HEAT TEST TRIALS BETWEEN FIELD TURF AND EPIC BASE
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Abstract:

Extensive temperature measurement tests on identical test plots were conducted June 22-27 in a suburb of Phoenix AZ. The purpose was to measure temperature differentials between a conventional Field Turf Infill material and foundation versus a Field Turf Infill surface constructed over an EPIC foundation. Test results subsequently verified by an independent testing laboratory showed significant cooling of the infill material by **25.8° - 28.6° F** degrees, and an infrared cooling reduction of **20.0° - 24.8° F** degrees when conventional Field Turf fabric and Infill material is placed over and EPIC base. Additionally when a modification of the conventional infill material was made, temperature reduction by **50.7° F** degrees in the infill material and **42.1° F** degrees in the infra-red emissions were observed.

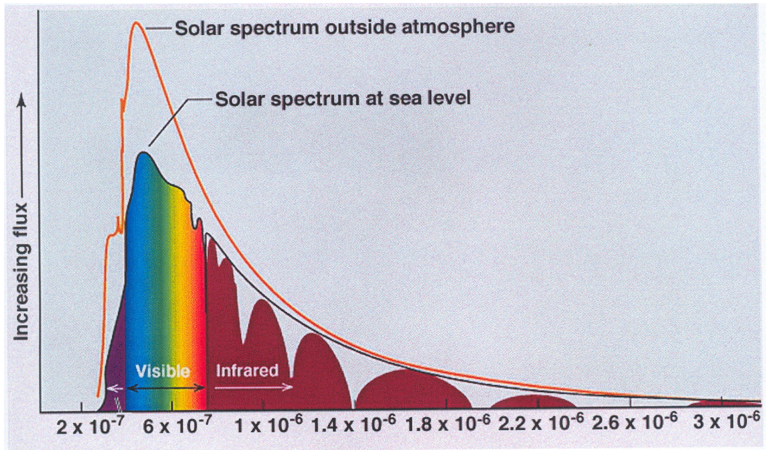
Background:

The largest negative feature of artificial turf surfaces is the high temperature rise of the infill material on sunny days. Various measurements and studies have demonstrated that temperature can quickly exceed 120° F when ambient air temperatures of the surroundings are as low as 80° F and even rise to above 150° F when ambient air temperatures approach 90° F on sunny days.

As such the durable artificial surfaces become a health hazard above 120° F and simply unusable for long periods of time during the summer, the prime recreation season.

Why do artificial fields get hot? We have all experienced the warming that occurs on sunny days. Wherever sunlight hits a solid surface, the solid starts to warm. In most cases the warming seems to be proportional to the ambient air temperature and the angle of the sun. A wood surface gets warm but not hot, a concrete sidewalk gets very warm but remains walkable, dark asphalt driveways get hot but not as high as an adjoining artificial field surface that is light green. Interesting?

Sunlight consists of a very broad spectrum of radiation. It is estimated that 44% of the spectrum is visible light, 52% infrared and 4% ultraviolet.



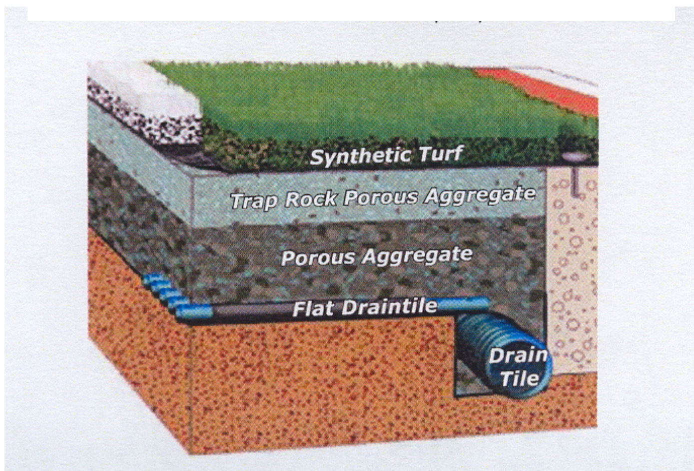
Relatively speaking both visible light and infrared are lower energy radiation waves. Objects struck by sunlight warm because the composition atoms of the object start to vibrate as some visible and most infrared energy is absorbed (Albedo index). Radiant heat absorption increases vibration of molecules and is measured as heat or temperature. White objects reflect back most of the visible wavelengths but still absorb infrared energy so the energy gain by the object may be less, but it still warms. Black objects absorb most of the visible spectrum in addition to the infrared radiation and will generally feel relatively hotter. A green color means that the green spectrum is reflected, but other energy wavelengths are absorbed. These variables then also transcend to other colors and even clear objects which pass through visible light. "Invisible" glass still warms when exposed to sunlight because of infrared radiation.

