

## **CALBO Cool Roofs Cool Roof Technical Presentation**

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### **Cool Roof Technical Presentation**

Cool Roofs provide an answer for building owners seeking an energy efficient roofing system. Cool Roof technology lowers electricity costs over the life of the building by reflecting the sun's energy away from the roof surface, reducing summertime air conditioning expense.

A Cool Roof product must have a surface reflectivity of 70% or more and an emissivity of at least 75% to qualify for Title 24 energy credits (emissivity is the ability of a material to emit heat energy). This means that at least 70% of the solar energy on a Cool Roof must be reflected, and that a minimum of 75% of the solar energy must be radiated away from the roof surface before it is absorbed.

Cool Roof technology is well suited for low-slope commercial roofs, those with a rise of less than 2-inches per one foot of roof slope. Cool Roof products for low-slope roofs fall into two categories – single-ply materials and coatings. Both can be used over the three most common types of roof systems for low-slope applications – single-ply membranes, built-up roof systems, and modified bitumen roof systems.

In order to understand Cool Roof technology, it's helpful to first become familiar with these three types of roof systems over which Cool Roof products can be applied.

### **Single-ply Roof Membranes**

Single-ply roof membranes are flexible sheets, 30 to 60 mil thick, which come in large rolls. They are installed by simply rolling the product out onto the roof. The membrane is glued or mechanically fastened to the roof deck using metal fasteners, plates and screws. Seams are then sealed using a solvent, or they are heat welded. Sometimes, they are ballasted with rock.

Some of the most common types of single-ply membranes include EPDM (ethylene, propylene, diene monomer), PVC (polyvinyl chloride polymers) and TPO (thermoplastic polyolefin). Single-ply membranes are sold in a variety of colors, ranging from tan and light grey to black. Typically, the solar reflectivity of a 'non-cool' single-ply membrane ranges from 5% to 25%. There are, however, some single-ply roof membranes available that have a surface reflectivity of 70% or more, which meets Title 24 standards, and so are considered 'Cool' without an added Cool coating or membrane.

### **Built-up Roof (BUR)**

A built-up roof system utilizes hot asphalt or solvent-based asphalt on the roof deck. It is the most common type of roofing system used in the US; it is also typically the lowest cost roofing option.

A BUR is installed by laying down redundant layers of hot asphalt and reinforcing materials, felt or polyester fabric between the asphalt. BUR systems are typically light grey, tan or terra cotta colored, and many have roofing granules broadcast across the top. Their solar reflectivity ranges between 15% and 20%, which does not meet 'Cool' standards.

In California, it's common to find BUR systems surfaced with a white cap sheet that provides Cool Roof properties. Or, a Cool Roof coating can be applied over the BUR using rollers, brushes or sprays.

### **Modified Bitumen Roof Membrane**

This roll roofing membrane is installed in layers, similar to that of a built-up roof system. Reinforcing sheets are layered between hot mopped asphalt or fastened with adhesive to the roof deck.

There are two common types of polymers added during manufacture of the bitumen membrane – APP (atactic polypropylene, a modified plastic product) or SBS (styrene butadiene styrene, which is more similar to rubber). These polymers 'modify' the properties of the bitumen, giving it plastic and rubber-like properties to make it more durable.

Modified bitumen roof membranes are typically black or grey. Today, modified bitumen roofs can meet Energy Star and Title 24 requirements for a Cool Roof only when topped with a Cool Roof material.

### **Other Roof Systems**

There are a number of other modified products used in low slope commercial roof applications, some of which meet Title 24 requirements for Cool Roof reflectivity and emissivity properties. For example, closed cell spray polyurethane foam can be surfaced with a coating, either acrylic or urethane, to comply with Title 24.

There are also a few Cool metal roofing products on the market. Metallic surface products might initially appear to be good Cool Roof products because of their high reflectivity, but their emissivity ratings (the ability of a material to emit heat energy) do not meet Title 24 requirements without some type of Cool Roof coating.

