ENERGY STAR® Label for Roof Products

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ABSTRACT

Home and buildings owners can save up to 40% of cooling energy costs by installing reflective roofs, especially in hot and sunny climates. The increase in exterior albedo and subsequent decrease in heat flow across the building envelope reduces the energy requirements to maintain air-conditioned space. Indirectly, the increase in overall albedo of a community as these roofs are installed on a large fraction of the buildings results in lower ambient air temperature and less need for air conditioning. Another indirect effect is a decrease in smog formation due to lower ambient air temperatures and less air pollution from power plants because of minimized electrical demand and use.

The U.S. Environmental Protection Agency and the U.S. Department of Energy are currently developing the ENERGY STAR Roof Products Program to create a vibrant market for energy-efficient, cost-effective roof materials through the widespread availability of products, clear recognition of the benefits by consumers, and active promotion of products by manufacturers. Several activities, including pilot procurements of roof materials, and the development of outreach and training materials, will be performed to assist the transformation of the roofing market toward more energy-efficient products.

Using the experiences gained in establishing the ENERGY STAR Roof Products Program as an example, this paper will discuss the barriers to the development of energy-efficient roofing practices, program implementation, and program successes. This paper will further describe the specifics of the ENERGY STAR Roof Products Program, its goals, benefits, activities, and timeframe.

Introduction to ENERGY STAR®

The U.S. Environmental Protection Agency and the U.S. Department of Energy are working together on a series of ENERGY STAR Labeling Programs. These programs help consumers easily identify energy-efficient products in the marketplace. Manufacturers join the ENERGY STAR Programs by signing a Memorandum of Understanding (MOU), after which they may place the ENERGY STAR label on products that they have determined to meet a mutually agreed upon, performance-based, energy-efficiency specification.

The overall goal of these programs is to stimulate the purchase of energy-saving products by making consumer purchasing decisions easier. By buying and using products with the ENERGY STAR label, consumers can reduce their energy use and save money on utility bills. In addition, these products prevent air pollution by requiring less electricity, which reduces the amount of fossil fuels needed to produce electricity, which in turn, reduces emissions that contribute to smog, acid rain, and global climate change.

ENERGY STAR Programs have already been established for office equipment, TVs and VCRs, residential light fixtures, insulation, exit signs, residential heating and cooling equipment, household appliances, windows, and new homes. The ENERGY STAR Roof Products Program will follow the same pattern as these other programs but will highlight the energy efficient characteristics of roof products, in

particular their albedo.

Albedo[1] is the ability to reflect energy absorbed from the sun, also referred to as reflectivity. For a given solar flux, a surface with low reflectance (10%) has a higher surface temperature and is therefore hotter than a surface with high solar reflectance (90%). The goal of the ENERGY STAR Roof Products Program is to help create a vibrant market for cost-effective, energy efficient, high albedo roof products through the widespread availability of products, clear recognition of the benefits by all consumers, and active promotion of products by manufacturers.

Benefits of ENERGY STAR Roofs

Reduced Air-Conditioning Bills. Reflective roofs have direct and indirect effects on building cooling loads. The direct effect is the energy savings of an individual building achieved by directly reflecting incoming solar radiation and thereby decreasing the heat transfer through the building envelope. Akbari, et al. (1997) and Parker, et al. (1995), measured direct cooling energy savings in the range of 10 to 50% (ranging from $10 to $100 per year per 100 m^2) in several residential and small commercial buildings after albedo was increased in the range of 34% to 61%. In another study, computer simulations were used for 11 U.S. metropolitan areas to estimate an average annual savings of about 175 kWh/1000ft^2 for residential buildings with an albedo increase of 0.30, and 273 kWh/1000ft^2 for commercial buildings with an albedo increase of 0.45 (Konopacki, et al. 1997).

