UT-BATTELLE

Energy Savings for Stucco Walls Coated with Cool Colors

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OAK RIDGE NATIONAL LABORATORY
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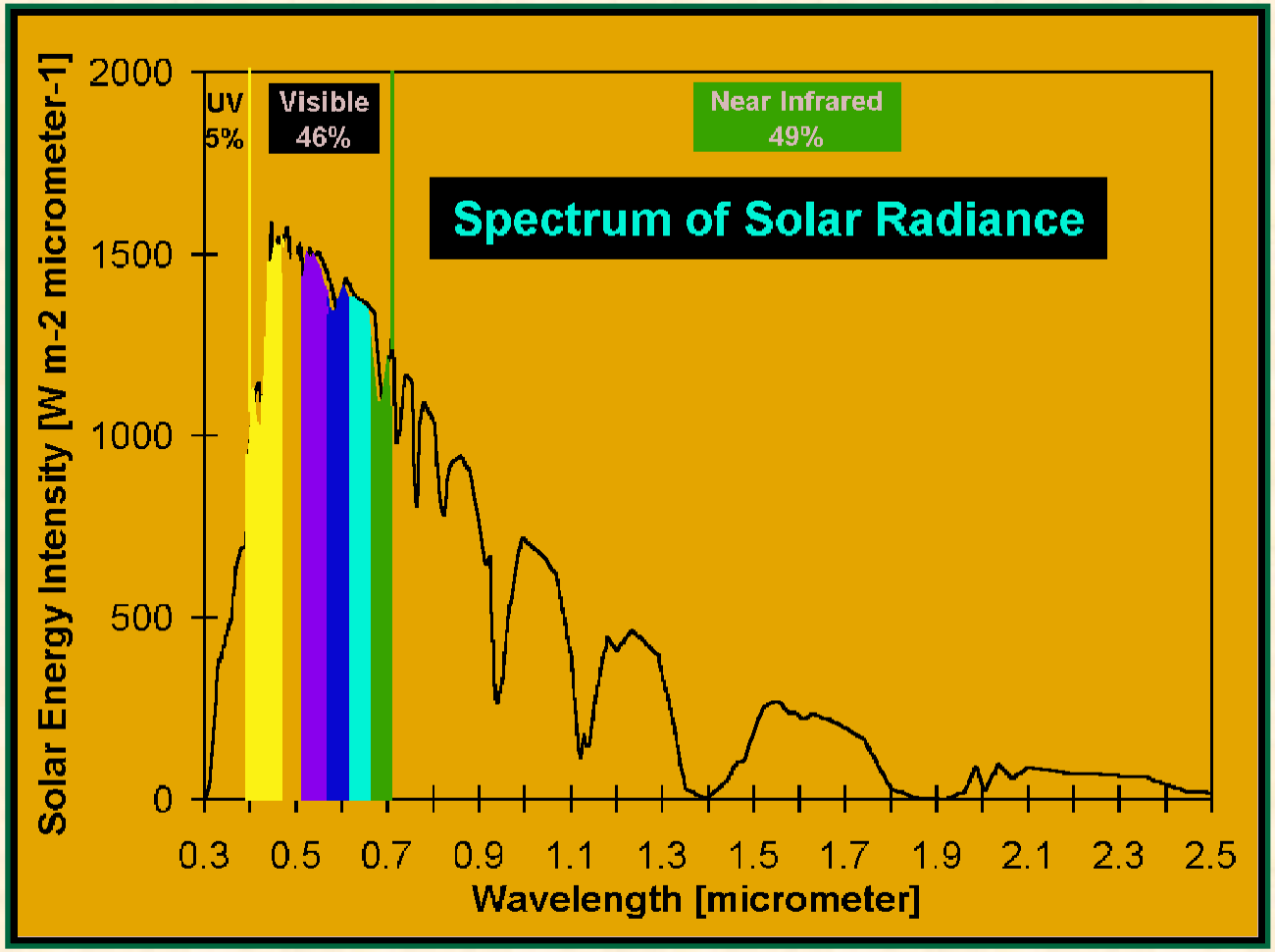
Pop Quiz

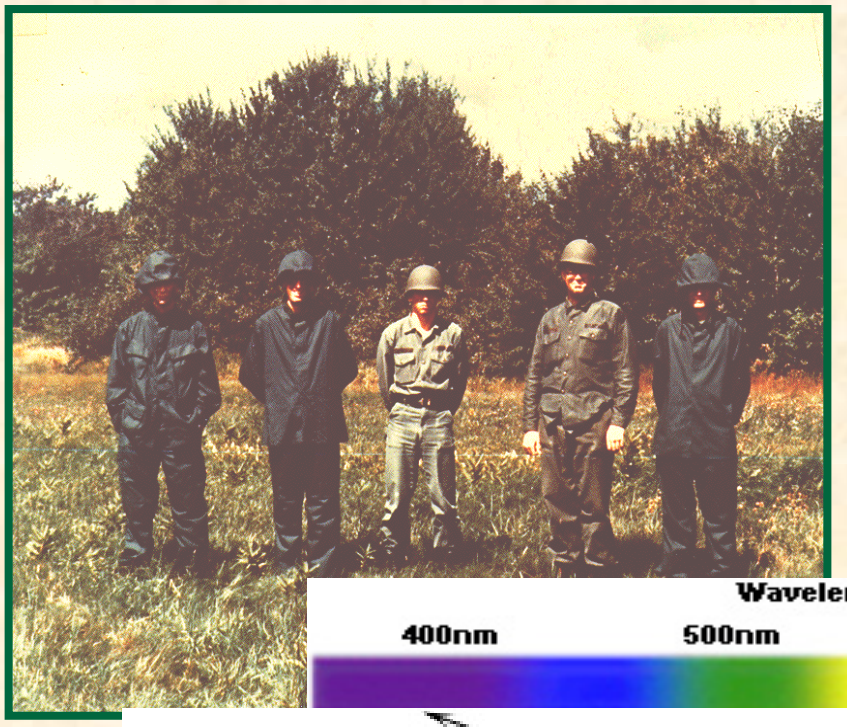
With Comfort and Energy Efficiency in mind, which car do you select to drive in Clearwater Beach during the summer?

