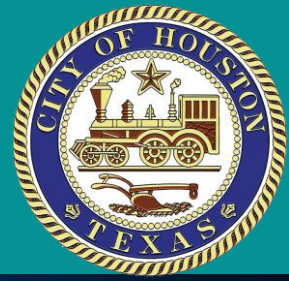


City of Houston Code Enforcement COOL ROOF CODE

EPA
Sustainable Communities Conference
Dallas, Texas
March 10, 2009

Sheila Blake MBA, CBO, LEED® AP
Assistant Director, PWE Planning and Development Services



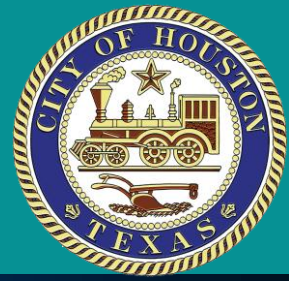
Houston Code Adoption

BACKGROUND

- Codes typically updated every 3 years - Houston Codes on 2000
Construction Industry Council : AIA, AGC, BOMA, ... , USGBC
- New Energy Codes
 - ▣ Commercial Energy Code (2004 ASHRAE 90.1) - Aug. 1 , 2008
 - ▣ Residential Energy code (2006 IECC) - Jan. 1, 2009
 - ▣ 15% phased efficiency increase - October 1, 2009
- TX Legislature SB5 requirement:
 - ▣ TAMU –ESL review for stringency
 - ▣ 2001 IECC minimum
- Code Enforcement Begins Review 2006 Series - January 2007
Priority on energy code



Houston New Directions in Code Adoption



MAYOR BILL WHITE

January 2006 Inauguration

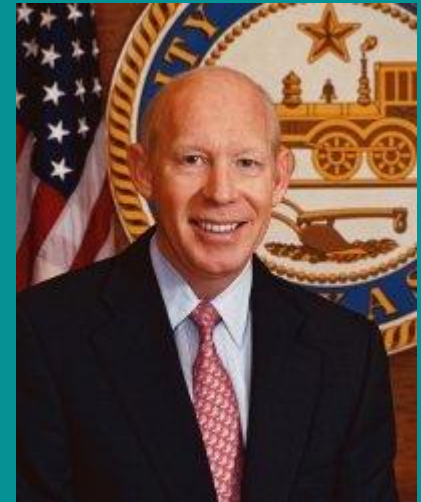
“Houston has long been the world's energy capital. Wouldn't it be great to also take pride in being a world leader in more efficient energy consumption and the use of alternative sources of energy”

January 2007

“Review the energy code first and include upgrades like cool roofs as long as they make economic sense.”

May 2007 Clinton Climate Initiative NYC

“Let's get the most cutting edge energy code available”
ASHRAE 189 / 90.1-2007 – under development, no software

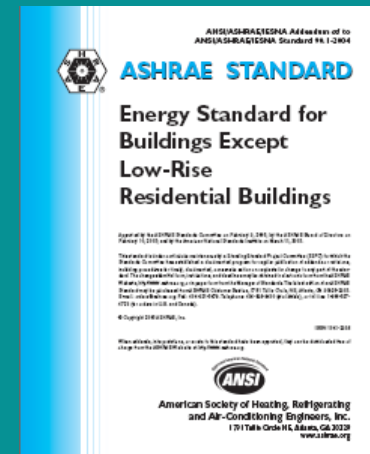


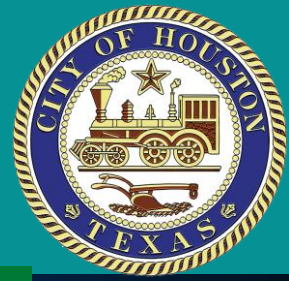
Houston Commercial Energy Conservation Code



ASHRAE 90.1 - 2004

- More detailed than IECC and affects installation in addition to design
- More stringent than IECC:
 - Cool Roofs
 - Commissioning
 - Owner's Manuals
 - Air Balance Testing
 - Power Requirements
- Basis for Green Building Certification
199+ LEED projects underway in Houston / 21+ Certified
- Issued as Houston Stand-Alone Code





Houston Cool Roof Code

Potential Annual Savings from Changing Roof Reflectivity in 11 Metropolitan Areas