The savings, of course, depend on building characteristics and climate conditions. Building characteristics that result in the largest savings include attic duct location and absence of ceiling insulation. In general, buildings and homes in the U.S. sunbelt will benefit the most from installation of a reflective roof. Those homes located in the northern regions may experience an increase in heating costs when a reflective roof is applied since less sunlight is absorbed by the roof during the heating season. However, in many locations, and for many buildings, the savings in cooling electricity dollars far exceed the penalty in heating gas dollars because solar gain is decreased by lower sun angles, shorter day lengths, cloudy weather, and snow on the roof (Bretz, et al. 1996).

The potential for total energy savings is high because the market is large. The U.S. market for roof materials includes about 60 billion ft^2 of residential and 40 billion ft^2 of commercial roofs (Konopacki, et al . 1997). It was estimated that installation of reflective roofs on all residential and commercial buildings would decrease annual direct electricity use by about 10 billion kilowatt-hours (BkWh) or 3% of the national cooling electricity use in residential and commercial buildings. This corresponds to an $800M decrease in national net energy bills. Peak electrical demand savings are predicted to be about 7 million kilowatts (MkW), or 2.5% (Konopacki, et al. 1997).

The primary indirect effect of reflective roofs is a lower ambient air temperature and consequent reduction in cooling demand resulting from increasing the overall albedo of a community. The ambient air temperature of a community decreases with the installation of reflective surfaces because these surfaces do not transfer as much heat to the air as conventional non-reflective surfaces. The consequent electricity savings from the indirect effect is not included in the savings estimates above, but is predicted to be about half as much as the direct effect (Rosenfeld, et al. 1997).

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[1] Albedo is defined as the total hemispherical reflectance of radiation from 0.3 to 2.5 micrometers, which encompasses most of the solar radiation hitting the earth's surface.

Lower Ambient Air Temperature and Less Smog. Reflective roofs also help prevent air pollution by decreasing the amount of electricity needed to maintain interior building comfort levels. Less electricity use reduces the amount of fossil fuels needed to produce electricity, thereby decreasing the amount of air pollutants that contribute to smog, acid rain, and respiratory disease. Smog formation is decreased further because of lower ambient air temperature. Smog is created by photochemical reactions of pollutants in the air, and these reactions are intensified at higher temperatures. When the ambient air temperature is decreased even by a few degrees there may be a significant decrease in smog formation. For example, a simulation of Los Angeles demonstrated when moderate amounts of reflective roofs and shade trees were added (up to 15% of all changes thought to be possible), that the average summer temperature in the Basin dropped 4°C. The moderate change in albedo reduced ozone on average, by 5% (Mestel, 1995).

Downsized AC Equipment. In some buildings, a highly-reflective roof (albedo greater than 50%) can reduce peak cooling demand by 10-15%. As a result, the home or building owner may be able to purchase a smaller HVAC system and the system would operate more efficiently and save a considerable amount of money.

Increased Durability. Roofs undergo significant expansion and contraction as they heat and cool. This "thermal shock" causes wear and tear on the roof. Heat absorbed by the roof can also accelerate degradation caused by ultraviolet rays and water. Although not yet quantified, keeping a roof cool with a high quality reflective material may also improve roof durability.

Analysis of the Roofing Market

Complexity of Roofing Market and Roofing Industry

There are eight main types of roof products: built-up-roofs, single-ply membranes, modified bitumen, metal panels, composite shingles, tile (ceramic, clay, or concrete), wood shakes, and slate. In addition, roof coatings are often applied as a top surface either to ensure the watertight nature or for aesthetic reasons. Within each of these roof types there are an enormous number of individual products whose formulations are changed depending upon the availability of raw materials and the desire to improve product performance. In addition, each roof product type must be tested based on different performance criteria and using different test methods. For example, to test each roof product type for weathering resistance, manufacturers may use any of three weatherometers for anywhere from 500 to 5000 hours at a practically unlimited number of cycle settings (degree temperature and length of cycle according to which climate is being simulated).