In studies of artificial fields it seems that the green or white polyethylene fibers still get hotter than the black infield rubber among the fibers. **Why the difference?** The answer is the 4% UV radiation and its repercussions. UV radiation is highly energetic, more so than infrared waves. The energy in UV radiation is strong enough to split certain molecules apart. The impact of UV radiation in the upper atmosphere splits the oxygen molecule (O_2) to create ozone (O_3). Organic molecules of the body can be split to create free radicals to cause skin burn or cancer. The effect of UV light on plastic polymers like polyethylene and polypropylene splits bonds and cause plastic degradation. Untreated plastics like milk jug bottles split and crack with sunlight exposure in less than a month.

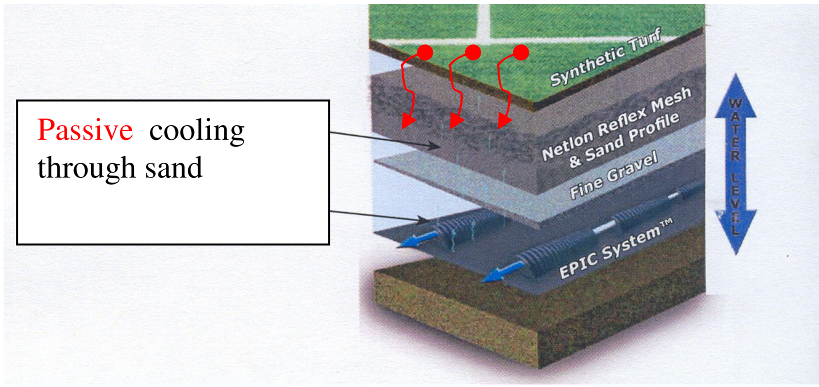
As such plastics that are intended to be exposed and used in the outdoor environment are frequently treated with other compounds that act as inhibitors to UV degradation. UV absorbers are added to unsaturated substances (plastics, rubbers) to decrease light sensitivity and consequent discoloring and degradation. Among a number of compounds used are benzophenones, benzotriazoles, and phenol-nickel complexes. These stronger bonded molecules have the ability to absorb the high energy of UV and convert it to heat energy in the molecules the compound is imbedded in. While UV energy may only consist of 4% of sunlight, the high energy radiation transitions to a lot of heat within the plastic molecule.

<u>Cooling Solution.</u> For the reasons above in artificial turf surfaces it is difficult if not impossible to curtail the formation of heat on sunny radiant days. **The solution is to get rid of the heat that is created**. Spraying the fibers with cold water provides temporary relief as water in contact with the 150° (+) F infill vaporizes, absorbs ambient heat, increases the surrounding humidity but in short order on sunny days dissipates to leave the process open for more heat production.

Polyethylene fibers get hot. Some heat is transferred and held in the surrounding infill. In conventional artificial fields the gravel base below the field provides air gaps between the base mass and the artificial turf cap. Heat transfer to the base is inefficient, and **as long as gravel bases are used, the plastic turf will remain hot.** Water films cannot be controlled or be continuous in gravel. Without a reliable water film heat conductance is inefficient.



The **EPIC system™** option is to use a reinforced **sand base** instead of gravel. By controlling moisture levels, the EPIC system™ is able to provide and control damp sand to be in contact with the polyethylene turf mat. Since water (damp water film) is conductive for heat transfer, the heat which has accumulated in the plastic fibers now has a pathway to move and be absorbed into the cool damp sand base below. If heat conductance is available as it is with water films, heat will always transfer from a hot area to a cool area. The EPIC system™ profile may hold and store as much as 2 gallons of water below each square foot of surface area. The maximum heat output potential from sunlight on a square foot area is 60 watts or **200 Btu's** in an 8 hour day. The mass volume of water in the EPIC™ profile is 16 pounds/SF. In the early morning hours the water has cooled to 65°F and is able to absorb **400 Btu's** of heat before the water in the sand base reaches 90° F. By establishing a passive but effective heat absorption pathway, in test models the artificial field infill material cooled by 28 - 30° F below identical models with a conventional dry gravel base.



Introduction:

The prominent and expanded use of artificial turf for sports fields and recreation areas in the past ten years has been compromised by the temperature differential on sunny days between artificial polyethylene and polypropylene surfaces as compared to natural grass. Although the artificial surfaces can take more punishing abuse and use less water, the temperature rise on sunny days make the fields virtually useless in warmer sunny climates. Public health agencies consider temperature levels above 120° F as dangerous. Yet it is not uncommon for these fields to exceed surface temperatures in excess of 150° F even over 200° F at peak temperature times.

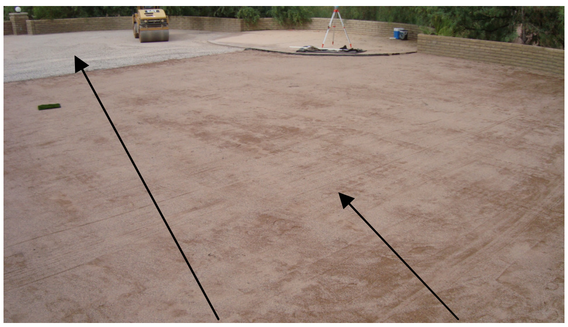
Over the last nine years a successful sub-surface irrigation and drainage system for natural grass demonstrated certain design characteristics and features that could also be capitalized for the artificial field industry to improve the characteristics and usage of these fields. To thoroughly prove or disprove the initial anecdotal evidence it was decided to co-operatively test the science in detail by constructing dual fields and make recordable observation of variables. RESI (Rehbein Environmental Solutions, Inc.) and Field Turf/ Tarkett cooperatively set up and cost shared expenses to build the test site.