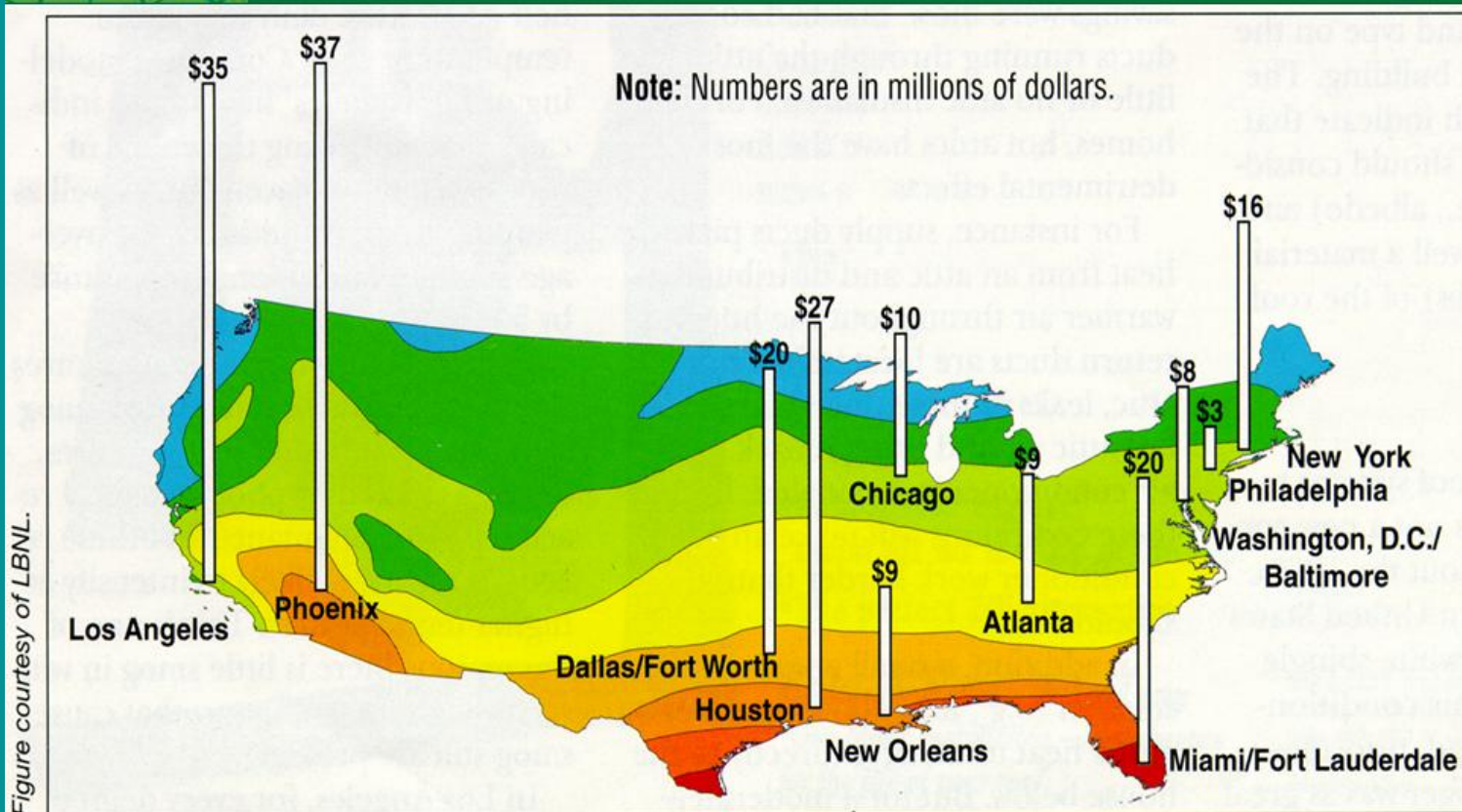
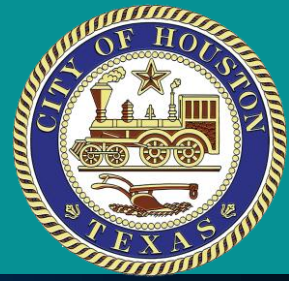


Figure courtesy of LBNL.

Figure 1: Annual net cooling energy savings for 11 metropolitan areas.