The roofing industry distribution chains are also complex. They consist of three main components: manufacturers, distributors, and contractors. Neither the residential homeowner nor the commercial building owner/operator plays a critical role in the selection of roof products. Instead, the contractor and sometimes the architect, roof consultant, or specification writer, have the most influence on product selection. It is also very difficult to identify all the individual companies involved in the industry. For example there are several large roof coatings manufacturers, but there are also an unknown number of tiny companies that make one or two roof coating products that are distributed for local use.

Division of the Roofing Market

The roofing market is diverse and fragmented and can be segmented along different lines. Industry associations such as the National Roofing Contractors Association and market research firms such as the Freedonia Group, Inc. typically sort market data along three basic divisions: market sector of application (commercial vs. residential); slope or pitch of the roof (flat and low-sloped vs. highly-sloped); and timeframe of application (new installation vs. retrofit or reroofing) (ICF Kaiser Draft Report *Cool Roofs*, 1997).

Certain roof products are limited to a single type of application; for example, the layered nature of composite shingles is designed to maximize water runoff at an angle. Roofs that are applied in horizontal layers using hot asphalt clearly cannot be applied to a medium- or highly- sloped roof or asphalt slippage will occur. However, other products such as some single-ply membranes can cover either flat or sloped roofs (fully adhered membranes can be affixed to sloped roofs, however, membranes held in place by mineral ballast would be confined to flatter roofs). Therefore, although most large commercial buildings have flat or low-sloped roofs and most single-family residences have highly-sloped roofs, this segmentation does not clearly divide commercial roofs from residential (ICF Kaiser Draft Report *Cool Roofs*, 1997).

Barriers

There are several barriers to widespread recognition and use of reflective roof materials in today's market. The major barriers and ways they may be overcome are discussed below.

Reflectivity Is A New Metric for the Industry and the Public

Although solar reflectance is a well-known metric, it is not one that is familiar to the roofing industry. Only a handful of manufacturers voluntarily test for this characteristic. In addition, only a few manufacturers highlight the energy efficiency benefits of their products. It is necessary to make manufacturers, suppliers, distributors, consultants, and contractors aware of, and comfortable with the use of reflectivity as a metric and a way to market their products. In addition, consumers are not familiar with reflectivity as it relates to their roofs. They do not currently make the correlation between reflectivity of a roof and energy consumption. Therefore, it is also necessary to increase awareness of reflectivity as a way for consumers to make intelligent roof material decisions. This will be accomplished through proliferation of the ENERGY STAR Roof Products label.

Expense of Testing Procedures and New Testing Requirements

The cost to a manufacturer of having its products tested for initial reflectivity using the established American Society for Testing and Materials (ASTM) procedure in the lab, E 903 - Standard Test Method for Solar Absorptance, Reflectance, and Transmission of Materials Using Integrating Spheres, is $80 per specimen, minimum $240 per order if the manufacturer sends it to an outside lab. It is assumed that, due to the purchasing cost (over $100,000), most manufacturers will not be willing to purchase the equipment in order to perform the test themselves at their in-house lab. The other required test is for maintenance of reflectivity over time using ASTM E 1918 - Standard Test Method for Measuring Reflectance of

Horizontal and Low-Sloped Surfaces in the Field. This test is much less expensive. A manufacturer may purchase the necessary equipment for under $20,000 and do the tests themselves. It is also possible that outside labs may offer this test for a reasonable price.

If a manufacturer must perform both tests on several specimens of an entire product line, or at least the samples thought to be highly-reflective, this could lead to a significant expense. In addition, these tests are not currently required by the National Building Code or similar code and standard setting organizations, so there is no direct enforcement incentive for manufacturers to test for these characteristics. Roof material manufacturers currently specify their products for many different physical properties depending on the specific product. These new testing procedures will add to the expense of specifying products for those manufacturers who choose to participate in the Program. However, as with the other ENERGY STAR Programs, manufacturers who realize the potential for increased market share and public recognition for being an ENERGY STAR Partner and making products that meet the label specifications will be willing to take on this extra expense. There has been no indication from conversations with manufacturers that these additional tests are an unreasonable request of the Program.