### **Effect of Roof Membrane Color on Temperature**

The color of the roofing membrane used has a decided impact on the air temperature at the roof's surface. During a recent test in Sacramento, researchers found the following roof surface temperatures on a 90 degree day with a light breeze:

<b>Color and Type of Roof Membrane</b>	<b>Surface Temperature</b>
Black EPDM roof	173 degrees
Built-up roof with dark aggregate	159 degrees
Built-up roof with a white cap sheet	158 degrees

which had a surface reflectivity of 25%	
Single-ply Cool Roof	121 degrees
Built-up roof with a Cool Roof coating	108 degrees

### **Effect of Cool Roofing Products on a Building's Insulation Effectiveness**

Adding insulation to a roof reduces cooling costs from a systems approach for several reasons. First, high roof temperatures significantly diminish the roof insulation's R-value, by as much as 40 to 50%. Gaps in the insulation board also reduce the effectiveness of the insulation. In addition, high temperatures create thermal shorts, which also adds heat flow into the building

Cool Roofing products reduce the thermal dynamic properties of a roof by reflecting solar energy away from the roof surface and by emitting infrared heat. Cool Roof products therefore reduce cooling stress on the building and improve the roof's thermal performance.

### **Cool Single-ply Membranes**

There are hundreds of low slope Cool Roof products available. Cool single-ply membranes have been available on the market for 25 to 30 years. The sheets are typically bright white, most often used in new construction, and user friendly. It is relatively easy to install a single-ply roofing membrane any time of the year under nearly any moisture condition, and they are quite durable.

There are two common types of single-ply Cool Roof membrane products – thermo-set products, where the seams put together with a solvent or tape, and thermoplastic products, whose seams can be heat welded.

EPDMs and CSPEs fall into the first category, as **thermo-set** products:

- EPDM (ethylene, propylene, diene monomer) is a synthetic rubber, a thermo-set product whose seams must be glued or taped. An EPDM roof is typically black, so roofers must use a field-applied coating over the top to make it Cool. EPDM roofs are very durable in terms of UV ray exposure, and so are used all over the US.
- The seams of a CSPE (chlorosulfonated polyethylene, also known as Hypalon) roof must be heat welded. However, once the product has cured, repairs can be made with solvents or tapes. A CSPE roof is typically white, and is shown to have good durability and weather resistance, but is not commonly used.

The seams for **thermoplastic** products, on the other hand, can be heat welded. Examples of a thermoplastic single-ply roofing product include PVCs and TPOs.

- PVC (polyvinyl chloride polymers) used to be the most common single-ply roofing product. Once the seams of a PVC roof are heat welded, they are actually stronger than the membrane itself. PVC roofing membranes have good flame resistance. They're made with plasticizers, which add flexibility. However, these plasticizers can leach out and make the roof sticky, which means the membrane

collects dirt, which reduces its reflectivity. PVC can also become brittle and discolored.

Note that some California jurisdictions (including San Francisco, Oakland and Berkeley) do not allow PVC use because of the byproducts (dioxins produced by chlorine) created during the product's manufacture.

- TPO (thermoplastic polyolefin) also has strong seams, with the durability and toughness of an EPDM, but with the heat welding capabilities of a PVC product. TPOs are perhaps the fastest growing segment of the single-ply market today.

There is another thermoplastic product new to America but used in Australia and New Zealand for the past 25 to 30 years. It is used to recoat and resurface tile. The coating provides high UV resistance; it also has an infrared pigment with a reflectivity of 45% to 50%, for impressive energy efficiency.

### **Cool Coatings**

Cool Roof coatings are easy to apply, with a consistency like thick paint, so it can be sprayed on using a power sprayer or rolled on like paint. Cool Roof coatings are designed to reduce temperature, reflect UV rays and add waterproofing integrity to the roof. They are very durable, and designed specifically for low slope roofing applications, where they are able to withstand standing water and very hot temperatures. Fluid applied membranes can be put directly on concrete, which waterproofs the structure. Overall, they provide a good bond and good flexibility.

Cool Roof coatings come in two forms: **Elastomeric**, which stretch, retaining their physical properties, and **Non-elastomeric**, which are cementitious coatings that do not stretch (they contain cement particles mixed with water and an adhesive binder). The latter was originally designed to protect asphalt roofs from UV radiation. However, they are not waterproofing products, and can become brittle and crack.

Three types of polymers are commonly used in Cool Roof coatings today – urethanes, acrylics and silicones. Each adheres well over different substrates, including asphalt, EPDM, modified bitumen, spray closed cell polyurethane foam and other rubber roofing products.

Granules may be added to a Cool Roof system to improve traction, making the roof more safe and durable around mechanical areas where people work. To conform to Title 24 requirements, the granules themselves must have a reflectivity greater than 70% and emissivity greater than 75%.