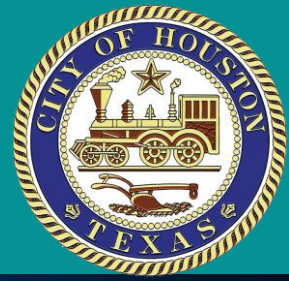
Houston Cool Roof Code

BENEFITS OF A COOL ROOF

- Light-colored roofs reflect more sun than dark roofs
- Buildings cooler; Reduces air conditioning demand (increases heating)
- Reduces CO2 emissions with reduced fossil-fuel generated electricity for AC
- Inhibits formation of smog
- Reduces Urban Heat Island
- Reduces thermal cycling affect on roof life span

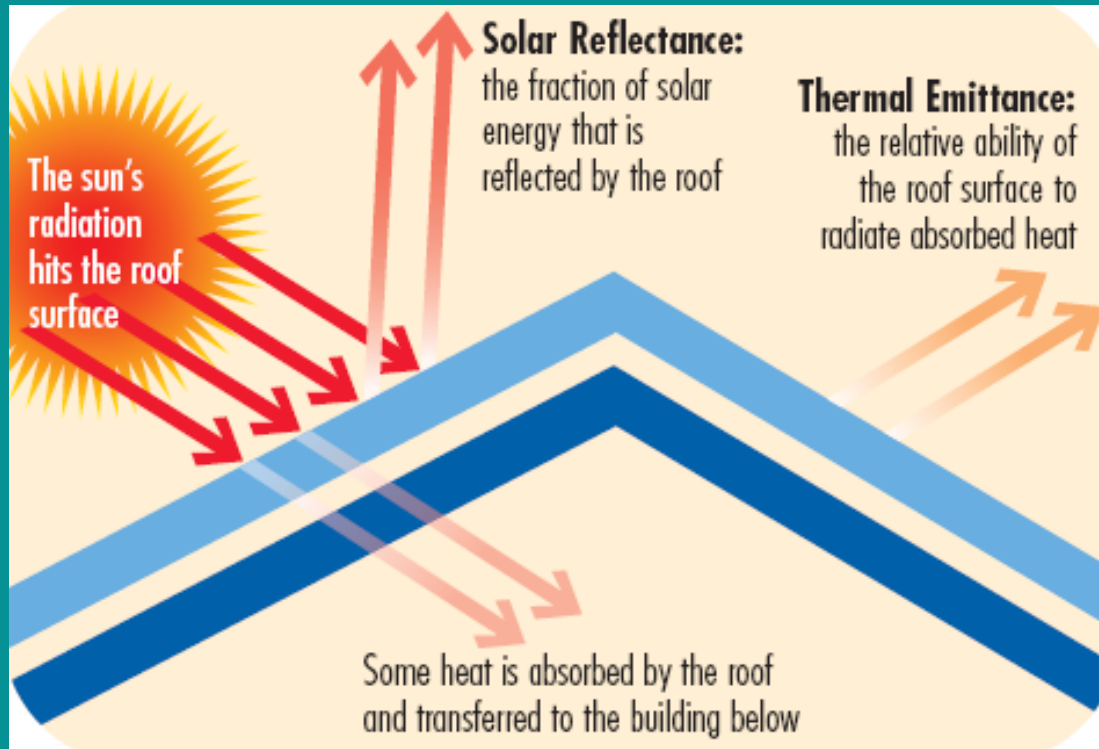
Cool Roof Rating Council

- Formed in 1998
- Ratings through independent, reliable roof performance data
- Initial and Aged Testing at 3 different test farms
- All types of common roofing products
 - field-applied coatings, factory-coated metal, capsheets single-ply, built-up, shingles and tiles
- “Cool” dark-colored products.



Houston Cool Roof Code

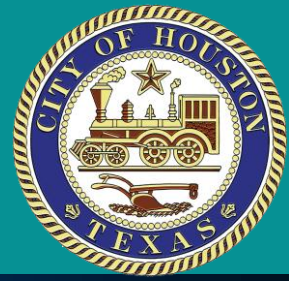
WHAT IS A COOL ROOF?