Limited Product Availability in the Residential Sector

There is a need to stimulate demand for reflective residential roof materials because there is little availability of these products in the market today. A high reflectance composite shingle with an albedo of 35% can be made with no change to the current production process, by using premium white granules that have been manufactured since 1972. However, most shingle manufacturers do not buy these granules due to limited storage space for the many colors of granules. The additional cost to the shingle companies is about $0.8/Square (100 ft^2), or about 3% of the uninstalled shingle price (Rosenfeld, 1996). This increase in cost for granules will more than likely be transferred to the consumer as an increase in the price of shingles. However, due to the average annual energy savings of 175 to 201 kWh for installing a reflective roof, the homeowner will realize a return on investment in less than one year. In order for shingle manufacturers to be willing to produce this more reflective shingle, a buyer of 100,000 ft^2 of the product is needed. Several procurement opportunities are currently being investigated that will help address this demand problem.

An even more reflective prototype shingle created by ISP Minerals exhibited an albedo of 55%. The prototype was made by using the bright white granules and altering the production process to include the placement of several sizes of granules to improve coverage of the black substrate. The increase in shingle price due to the change in production process is uncertain, as is the return on investment. However, an increase in albedo will most likely increase the annual energy bill savings, so the return on investment may be realized in less time.

Through awareness-building mechanisms, such as PSAs, articles, press releases, and the ENERGY STAR hotline and website, more homeowners will understand the benefits of reflective shingle roofs and will therefore ask for these labeled products, thereby increasing demand. One aim of the ENERGY STAR Roof Products Program is for awareness to increase demand to such an extent that not only will more manufacturers produce reflective shingles using existing technology (35%), but they will take the next step and change their production lines to accommodate shingles with 55% albedo.

Aesthetics and Glare

People's preferences limit the colors and hues they are willing to put on the exterior of their homes

and businesses. Building owners and architects prefer a choice in color when selecting roof materials. This is particularly a concern for highly-sloped roofs. For residential buildings, composite shingles that are both reflective and of some color other than white (tan, pastels, or others) can be produced as long as there is adequate demand for them. In some cases, reflective sloped roofs have the effect of making a home or building appear larger. This aspect will likely be attractive to owners and be a driving force that will increase demand for ENERGY STAR labeled products.

A drastic increase in the overall albedo of many roofs in an area has the potential to create glare and visual discomfort if not kept at a reasonable level. Besides being unpleasant, extreme glare could increase the danger and incidence of traffic accidents. Fortunately, on buildings with flat roofs, such as those found on most commercial buildings and homes in hot climates, glare is not a major concern.

New and Different Installation Processes of Reflective Roofs

Especially in the commercial sector, roofing contractors rely on materials they were trained to use and those they feel comfortable recommending to clients. Some of the new reflective roof products have installation processes that are different and perhaps more complex than what contractors are used to using. Contractors may therefore be less inclined to recommend these products to their clients. However, with the increase in awareness and production of reflective products and as a part of their responsibility as an ENERGY STAR Partner, manufacturers will include any newly-required installation procedures in their contractor training programs to help overcome this barrier.

Cost Differential between Reflective and Non-Reflective Roof Products

In some instances, a significant cost differential exists between a product and its reflective alternative. According to R.S. Means data and discussions with manufacturers, the increase in cost of buying and installing reflective roofs, as opposed to traditional non-reflective roofs, ranges from 0-35% depending on the technology (Bretz, 1997). As stated above, a composite shingle with premium white granules increases manufacturer cost by 3%. In contrast, switching from a black single-ply membrane to a white single-ply membrane could increase costs by up to 20%, and the switch from a clay tile to a white clay tile could increase cost by 35%.

The increase in initial cost may make it prohibitive for some home and building owners to install the more reflective alternative and may greatly extend the amount of time before a return on the investment is realized. It is expected that, over time, the increase in demand and production of reflective roof products will help lower the price differential between reflective and non-reflective roof products to be more affordable for the average consumer.