Test site:

A 5800 sq. ft. area at the Pera Club's Salt River Project Demonstration facility in Tempe Arizona was divided into two equal 2900 sq. ft. halves in order to test temperature differences on a Field Turf Artificial Sports Turf profile between a conventional gravel base profile and an EPIC sand base profile.

Pic.1 Site preparation and division

Pic. 2. EPIC base in foreground



Pic. 3. Compacted gravel (FT) and EPIC sand bases

Pic. 4. Identical cap and infill over both bases.

Sun exposure, dimensions, wind influence, elevation, surface treatment, etc. was identical on both halves of the test field.

Testing procedure:

Comparative testing parameter goals were to test and record temperature variations at the following points:

- Actual temperature 1” below the surface in the infill material
- Infrared Temperature readings taken from 1’ above the surface.
- Air temperature 1’ above the surface
- Air temperature 3’ above the surface
- Air temperature 5’ above the surface
- Core temperature 6” below the surface

To achieve accurate and unbiased comparative readings the following procedural points and tools were developed for implementation.

- Identical equipment for simultaneous testing was developed using 8 AcuRite metal probe digital Thermometers (4 per test area) and identical Thermometer holding stands.
- Infrared readings were made by the same infrared digital temperature scanner on both field sections.
- Readings were made simultaneously in the center point of each comparative test plot.

- Air temperature probes were positioned in the shade and not influenced by sunlight impact on the metal thermometer probe.
- Infill probe measured infill in contact with sunlight, but the probe it self was protected from sunlight exposure.
- Ambient weather conditions were measured by an automatic weather station positioned between both test sites.
- Temperature recordings were made and certified by an unbiased testing lab.

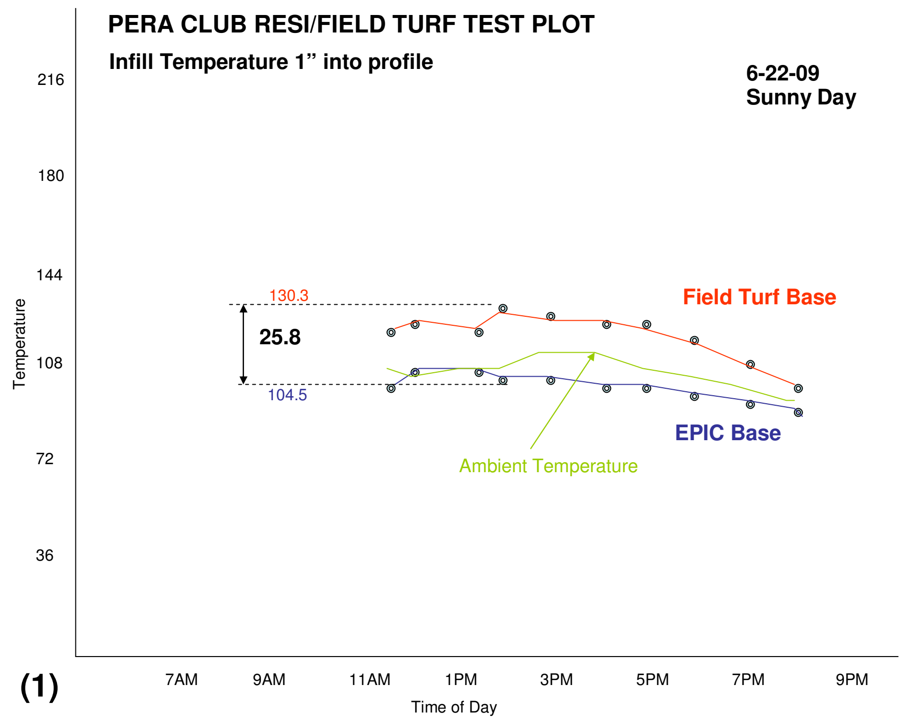
Test measurement areas were duplicated in terms of position and placement of thermometers and infrared reading points.

Pic. 5 Thermometer holding stand and markers

Fig. 6. Synchronizing digital thermometers.