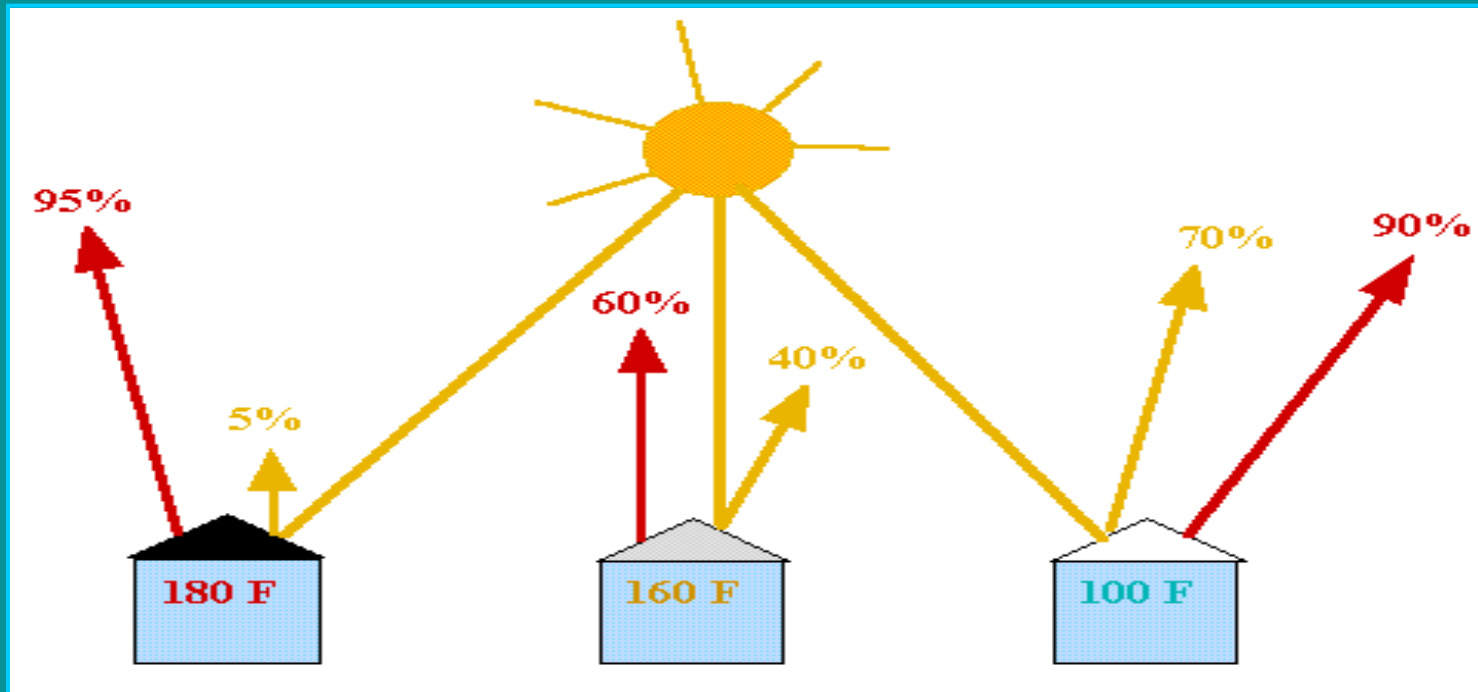
SOURCE: Cool Roof Rating Council

black (reflectance 0.05, emittance 0.90)

white (reflectance 0.80, emittance 0.90)