Solar Energy Spectrum

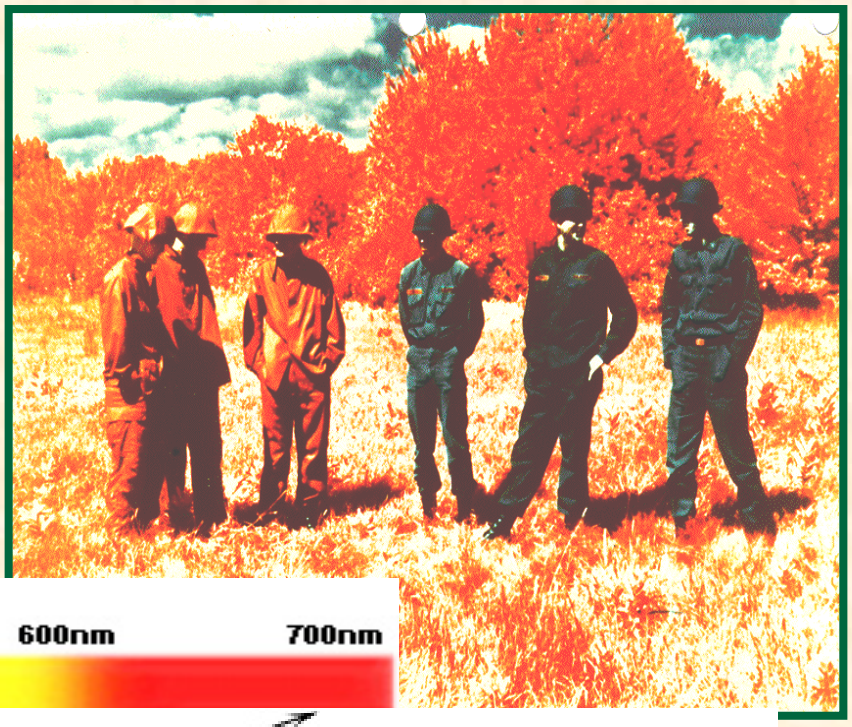


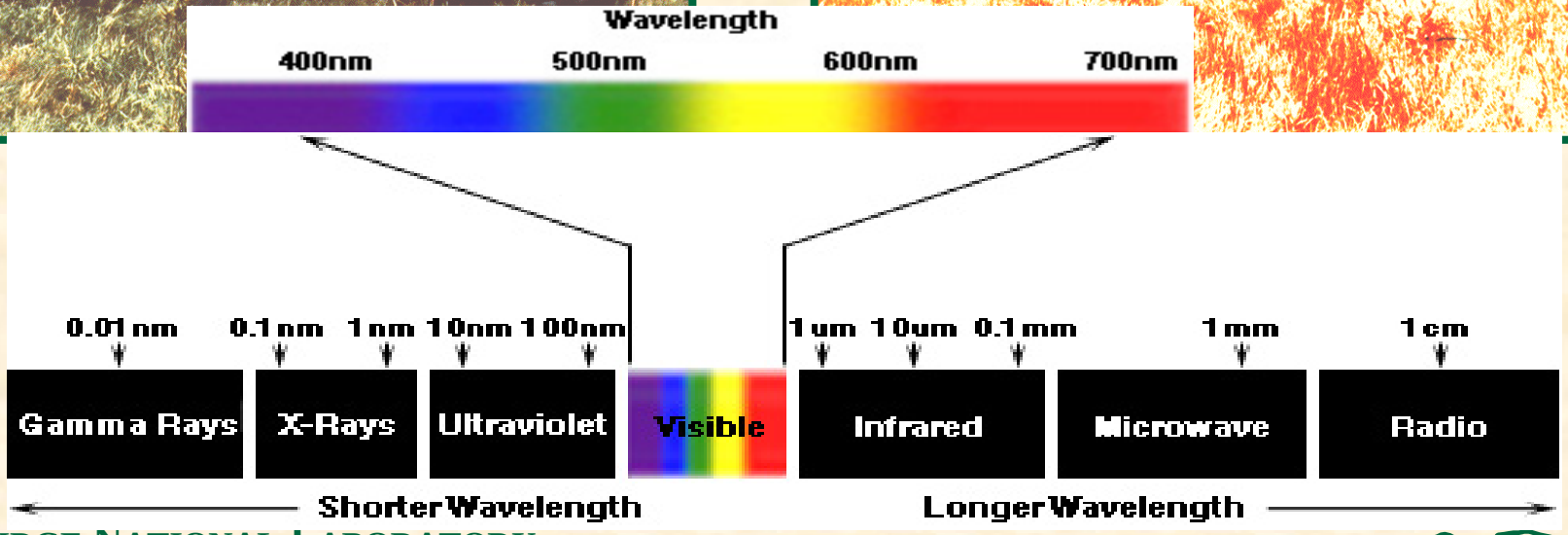
Camouflage Invisible to Night Vision

Conventional Film

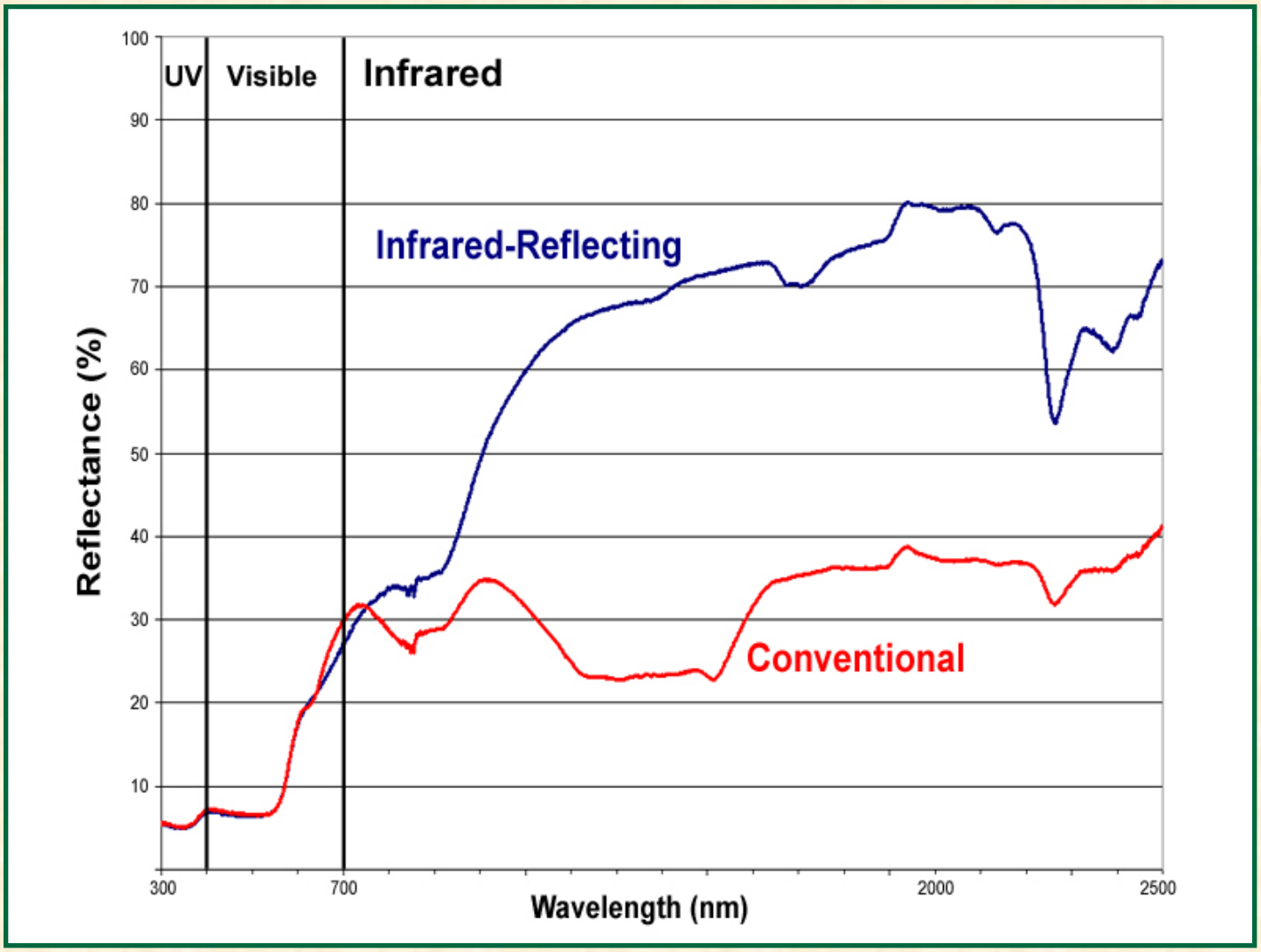


Near Infrared Film





Conventional vs. Infrared Pigments



Overview: Scope of Work

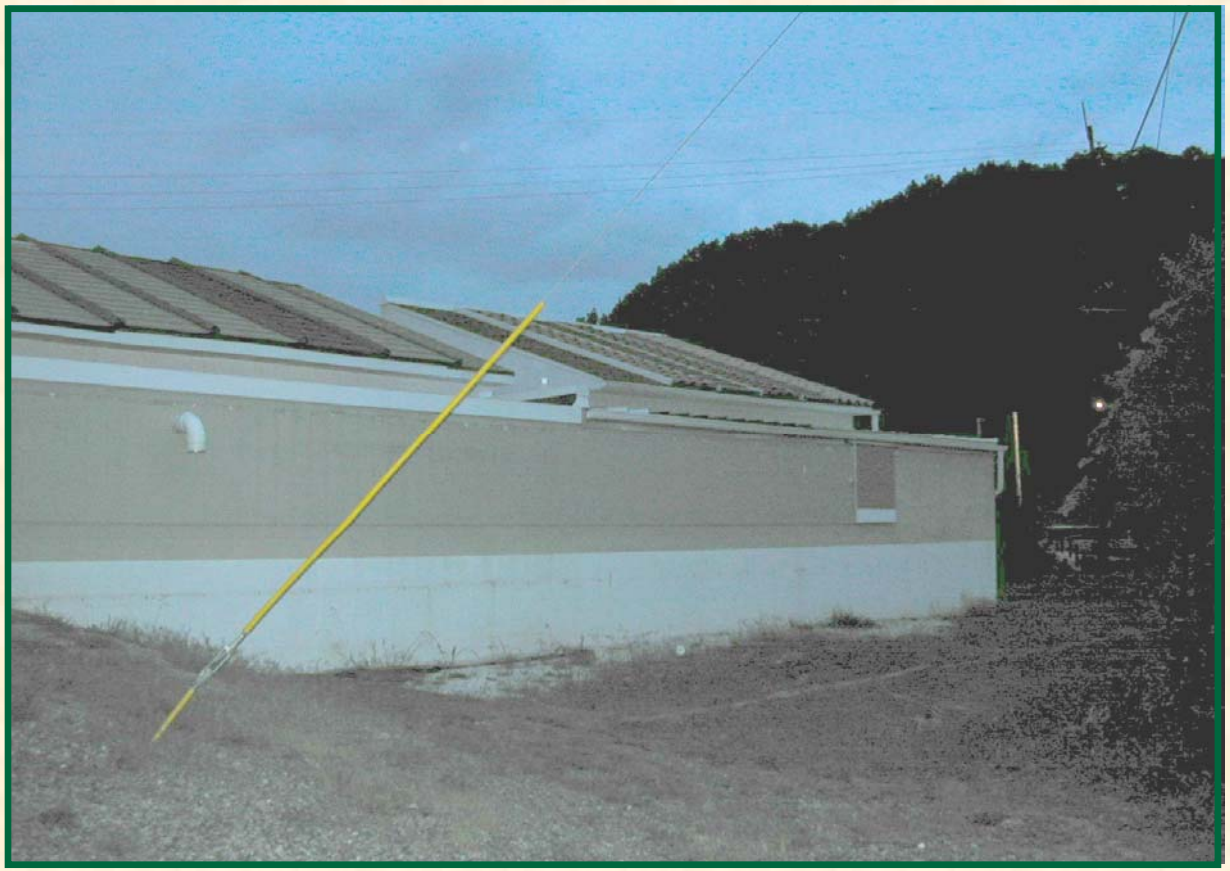
- **Compare thermal performance of walls with cool (high infrared reflectance) and standard colors**

Overview: Scope of Work

- **Phoenix site: Stucco-coated with various constructions facing east, south, southeast and southwest already covered with gray color. Install instrumentation and recoat test areas.**
- **Jacksonville site: Wood siding facing south already covered with aqua color. Install instrumentation and recoat test areas.**
- **Oak Ridge site: Bare stucco-coated test area facing south. Add instrumentation; prime and coat test areas.**

Oak Ridge Site

- **Stucco test section on south wall of Envelope Systems Research Apparatus (ESRA)**