Split Incentives

As with most building construction materials, the purchase and installation of reflective roofs may provide a situation of split incentives. Particularly for commercial buildings, the owner or maintenance provider is not necessarily the one who pays the utility bill. Therefore, the roofs will most likely be selected based on factors other than energy efficiency, such as cost, ease of installation, durability, and warranty. Articles, editorials, and advertisements in trade publications such as *Buildings* and *Building Operating Management*, that highlight not only the energy savings of reflective roof products but the potential for increased durability will provide incentive for building owners and maintenance personnel

to choose an ENERGY STAR labeled roof product during routine replacement schedules.

Maintenance Costs

Reflective roofs that are light colored require more upkeep in order to maintain their reflectivity over time. Maintenance may be in the form of cleaning with water and perhaps a mild detergent or, in the case of coatings, periodic recoating. The cost of a regular maintenance program could be significant depending on the location of a building, how much dirt and dust accumulates on it, and how susceptible the roof is to microbial growth. Typically, flat roofs, highly-sloped roofs of rough surface texture, and roofs on buildings located in hot and humid climates are more susceptible to dirt and microbial accumulation. Ponding water on flat roofs, caused by inadequate slope and sometimes improper installation, is also a cause of decreased reflectivity and requires maintenance to ensure the roof does not leak.

In some cases, it is not appropriate or recommended to clean a roof. For example, composite shingle manufacturer warranties explicitly state that the warranty is void if the roof is cleaned because cleaning could remove the granules that provide the necessary protection from ultraviolet light. In other cases maintenance is not needed because of the ability of a product, such as a coating, to shed dirt or chalk through natural weathering.

Although routine maintenance programs including recoating, and tools such as visual and moisture surveys increase the initial cost of a roof, they pay off in the long run. A study by Rohm & Haas, in which several different scenarios are compared using a life cycle cost analysis, "should easily convince the building owner or facility manger of the value of regular professional roof inspections and the use of maintenance coatings as the economically preferred alternative to tear off and reroofing every ten years." (Kirn, 1998)

Federal Government's Million Solar Roofs Initiative

It is not entirely clear how the Million Solar Roof Initiative will complement or be competitive with the ENERGY STAR Roof Products Program. The Million Solar Roofs Initiative promotes the installation of solar water heaters and photovoltaic cells or shingles on rooftops nationwide. To be counted as a "solar roof" the system must be able to produce one-half of a kilowatt-hour (kWh) on a home and 2 kW on a commercial building. EPA and DOE are working together to coordinate the success of these programs. A community wanting both cool roofs and PV roofs can integrate them for a maximum effect of air quality improvement and reduced CO_2 emissions. This can be accomplished by making reflective the part of the roof not converted to PVs.

The Roof as a Surface vs. The Roof as a System

The primary purpose of a roof is to be a waterproofing layer between the outside and the interior of a building. In addition, the roof needs to be durable. Many layers of materials can be installed on the top of a building: roof deck, insulation, felts, asphalt, membranes, ballast. A roofing contractor or a specifier will consider all these different materials together as a roof system and not necessarily put the importance of one layer over another.

Manufacturers have voiced concern that the ENERGY STAR Roof Products Program only considers the energy efficiency of the roof surface manifested in its reflectivity as opposed to considering the energy

efficiency of the roof as a system. In particular, some manufacturers would like for insulation to be considered in an ENERGY STAR Roof Products Program.

The amount of insulation a building has is important in determining the amount of cost saving realized by installing a reflective roof. This, along with several other factors such as climate, location of ducts, and the original albedo of a roof, are addressed in the program in the form of education materials to be distributed via the hotline and the Internet. In addition, there is a separate ENERGY STAR Program for insulation that deals with appropriate levels of insulation for different areas of the country.