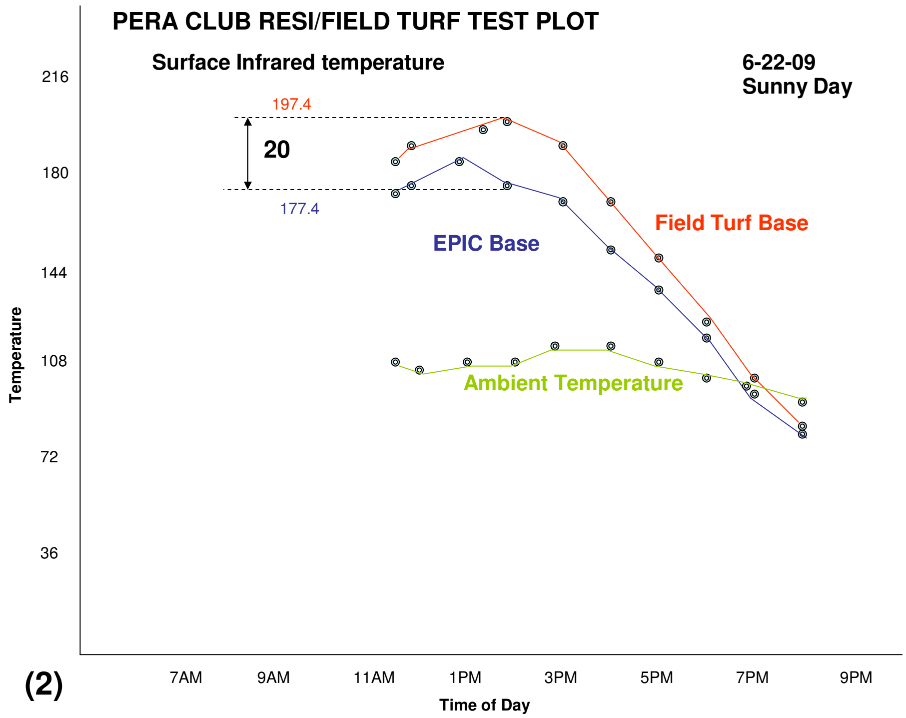
Results and Conclusions:

The following eleven (11) graphs summarize the obtained data on the test site.



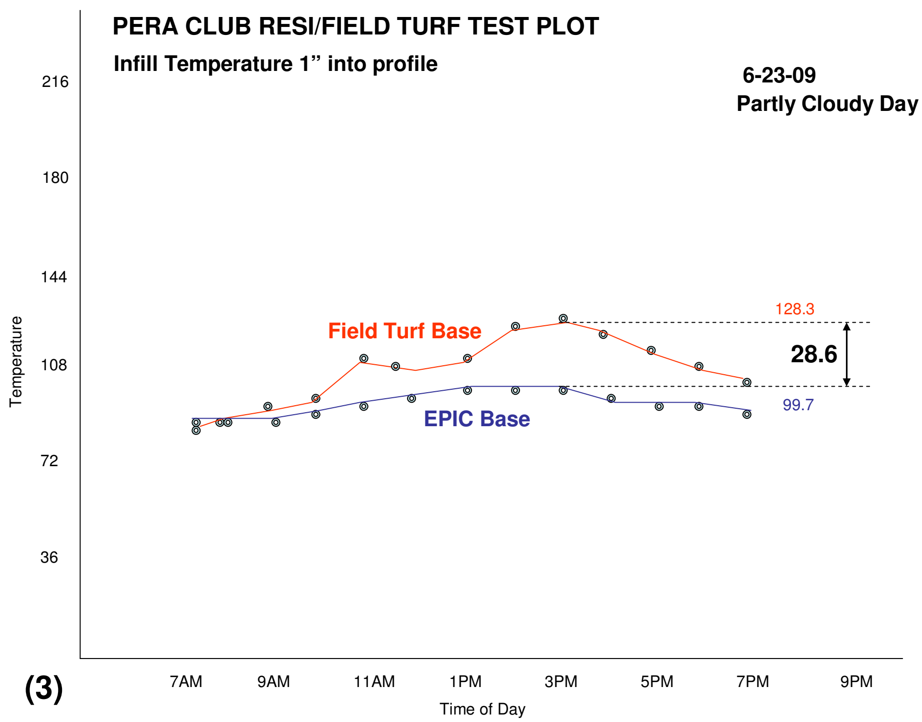
(1)

Graph No. 1. Illustrates that on the initial testing, Infill temperatures (heat retained) on a large scale were similar to those obtained in initial small scale tests in Reno, NV and consistently lower than the ambient temperature in the EPIC base.