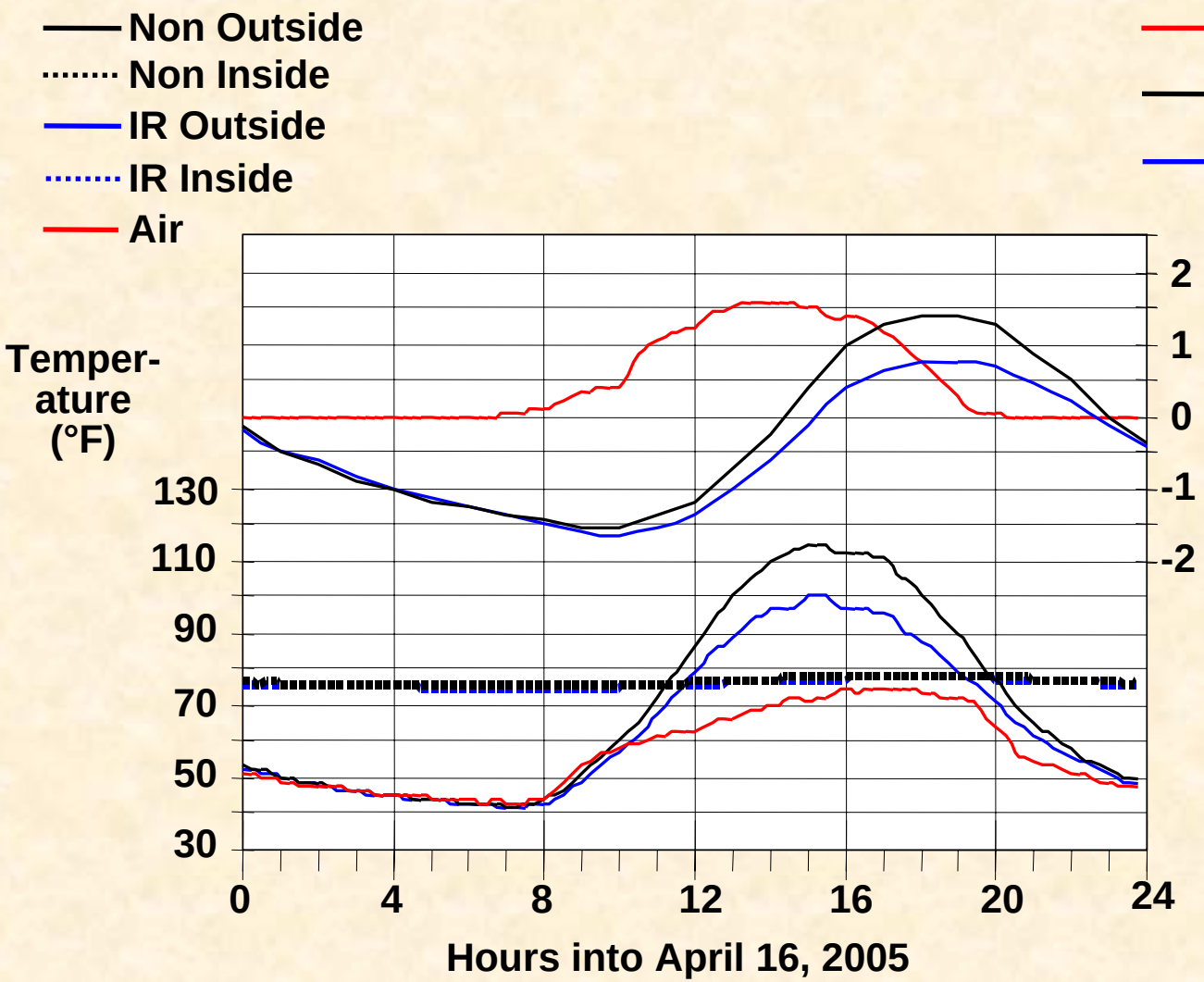
Oak Ridge Site

- **Cool color on right stud space and upper half of middle; Non-IR on rest except for strip of uncoated primer at bottom**

ORNL Site

- **Data starting 7/30/04 with coating on 8/3/04. Data acquisition through August 2005**
- **Check consistency of data with program to estimate wall properties from temperature and heat flux measurements (PROPOR). Data very consistent from month to month**