Houston Cool Roof Code

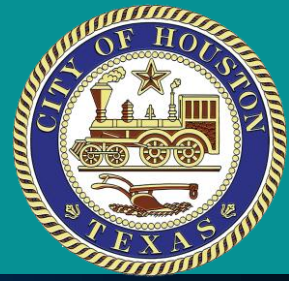


black asphalt
low reflectivity
High emissivity

aluminum coating
high reflectivity
moderate emissivity

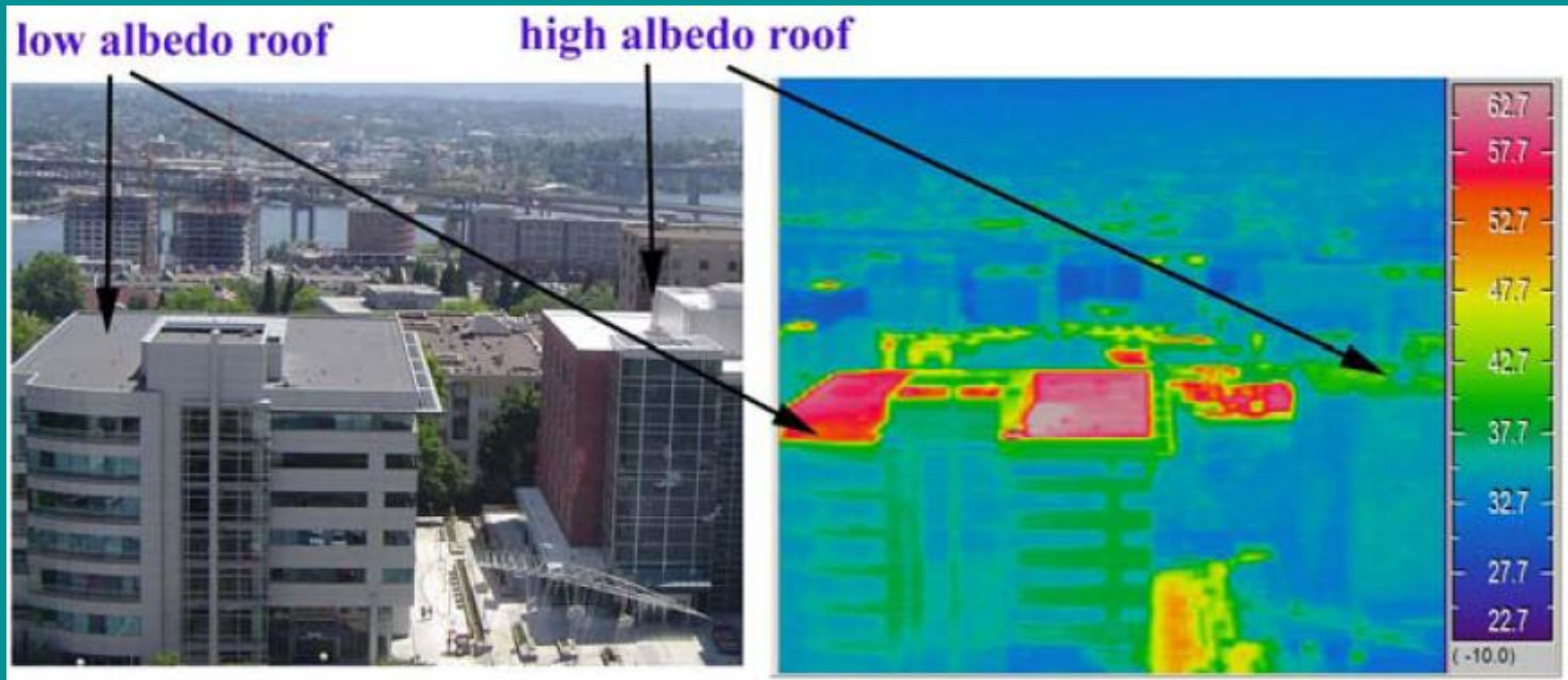
white membrane
very high reflectivity
high emissivity

SOURCE: Cool Roof Rating Council

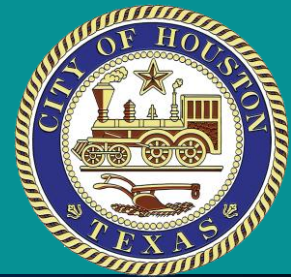


Houston Cool Roof Code

Figure: Albedo and thermal infrared imagery of a traditional and cool roof (temperature in degrees C) in Portland Oregon.



SOURCE: David Sailor, Portland State University



Houston Cool Roof Code

MATERIALS AND PRODUCTS

<u>Roofing Material</u>	<u>Emissivity</u>	<u>Reflectivity</u>
Black EPDM	.86	.06
Gray EPDM	.87	.23
White EPDM	.87	.69
Smooth BUR	.86	.06
White Granular Modified	.92	.26
SBS Modified Bitumen	.92	.26
Dark gravel BUR	.90	.12
White coated BUR	.90	.65
Sarnafil/GAF white membranes	.92	.83

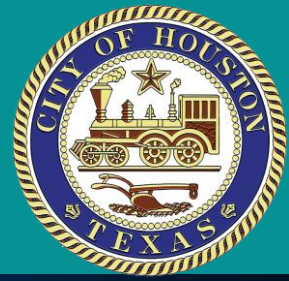
SOURCE: Sarnafil to International Code Council



Houston Cool Roof Code

MATERIALS AND PRODUCTS

Built-up Roof	6
Factory or Field Applied Coating	2
Factory-Applied Coating	3
Field-Applied Coating	224
Metal	45
Modified Bitumen	27
Other - Concrete coated polystyrene panel	1
Other - Field applied coating & granules	1
Other - Finished Insulation Panel	1
Other - PTFE coated fiberglass	1
Other - Roof Surfacing System	3
Single-Ply-Thermoplastic	34
Single-Ply-Thermoset	6
TOTAL	354