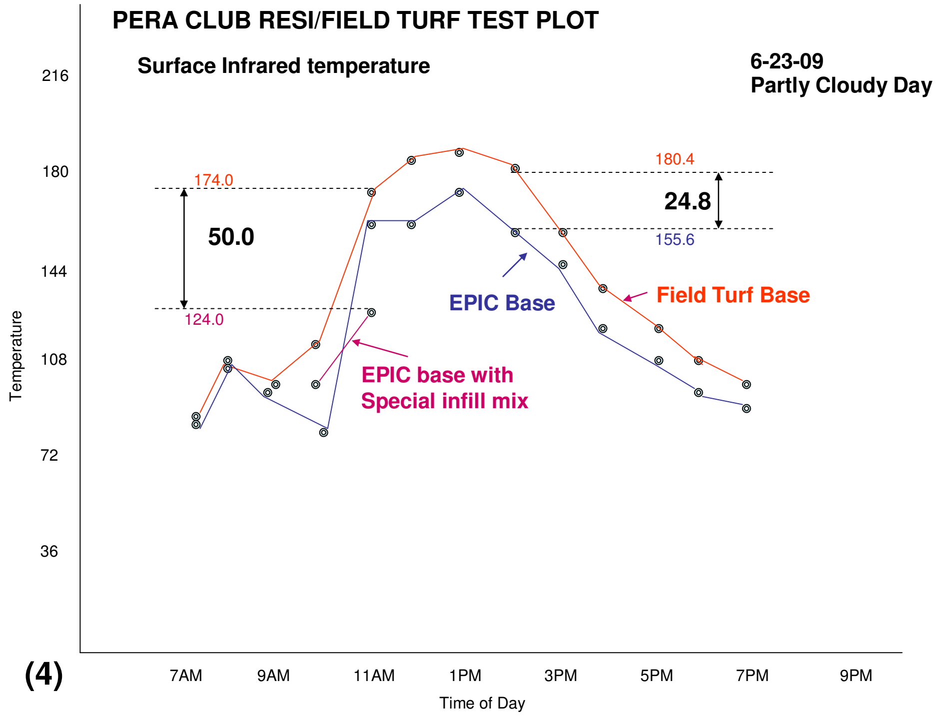
(2)

Graph No. 2 Illustrates that Infrared temperatures (heat production) is significantly higher than the ambient temperature, but in the EPIC base field still 20 degrees lower than in the gravel based Field Turf base.

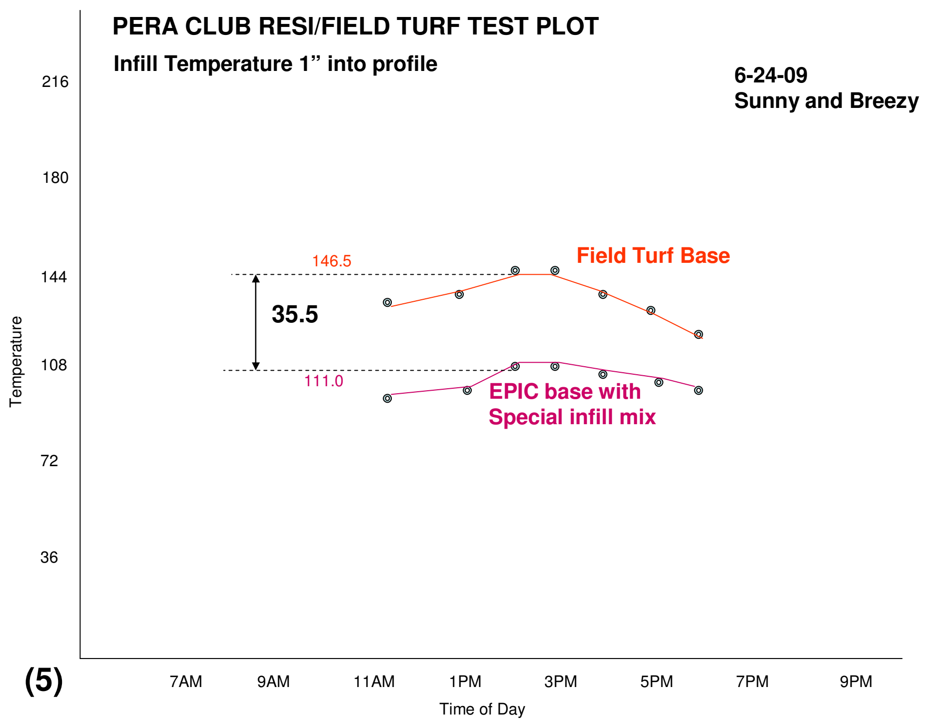


(3)

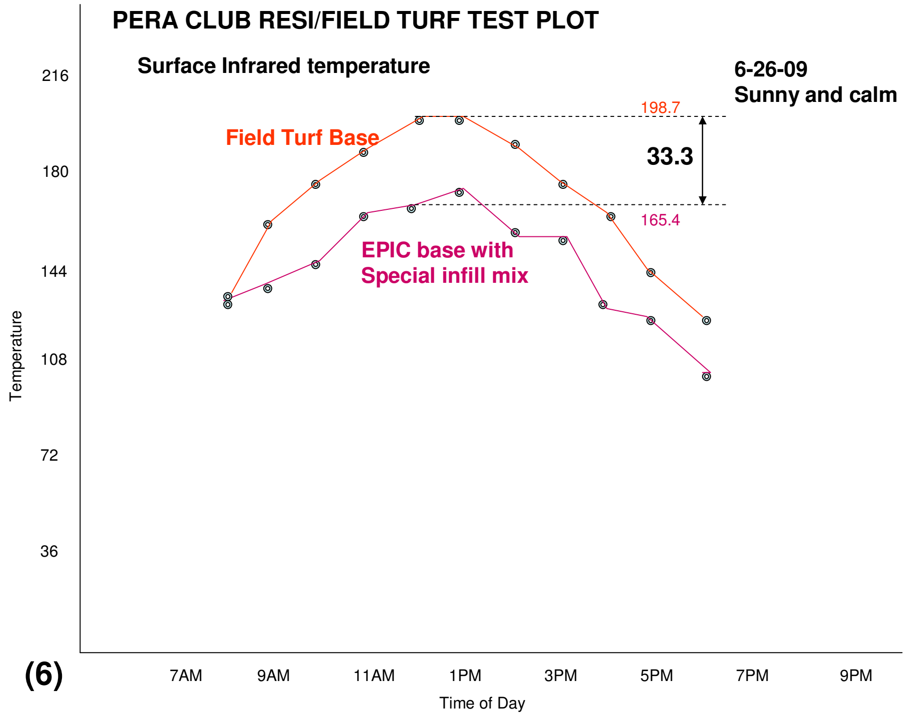
Graph No. 3 Illustrates that heat is still produced and retained even on partly cloudy days, and retained heat is more evenly distributed in an EPIC base and probably more erratic due to irregular radiation bursts in the Field Turf structure.



