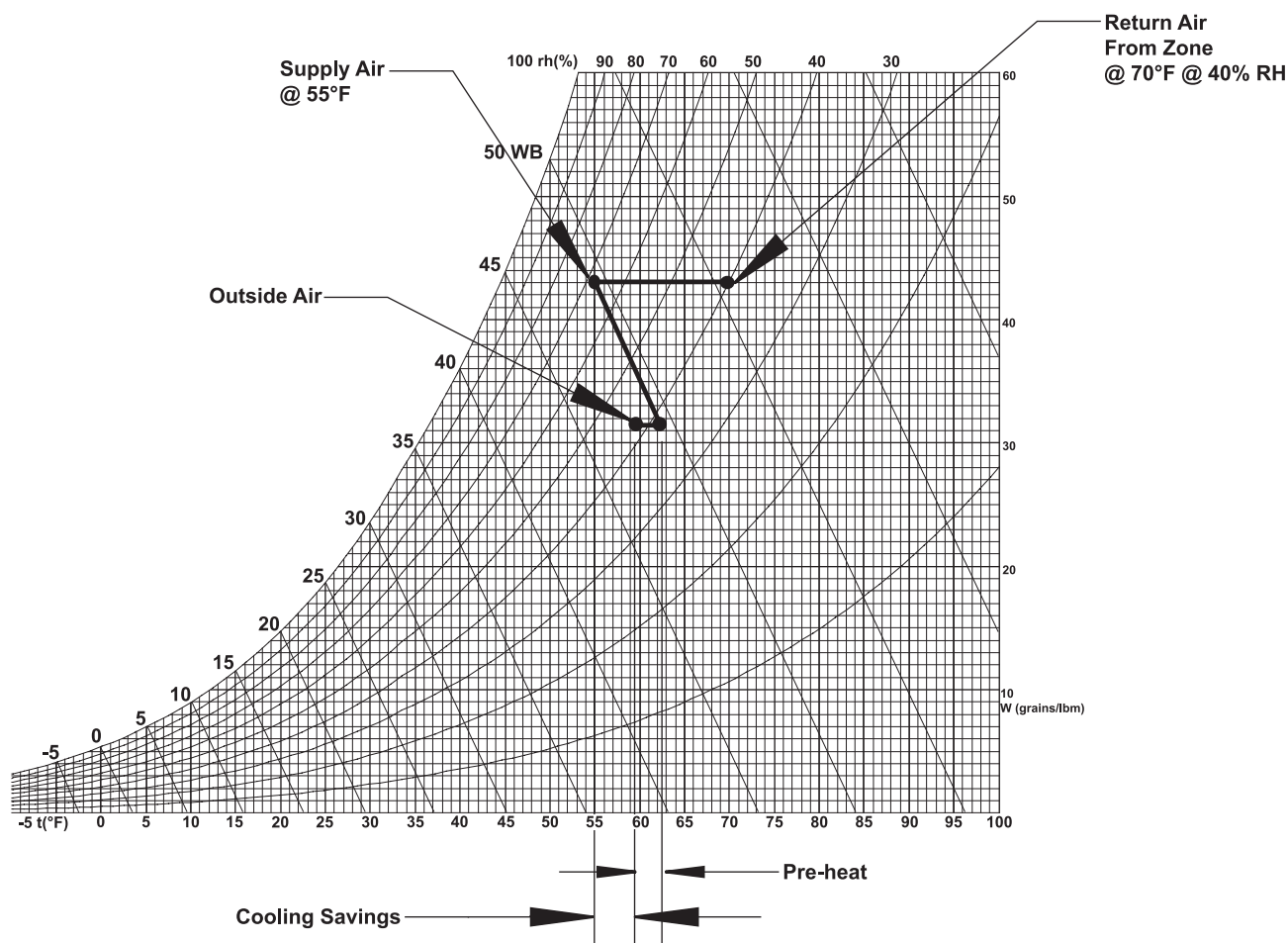
In hot and dry climates with light heating season and extensive cooling and humidification season, substantial energy savings can be realized with evaporative cooling systems, even when 100% outside air is required.

The potential energy savings for each temperature bin may be calculated as:

- + Cost of Differential Increase in Mechanical Cooling with Steam Humidification
- Cost of Preheat (if any)
- Cost of Air Compressor with Armstrong-Cool Fog
- = Cooling Energy Savings

The psychrometric representation of the 100% outside air cooling savings is as follows: (see Figure 164-1)

Figure 164-1. 100% Make-up Air Cooling Savings



Note: Psychrometric chart representations do not include fan heat gains, duct losses, infiltration losses or cooling coil dehumidification.