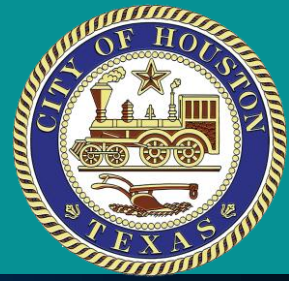


Houston Cool Roof Code

HOUSTON ADVANCED RESEARCH CENTER COOL ROOF REPORT

- **Cost Benefit Analysis For Four Typical Scenarios:**
 - Commercial, conditioned space
 1. Strip –Retail
 2. 3 – 5 story office
 3. Apartment
 - Commercial, unconditioned space
 4. Typical warehouse
- **Two Aspects:**
 1. Capital investment: comparison of roof costs, life expectancy
 2. Operational (energy) comparison – estimated percentage difference





Houston Cool Roof Code

Aerial images of conventional apartment (A), warehouse (B), strip retail (C), and midsize office (D) roofs in the city of Houston

A. Apartment complex



Picture Source: H-GAC GDC

B. Warehouses



Picture Source: H-GAC GDC

C. Strip retail



Picture Source: H-GAC GDC

D. Midsize-office



Picture Source: H-GAC GDC



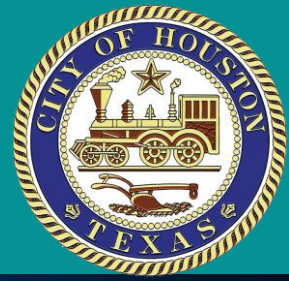
Houston Cool Roof Code

HOUSTON ADVANCED RESEARCH CENTER COOL ROOF REPORT*

- Apartment Savings :
\$425 Retrofit \$132 New
- Unconditioned Warehouse: \$0
- Strip–Retail Savings :
\$1789 Retrofit \$1077 New
- Mid-size Office Savings:
\$482 Retrofit \$ 219 New

*Assumed 15 year life, 20% cost premium, R-11 Retrofit, R-19 New

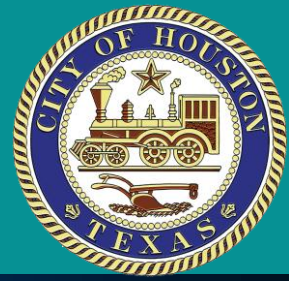




Houston Cool Roof Code

ENERGY STAR and CA TITLE 24

- **ASHRAE Standard 90.1 - Energy Standard For Buildings Except Low-rise Residential Buildings – Insulation Exception**
Solar Reflectance: 0.70
Thermal Emittance: 0.75
- **CALIFORNIA'S Building Energy Efficiency Standard (Title 24)**
Solar Reflectance: 0.70/ Aged 3 years 0.50
Thermal Emittance: 0.75
- **ENERGY STAR:**
Initial Solar Reflectance: 0.65 / Aged 3 years 0.50
Emissivity not addressed
but does have steep slope 0.25



Houston Cool Roof Code

STANDARDS

- **Solar Reflectance Test Methods:**

ASTM E903 Standard Test Method for Solar Absorptance, Reflectance, and Transmittance of Materials Using Integrating Spheres (Withdrawn 2005)

ASTM E1175 - E1175-87(2003) Standard Test Method for Determining Solar or Photopic Reflectance, Transmittance, and Absorptance of Materials Using a Large Diameter Integrating Sphere

ASTM E1918 - Standard Test Method for Measuring Solar Reflectance of Horizontal and Low-Sloped Surfaces in the Field

- **Thermal Emittance Test Methods:**

ASTM C835 - Standard Test Method for Total Hemispherical Emittance of Surfaces up to 1400°C

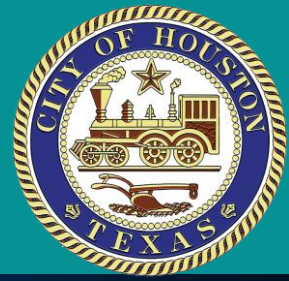
ASTM C1371 - Standard Test Method for Determination of Emittance of Materials Near Room Temperature Using Portable Emissometers

ASTM E408 - Standard Test Methods for Total Normal Emittance of Surfaces Using Inspection-Meter Techniques

- **Cool Roof Rating Council:**

Suggest adding Standard ASTM C1549 - Standard Test Method for Determination of Solar Reflectance Near Ambient Temperature Using a Portable Solar Reflectometer