- **Behavior of solar radiation control on vertical walls more complicated than low-slope roofs. Difficult to generalize simply**

ORNL Site: Non vs IR -- Spring Day



- Heat fluxes delayed four hours relative to outside temp
- Peak temps consistent with coatings over primer
- Non and IR behave identically at night

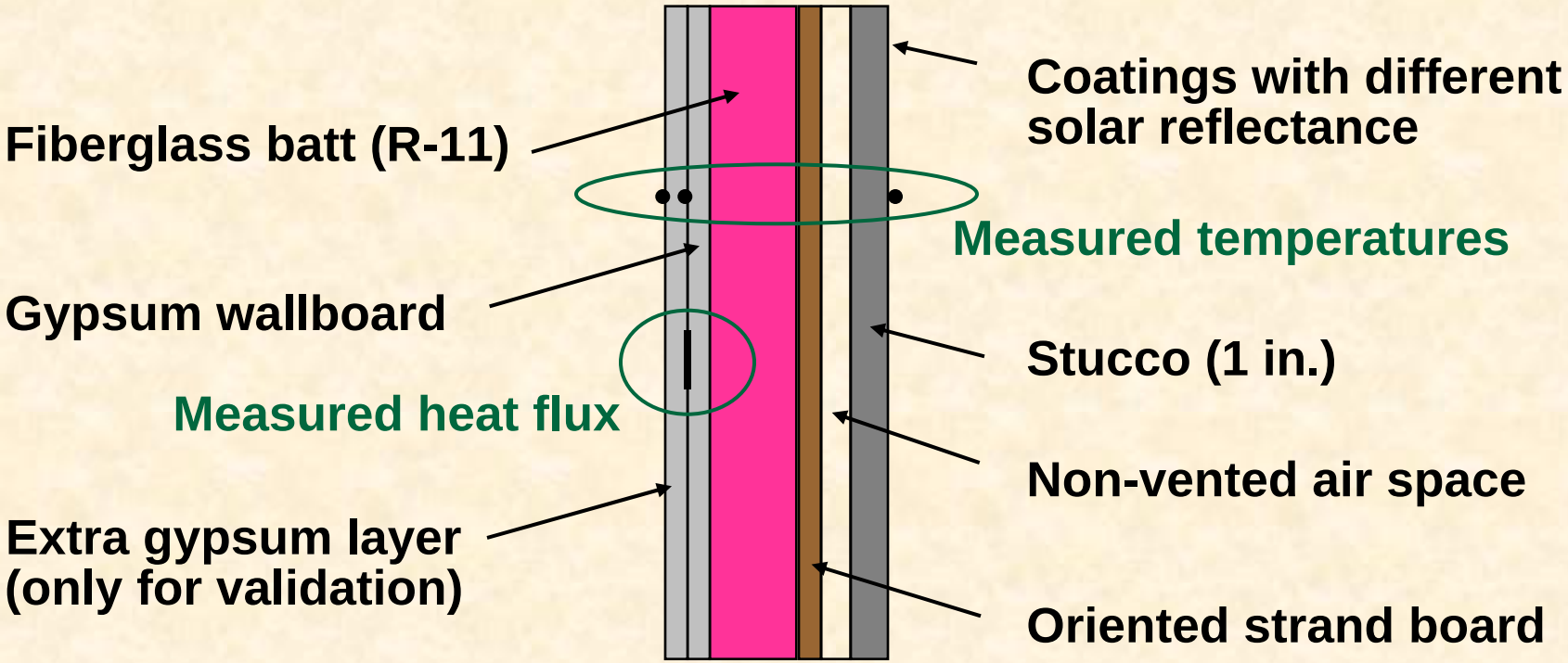
Model for Wall Behavior

- **Seek a model that can be generalized to give results for whole buildings**
- **Have done extensive validation of a model in DOE 2.2 for a 1100 ft² ranch house**