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5. Pre-Cooling of Inlet Air for Air Cooled Water Coils or Gas Fired Turbines

In hot and dry climates, evaporative pre-cooling of air cooled water coils for industrial process cooling or air conditioning can present the opportunity for substantial energy savings over mechanical refrigeration.

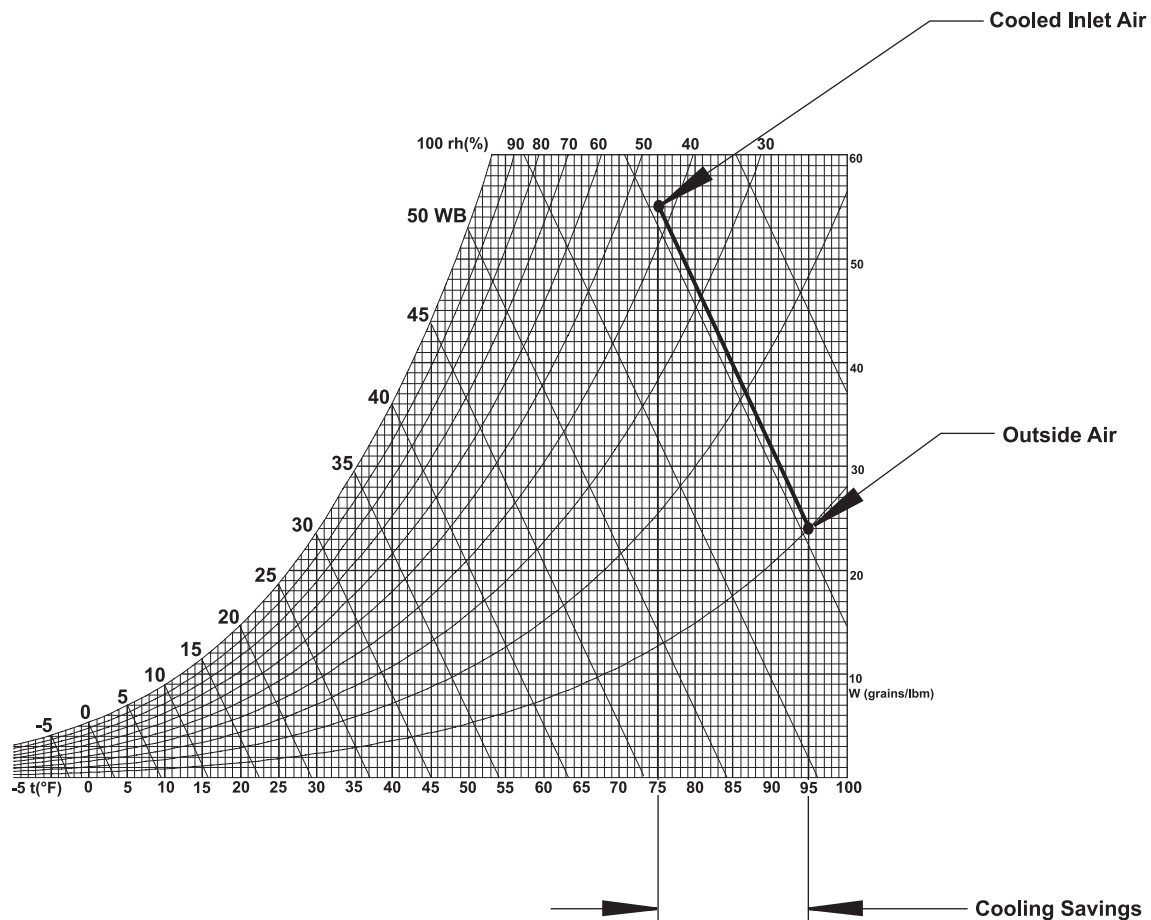
Because the system is only used when excessive outdoor temperatures persist, no preheat is ever required.

The energy saved **for each temperature bin** can be calculated as follows:

$$\begin{aligned} &+ \text{Cost of Equivalent Mechanical Cooling} \\ &- \text{Cost of Air Compressor with Armstrong-Cool Fog} \\ &= \text{Mechanical Cooling Savings} \end{aligned}$$

The psychrometric representation of the water coil pre-cooling savings is as follows: (see Figure 165-1.)

Figure 165-1. Pre-Cooling of Inlet Air for Air Cooled Water Coils or Gas Fired Turbines



Note: Psychrometric chart representations do not include fan heat gains, duct losses, infiltration losses or cooling coil dehumidification.