Program Goals and Design

The ENERGY STAR Roof Products Program specification delineates flat and low-sloped roofs from highly-sloped roofs in an attempt to differentiate product types. The specification consists of two tables: Table 1 is for flat and low-sloped roofs and Table 2 is for highly-sloped roofs. Products that can be installed on both roof pitches (e.g. coatings, single-ply membranes, and some metal panels) must meet the specification in Table 1. The result is a simplified and non-duplicative set of specifications for the ENERGY STAR Roof Products Program (Tables 1 and 2).

Of the total 1996 roofing market of 253 million Squares, the office and commercial roofing market is about 20% of the total by area (Freedonia, 1997). In dollar sales however, the commercial market was over 70% of the total annual U.S. market in 1996. Also, in terms of dollar value, 4.5 billion (23%) was new construction, and 15.1 billion (77%) was reroofing (NRCA, 1996). Another reason to analyze the distinction between commercial and residential roofs, and also the division between new construction and reroofing, is for the education and outreach part of the ENERGY STAR Roof Products Program. Outreach materials will be designed to specifically address issues and concerns of each type of customer.

Specification

The current ENERGY STAR Roof Products draft specification consists of three main characteristics and the corresponding performance specifications. The three characteristics are energy efficiency, durability, and reliability. Since all ENERGY STAR programs are designed to be simple, performance-based, and technology-neutral, the ENERGY STAR Roof Products specification highlights only a few characteristics. At the time this paper was written, the specification was still in draft form. It is expected that the agreed-upon final version of the specification will be somewhat different from the one included in this paper.

Energy Efficiency. The most important component of all ENERGY STAR Programs is the energy efficiency of a product. In the case of roof products, energy efficiency is dependent upon the solar reflectivity of the roof.

Initial Reflectivity - There are several reasons for listing solar reflectivity at initial installation as the first sub-characteristic under energy efficiency. First, initial reflectivity is the starting point for determining the amount of energy savings possible from an ENERGY STAR roof product. Reflectivity and energy savings have a basic linear relationship. The higher the reflectivity the greater the potential energy savings and vice versa. In addition, initial reflectivity is a property that can be measured in a laboratory using the industry-approved standard procedure ASTM E 903. This allows for confidence that those products that are labeled as ENERGY STAR will actually provide maximum benefits to the consumer.

The ENERGY STAR Roof Products Program specification includes microbial resistance in order to ensure that reduced reflectivity due to algae and fungus is minimized. Microbial resistance has typically been important with regard to highly-sloped roofs of rough surfaces. Highly-sloped roofs are more visible and therefore attract more attention based on aesthetics. Microbial growth (usually algae and/or fungus) causes discoloration and can be extensive in hot and humid climates such as Florida. The addition of microbial resistance in product formulation has become a common practice especially for composite shingle manufacturers who distribute their products in these humid climates.

Maintenance of Reflectivity - There is consensus in the roofing industry that attention should be given to the ability of roofs to maintain reflectivity over time. In general, natural weathering and air pollution cause light-colored roofs to get darker with age and dark-colored roofs to get lighter. To address this issue, a value of 15% absolute (not 15% of the initial albedo) was given for the maximum decrease in reflectivity allowed over three years for a product that receives an ENERGY STAR label. This value was chosen based on the limited data available on maintenance of reflectivity of white coatings (Bretz and Akbari, 1997). Testing procedures for measuring reflectivity in the field were just recently approved (December 1997) and have been designated as E 1918 (ASTM, 1997). This new standard will be used to determine the effects of weathering on the reflectivity of materials over a three year period.

Durability. Durability is another characteristic manufacturers hold in high regard when evaluating their products. A roof product can have a solar reflectivity near 100%; however, if it does not provide a waterproofing barrier for the structure beneath and does not last for its expected lifetime, it is considered a failure. Manufacturers are concerned that competitors will offer new but low-quality products with claims of high reflectivity. For this reason, the ENERGY STAR Roof Products Program includes a characteristic for the durability of a product specifically as it relates to its ability to resist the effects of weathering. Resistance to weathering is tested using standardized procedures, and most manufacturers already include these tests in their current product performance evaluations. The current ENERGY STAR draft specification requires that products exhibit no cracking, crazing, discoloration, or excessive chalking after 2000 hours in a weatherometer under a setting equivalent to a harsh climate, such as the desert Southwest U.S.