- **Heat/cool with heat pump: 68°F winter; 76°F summer; size heat pump for climate**
- **Occupy with 3 people + Building America energy use profiles**

Model for Wall Behavior

- **To validate model, generate climatic data from ORNL weather station records for year of test**
- **Use properties of wall materials along with construction details for test section**



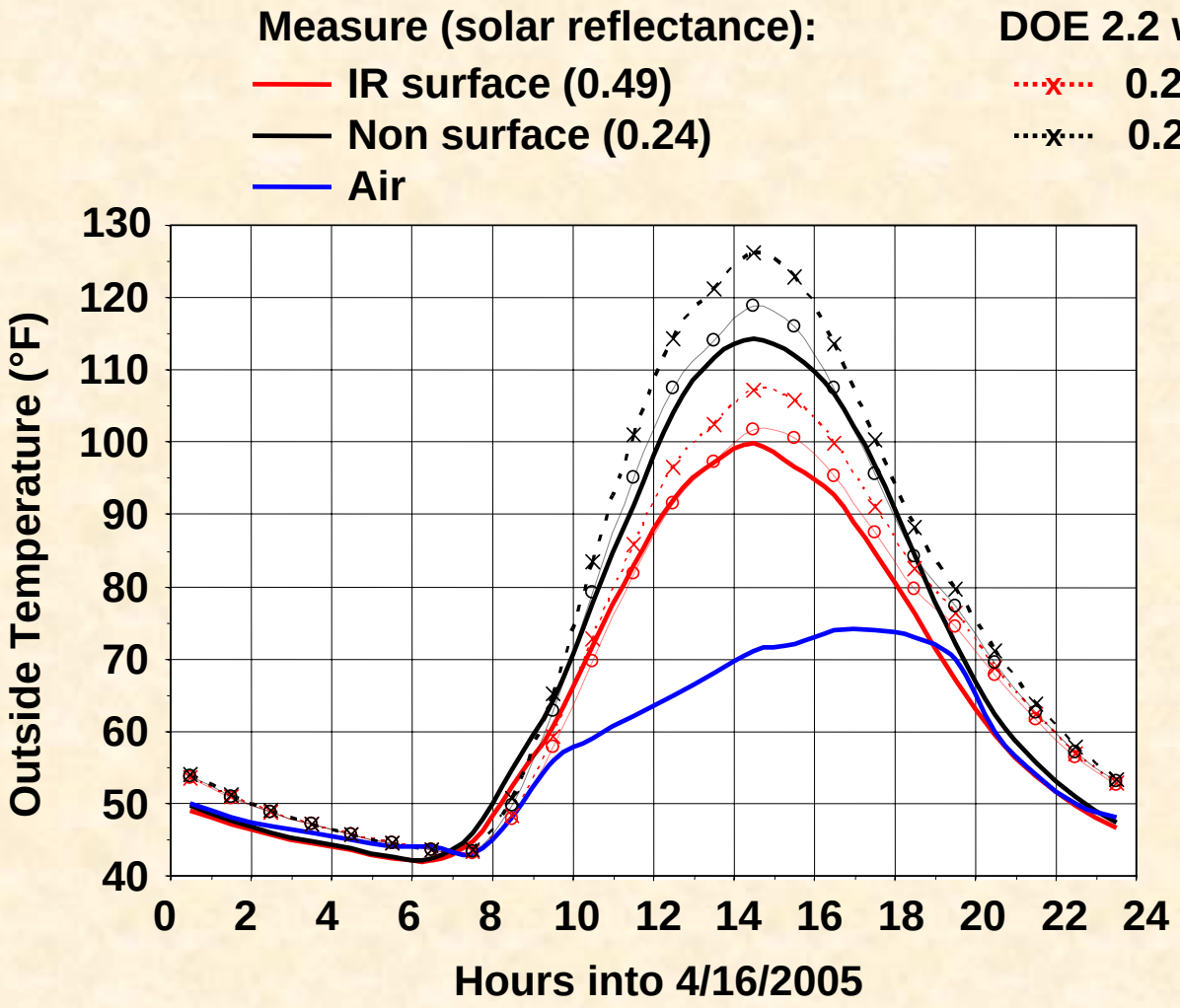
Solar Reflectance of Coatings

- **Test Site** **8/4/04** **9/27/04** **5/18/05** **8/3/05**

Primer	**0.71**	**0.67**	**0.72**	**0.66**
IR	**0.49**	**0.50**	**0.49**	**0.49**
Non IR	**0.24**	**0.24**	**0.24**	**0.24**