Used by LEED, DOE and Title 24



Houston Cool Roof Code

CHICAGO

- Reflectance (ASTM E903, E1918, or field reflectometer verified)
- Low-Sloped roofs ($\leq 2:12$)
- Initial ≥ 0.65 , Maintain ≥ 0.50 for 3 years, BUT
- Minimum 0.25 if installed on or before 12/31/2008
- EPA Energy Star label standards thereafter
- Medium-Sloped roofs ($2:12 < X \leq 5:12$)
- Initial ≥ 0.15 , Maintain ≥ 0.15 for 3 years
- Emissivity ≥ 0.9 (ASTM E408)
- Exceptions:
 - Roof top gardens
 - Solar thermal systems
 - Photovoltaics

Houston Cool Roof Code



HOUSTON CODE LANGUAGE

5.4 Mandatory Provisions

5.4.3.5 Cool roofs. Low slope roofs up to 2:12 shall be provided with a roof covering where the exterior surface has:

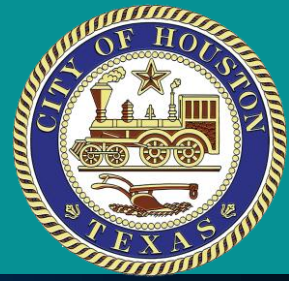
- (a) a minimum total solar reflectance of 0.70 when tested in accordance with one of the solar reflectance test methods listed below, and
- (b) a minimum thermal emittance of 0.75 when tested in accordance with one of the thermal emittance test methods listed below.

Solar Reflectance Test Methods: ASTM C1549, ASTM E903, ASTM E1175, or ASTM E1918.

Thermal Emittance Test Methods: ASTM C835, ASTM C1371, or ASTM E408.

Exceptions to 5.4.3.5:

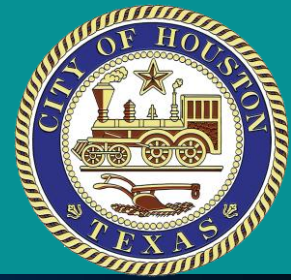
- (a) The portion of the *roof* that is covered by a rooftop deck covering 1/3 or less of the aggregate area of the roof, or a rooftop garden, or a green roof, is exempted from the requirements of this section.
- (b) An area including and adjacent to rooftop photovoltaic and solar thermal equipment, totaling not more than three times the area that is covered with such equipment, is exempt from the requirements of this section.



Houston Cool Roof Code

STAKEHOLDERS

- CIC PROCESS
- GREATER HOUSTON PARTNERSHIP ROOFING SUBCOMMITTEE
- REAL ESTATE COUNCIL
- CODE ENFORCEMENT STAFF
- COOL ROOF COMMITTEE OF CITIZENS
- ROOFING CONTRACTORS ASSN