Reliability. All manufacturers of roof products provide warranties. The length of coverage, extent of coverage, exclusions, and pro-rating schedules are covered in the ENERGY STAR Roof Products specification. By requiring certain warranty criteria, the program can ensure that manufacturers will stand behind their products at least as much, if not more than they do for their comparable non-reflective products. Limits on pro-rating schedules allow consumers to retain more of the value of the warranty for a longer period of time. In addition, disallowing the exclusion of discoloration due to microbial growth in a warranty is directly related to the energy efficiency criteria as addressed above.

Partners

ENERGY STAR Roof Products Program partnerships will be made available to all manufacturers of roof products. Partners sign a voluntary Memorandum of Understanding (MOU) with EPA agreeing to label any product that meets the specifications or to develop a product that does so within one year of signing the MOU.

Table 1 - Roof Membrane Products and Roof Coatings Installed on Horizontal or Low-Sloped Surfaces including single-ply membranes, metal panels, roof coatings, and built-up-roofs.

DRAFT Roof Specification	
Characteristic	**Performance Specification**
Energy Efficiency	
Initial Reflectivity	For roof membrane products and roof coatings installed on smooth surfaces: initial reflectance greater than or equal to 0.65.
	For roof membrane products and roof coatings that are not smooth due to surface texture, granules, or intentional modifications made to surface of product, or that are incompatible with smooth surfaces: initial reflectance greater than or equal to 0.60.
Maintenance of Reflectivity	Reflectivity may not decrease by more than 0.15 (to 0.50 or 0.45, respectively) over three years.
Durability	
Weathering	No visible cracking, crazing, discoloration, or excessive chalking after 2000 hours in weatherometer.
Reliability	
Manufacturers warranty for defects in materials and manufacturing	Roof membrane product warranty must be comparable to those offered for comparable non-reflective roof membrane products. In addition, roof membrane product warranty must: 1) cover repair or replacement of materials for a minimum 15 years from date of installation; 2) not exclude discoloration from dirt, airborne material, or microbial growth. 3) not begin prorating before the fifth year from the date of installation.
	Roof coating warranty must be comparable to those offered for comparable non-reflective products. In addition, roof coating warranties must: 1) cover repair or replacement of materials for a minimum of 5 years from date of installation; and 2) not exclude discoloration from dirt, airborne material, or microbial growth.

Table 2 - Roof Membrane Products Installed only on Highly-Sloped Surfaces.

DRAFT Roof Specification	
Characteristic	**Performance Specification**
Energy-Efficiency	
Initial Reflectivity	Initial reflectance greater than or equal to 0.35.
Maintenance of Reflectivity	Reflectance may not decrease by more than 0.15 (to 0.20) over three years. For products with rough surfaces inclusion of microbial resistance in product formulation is required.

Reliability	
Manufacturer warranty for defects in materials and manufacturing	Roof membrane product warranty must be comparable to those offered for comparable non-reflective roof membrane products. In addition, roof membrane product warranties must: 1) cover repair or replacement of materials for a minimum 25 years from date of installation; 2) cover replacement or cleaning of discolored or unsightly roof product due to microbial growth for a minimum of 15 years from date of installation; and 3) not exclude discoloration from dirt, airborne material, or microbial growth; 4) not begin prorating before the fifth year from the date of installation.