Use averages

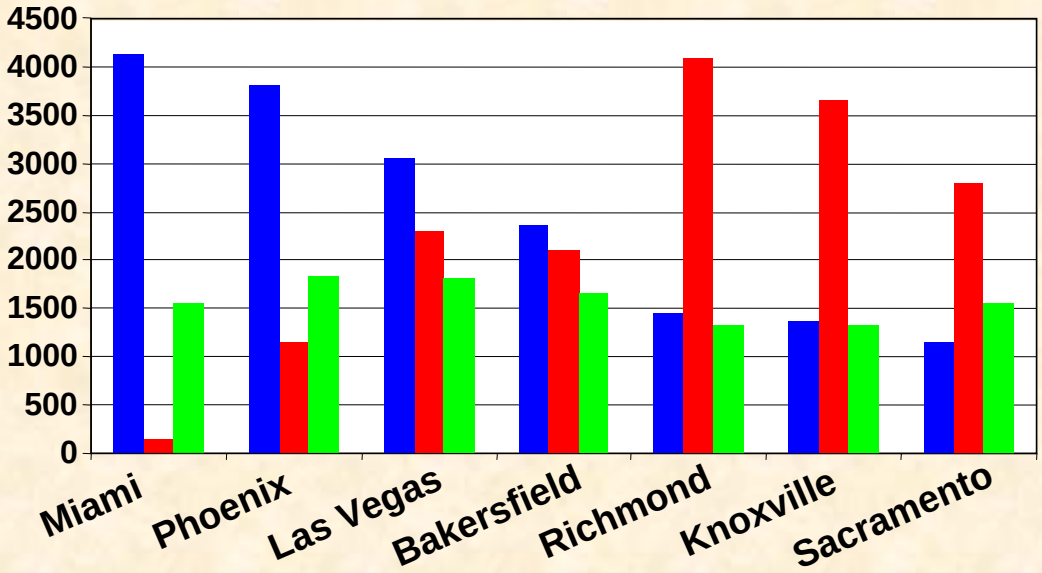
Model of South Wall vs Measurement:
Temperatures at Outside – Spring Day



- Surface measurements and DOE 2.2 predictions equal air temperature at night
- DOE 2.2 peak predictions above peak measurements
- Ground reflectance of 8% (dark soil, asphalt) better than 24% (dry grass) for spring day

Model Generalizations

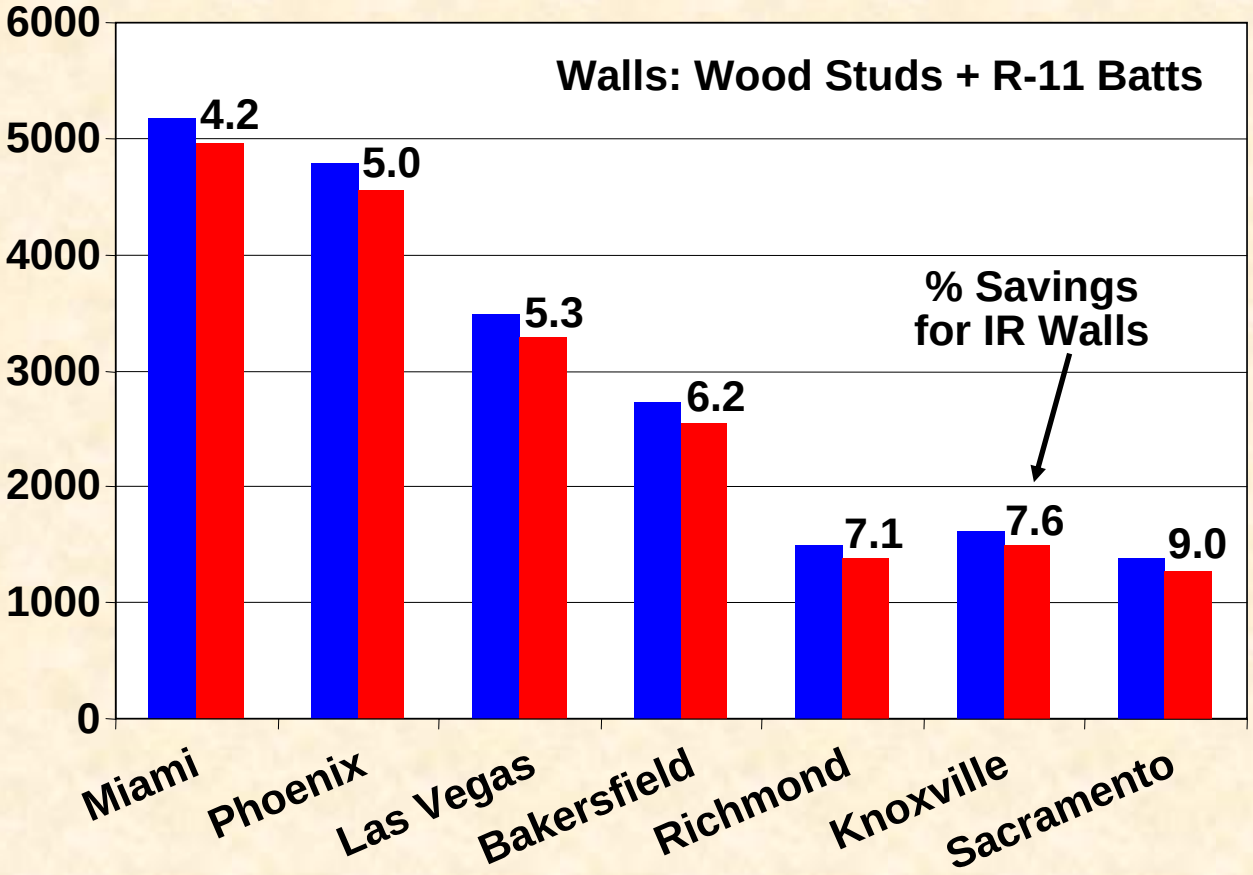
- **Building America Performance Analysis Resources at http://www.eere.energy.gov/buildings/building_america/pa_resources.html gives energy use profiles for three occupants (3 BR home). Choose to heat and cool with air-to-air heat pump (76°F cooling; 68°F heating; no setup or setback)**
- **Choose seven different climates to show response of typical house to cooling and mixed climates of interest**