Graph No. 4. A small area restructuring of the infill mix alluded that infrared temperature production can be further reduced on an EPIC base vs. the standard fill.

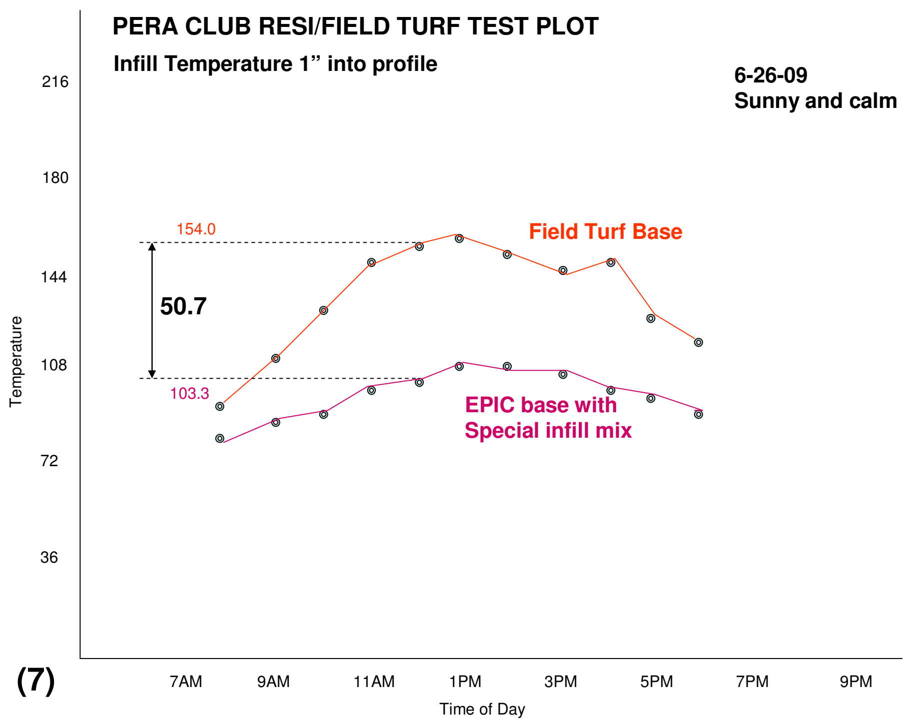


Graph No. 5. Illustrates that sunny but windy conditions can have an infill temperature reduction but differences between a Field Turf base and an EPIC base are still significant.



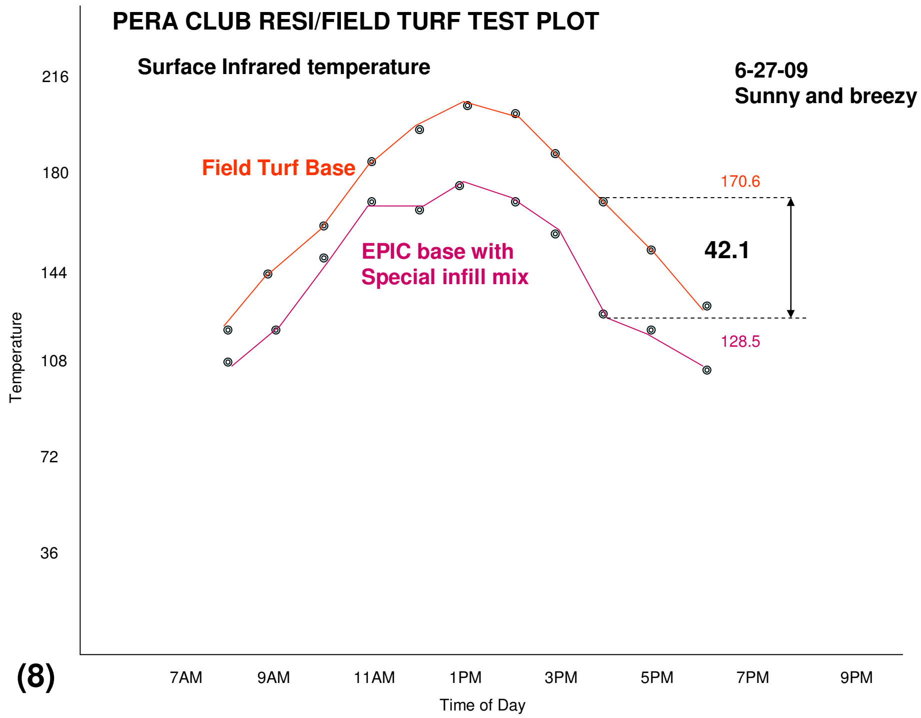
(6)

Graph No. 6. Illustrates that Infrared red (heat production) temperatures can be reduced by as much as 33 degrees on an EPIC base with a modified infill mix.