Label Use

Partners in the ENERGY STAR Roof Products Program must use the ENERGY STAR label according to the same guidelines as followed by partners in other ENERGY STAR Programs. The ENERGY STAR label is a registered certification mark with the U.S. Patent and Trade Office and may be used as a product label to identify only products that meet the specifications contained in the MOU or for general educational purposes. Program partners may include the ENERGY STAR name in general educational or informational materials that discuss the ENERGY STAR Program. This includes promotional materials, brochures, newsletters, annual reports, speeches, posters, advertisements, articles, product sales materials and packaging. However, in each of these cases, the mark must be used to make reference to a specific product. The only time it may be used without making this reference is when it is used to inform the public of certification purposes of the mark.

Under no circumstances can the ENERGY STAR name or label be used to imply EPA or DOE endorsement of the Partner, its products, or its services. When the label is used by a Partner in connection with a product or its advertising, it must be accompanied by the following statement: "As an ENERGY STAR® Partner, (*company name*) has determined that this product meets the ENERGY STAR guidelines for energy efficiency."

Education and Outreach Strategy

An extensive education and outreach program is being planned for both the general public and the roofing industry. As discussed above, elements of this program include press releases, articles, editorials, and advertisements in trade publications, newspapers and magazines. Contractors will also be made aware of the ENERGY STAR label through their industry associations, manufacturer provided training programs, and on point-of-purchase displays in distribution centers. Consumers will see the label on public service announcements (PSA), and in articles and editorials in newspapers and magazines. Finally, through the ENERGY STAR website and the toll-free hotline, both consumers and those involved in the roofing industry can acquire information about the ENERGY STAR Roof Products Program, the label and reflectivity as a metric.

Timeframe

It is anticipated that the program specification and MOU will be completed during Summer 1998. Charter Partners will be signed onto the program once the MOU is distributed so that the program can be

launched by Fall of 1998.

References

Akbari, Hashem, Sarah Bretz, Dan Kurn, and James Hanford 1997. "Peak Power and Cooling Energy Savings of High-Albedo Roofs." *Energy and Buildings*, March: 117-126

American Society for Testing and Materials 1997. "Standard Test Method for Measuring Solar Reflectance of Horizontal and Low-Sloped Surfaces in the Field." ASTM E 1918-97.

Bretz, Sarah, 1997. "Task 17-3. Steps and Costs to Make Roofs Cool." Lawrence Berkeley National Laboratory draft report to EPA.

Bretz, Sarah and Hashem Akbari 1997. "Long-Term Performance of High-Albedo Roof Coatings." *Energy and Buildings*, March: 159-167.

Bretz, Sarah, Hashem Akbari, and Arthur Rosenfeld 1996. "Practical Issues for Using High-Albedo Materials to Mitigate Urban Heat Islands." Lawrence Berkeley National Laboratory report LBL-38170.

Freedonia, Group 1997. "Roofing Market by Sector: Roofing Demand by Sector." The Freedonia Group.

ICF Kaiser 1997. "Cool Roofs." Draft Report to EPA.

Kirn, William A. 1998. "Life Cycle Cost Analysis Using Roof Coatings." *Interface*, April: 4-10.

Konopacki, Steve, Hashem Akbari, Mel Pomerantz, S. Gabersek, and Lisa Gartland 1997. *Cooling Energy Savings Potential of Light-Colored Roofs for Residential and Commercial Buildings in 11 U.S. Metropolitan Areas.* Lawrence Berkeley National Laboratory, LBNL-39422.

Mestel, Rosie 1995. "White Paint." *New Scientist*, March: 34-37.

National Roofing Contractors Association 1996. *1996-1997 Annual Market Survey.*

Parker, Danny, S. Barkaszi, S. Chandra, and D. Beal 1995. "Measured Cooling Energy Savings from Reflective Roofing systems in Florida: Field and Laboratory Research Results." Florida Solar Energy Center, Cocoa Beach, FL, FSEC-PF-293-95.

Rosenfeld, Arthur, Joseph Rohm, Hashem Akbari, and Mel Pomerantz 1997. "Cool Communities Strategies for Heat Island Mitigation and Smog Reduction." Lawrence Berkeley National Laboratory, LBNL-38667.

Rosenfeld, Arthur 1996. Personal communication.