- **Cities arranged by decreasing cooling degree days**

Model Generalizations

- **IR reflective coating on conventional walls saves cooling energy. Savings are 4% to 9% compared to non-IR reflecting walls**



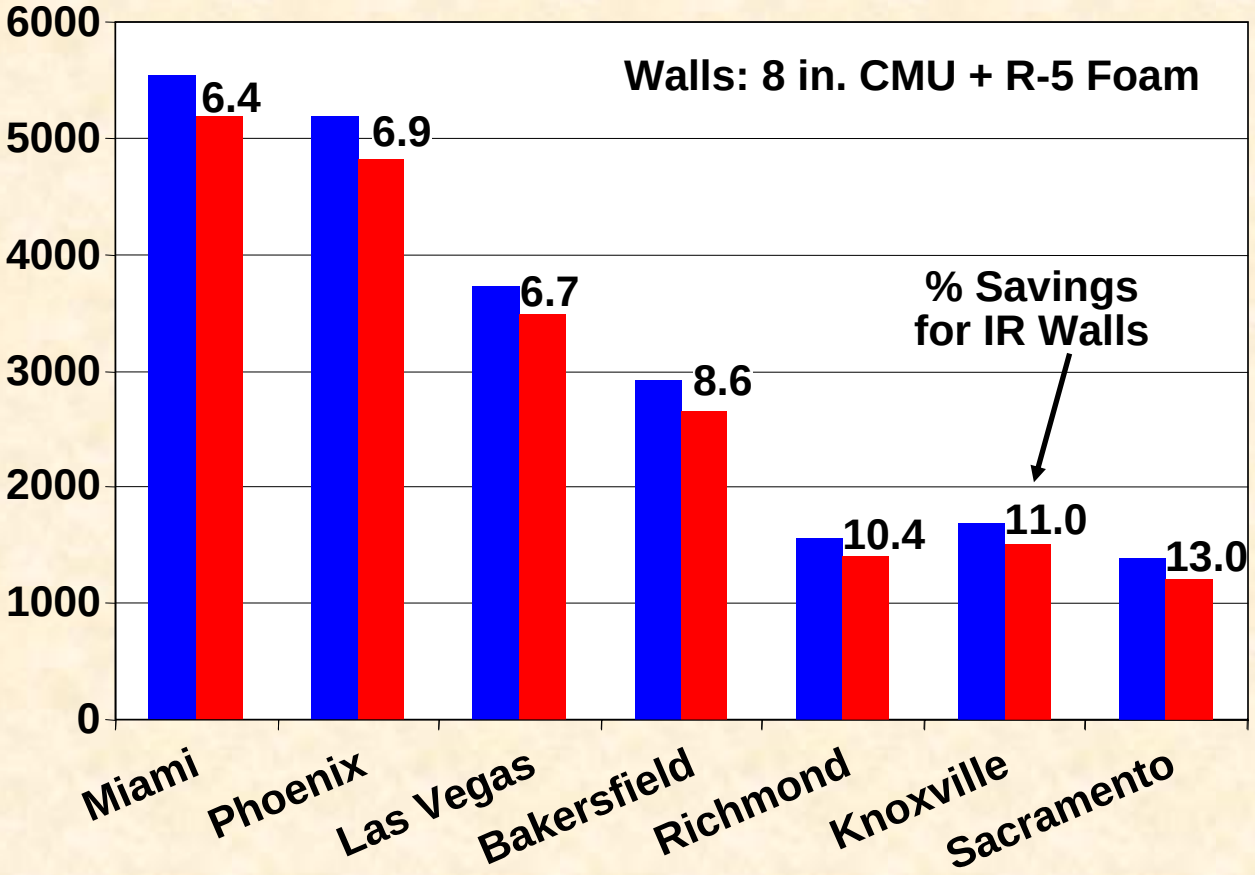
Annual Electricity for Cooling (kWh)

- Non Walls
- IR Walls

- **Absolute savings vary from +240 (Phoenix) to +110 (Richmond)**

Model Generalizations

- **IR reflective coating on CMU walls shows larger savings of cooling energy. Savings are 6% to 13% compared to cooling energy with non-IR reflecting walls**



- **Absolute savings vary from +360 (Phoenix) to +160 (Richmond)**

Project Summary

- **Full year of field data validated DOE 2.2 model**
- **Complexity of real wall applications (different orientations, shading and construction) makes generalization very difficult**
- **DOE 2.2 whole building annual energy estimates for ranch house show that IR reflecting pigments save 4% to 13% of cooling energy**

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Questions or comments?

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