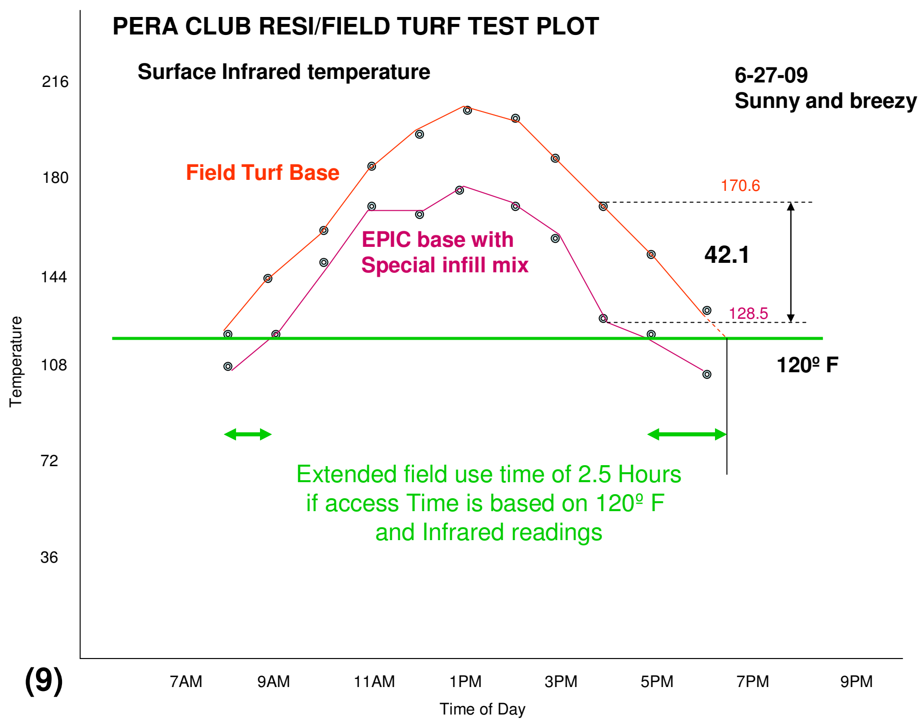
(7)

Graph No.7. Illustrates that Infill temperatures (heat retained) can be reduced as high as 50 degrees in an EPIC base with a modified infill mix.



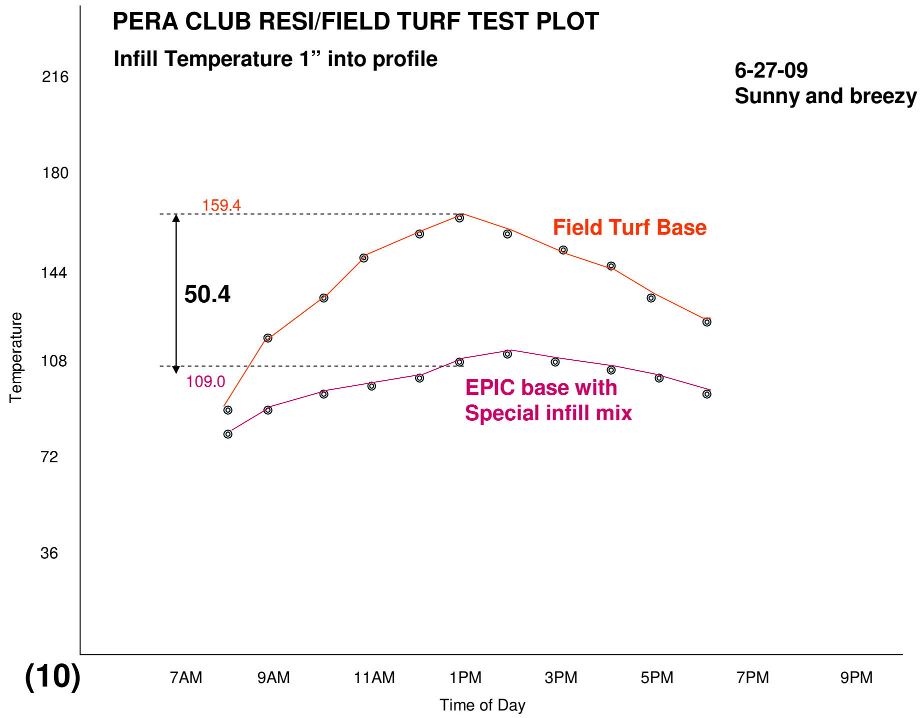
(8)

Graph No. 8. Illustrates that Infrared temperatures (heat produced) are lower on a windy day than a calm day (Graph No.6) but still significantly lower on an EPIC base.