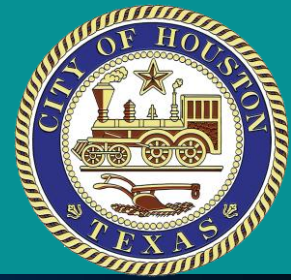


Houston Cool Roof Code

GUIDELINES

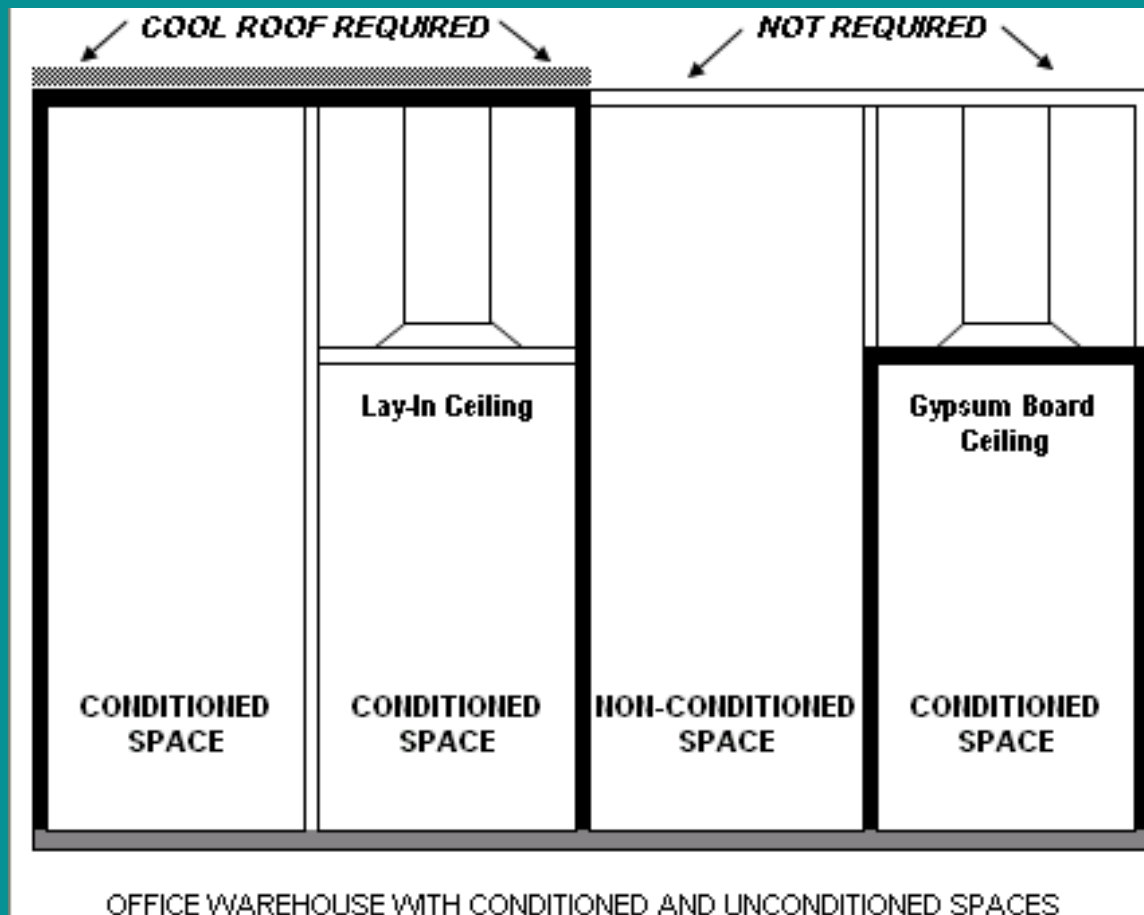
Project Matrix

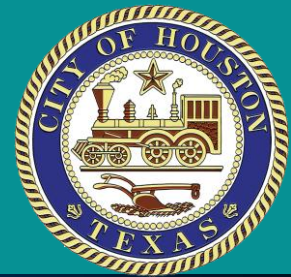
SCOPE OF WORK	EXISTING ROOF COVERING	EXISTING INSULATION	REQUIREMENT
ROOF REPLACEMENT, COMPLETE REMOVAL OF ROOF MATERIALS TO DECK	Removed	Removed	Roof Insulation and Cool Roof
ROOF REPLACEMENT, ROOF COVERING ONLY	Removed	Cavity full depth @ min R-3/inch	No requirement
		None or other	Roof Insulation and Cool Roof
APPLYING COATINGS ONLY	Remains	Remains or None	No requirement
REPLACING PORTIONS OF ROOF FULL DEPTH	Patches	Patches	Repair affected area to existing
	Edge-to-edge, or Corner-to-corner	Removed	Replace that portion of the roof insulation and cool roof
	NOT an Edge-to-edge, or Corner-to-corner and < 50% total area	Removed	Roof Insulation only
	Add 2nd Recover	Remains	No requirement
	Remove top membrane only	Remains	No requirement



Houston Cool Roof Code

APPLICABILITY

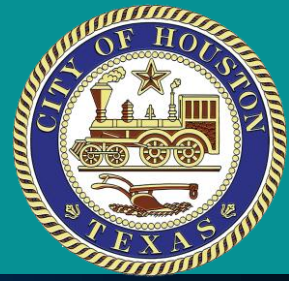




Houston Cool Roof Code

RESOURCES

- **Cool Roof Rating Council**
<http://www.coolroofs.org/>
- **DOE Cool Roof Calculator**
<http://www.ornl.gov/sci/roofs+walls/facts/CoolCalcEnergy.htm>
- **City of Houston's Commercial Energy Conservation Code**
http://www.publicworks.houstontx.gov/planning/enforcement/docs/houston_commercial_energy_conservation_code.pdf
- **Mayor's Office of Environmental Programming web site:**
www.greenhoustontx.gov



Final Thought

Archbishop Desmond Tutu

“The world is enough for everyone’s need, but it is not enough for anyone’s greed”

--- Greenbuild Boston November 19,2008