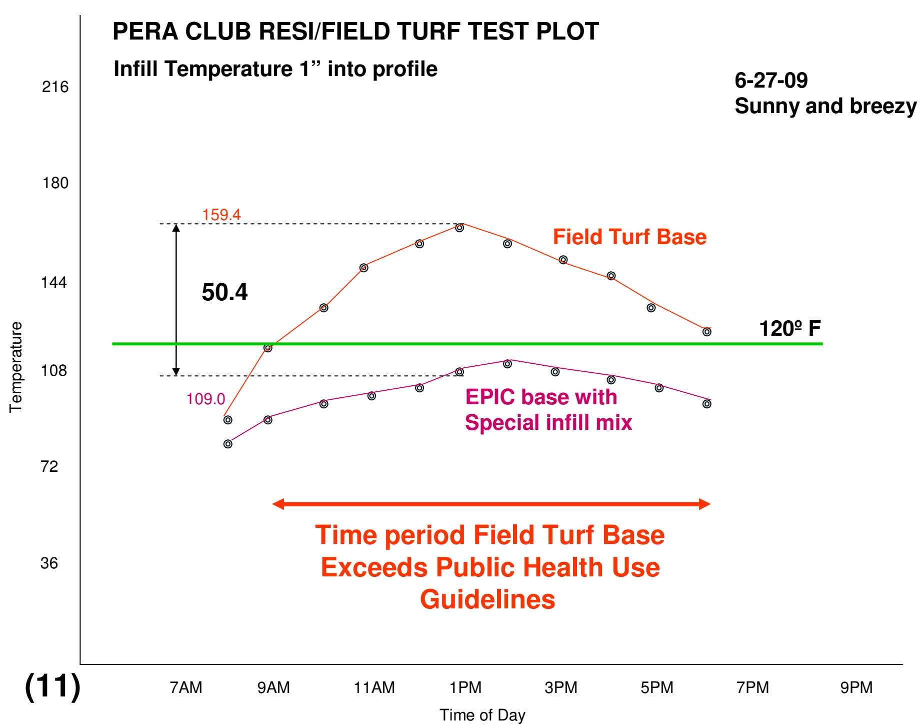
(9)

Graph No. 9. Illustrates that when superimposed on a 120° F public health issue line, 2.5 hours of field usage time is available on an EPIC base.



(10)

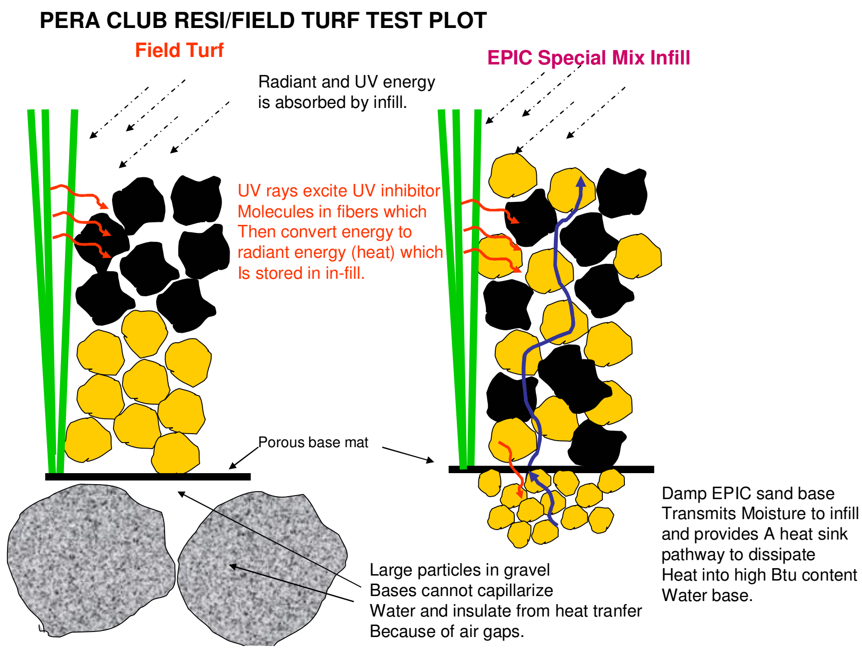
Graph No. 10. Illustrates that a higher differential of cooling occurs in the infill temperature between a Field Turf base and an EPIC base with a modified infill.



(11)

Graph No. 11. Illustrates that when infill temperature is measured, the Artificial Field surface on an EPIC base is acceptable for use by public health guidelines, and the conventional gravel base makes the field unusable under the same guidelines.

Heat production and absorption by the infill can be explained as shown in the following diagram.



The described infill differences between the conventional Field Turf practice as compared to the modified EPIC infill mix is illustrated below.