

# Providing Occupant Comfort



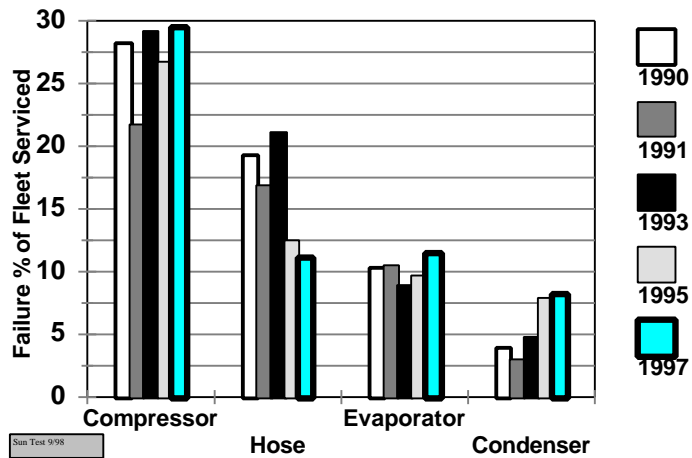
## Vehicle Design Considerations For Air Conditioning Systems

6/2/99

1

# System Failures

Mobile Air Conditioning Society  
Field Service Study Type of Failure



6/2/99

2

## Effects on A/C System Performance

- **Body Leakage**
  - SAE Specification J 638 Not to exceed 165 Ls at 250 Pa (350 CFM at 1" H<sub>2</sub>O)
    - Entry of Unconditioned Air
- **Mode of Operation**
  - 100 % Outside Air
  - 100 % Recirculated Air
  - Portion of OSA and Recirculated Air

6/2/99

3

## Design Considerations

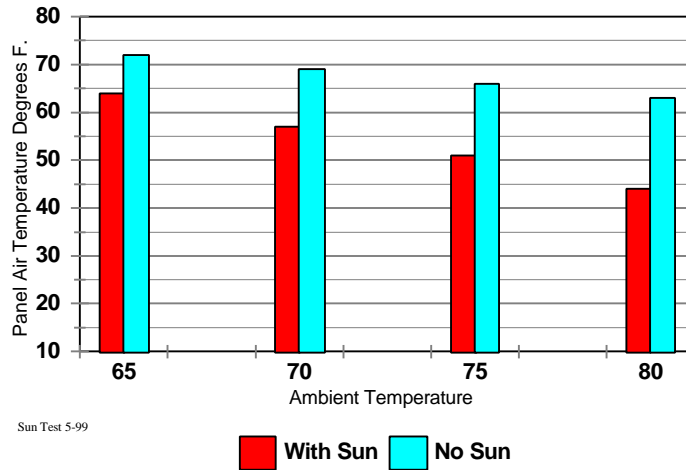
- Extensive Use of 100% Recirculated Air
  - **Odor Problems**
  - **Allows Outside Air Entry** (Body leakage)
    - Reduced System Performance
    - Dust entry
    - Controlled Body Exit Vents
  - **Evaporator & Duct Sweating**  
(water collecting)
  - **Window Fog or Ice Conditions**  
(heater mode)

6/2/99

4

## Vehicle Cooling Requirements

Panel Outlet Air Temperature @ 170 CFM  
To Maintain 75 Degree F. Breath



6/2/99

5

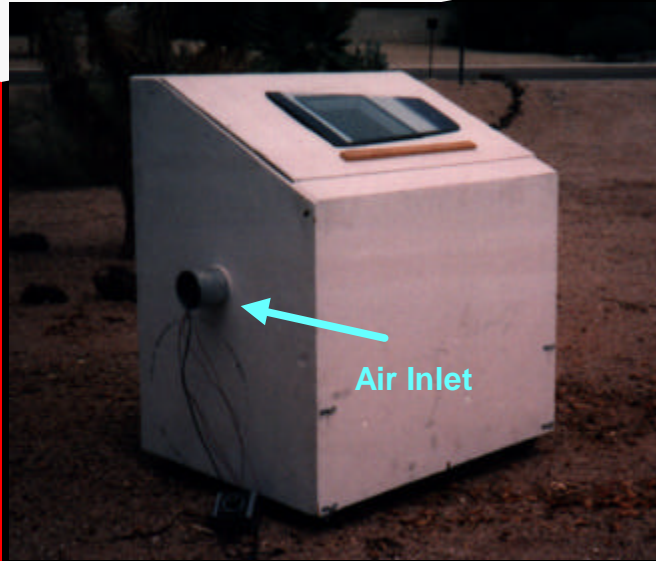
## Interior Soak Temperatures

- **Temperatures are result of:**
  - Vehicle Exterior and Interior Surface Color
  - Tinted vs Clear Glass
- **Breath Level** 40° F. - 60° F. Above Ambient
- **Surface** (In Sun) 50° F - 100° F Above Ambient

6/2/99

6

## Glass Test Box



6/2/99

7

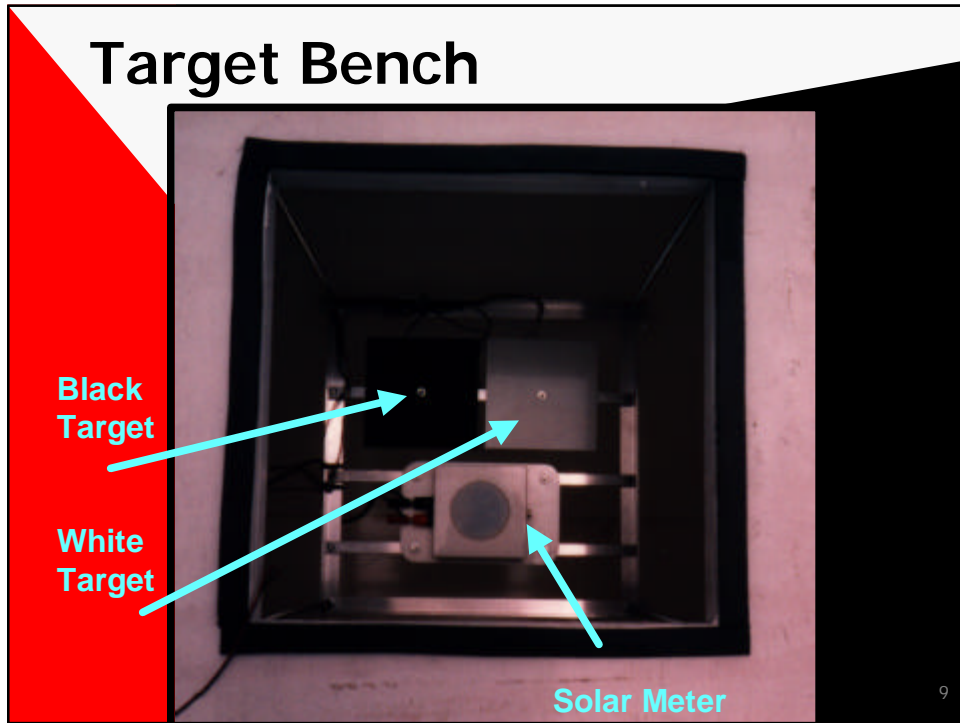
## Glass Test Box Fan



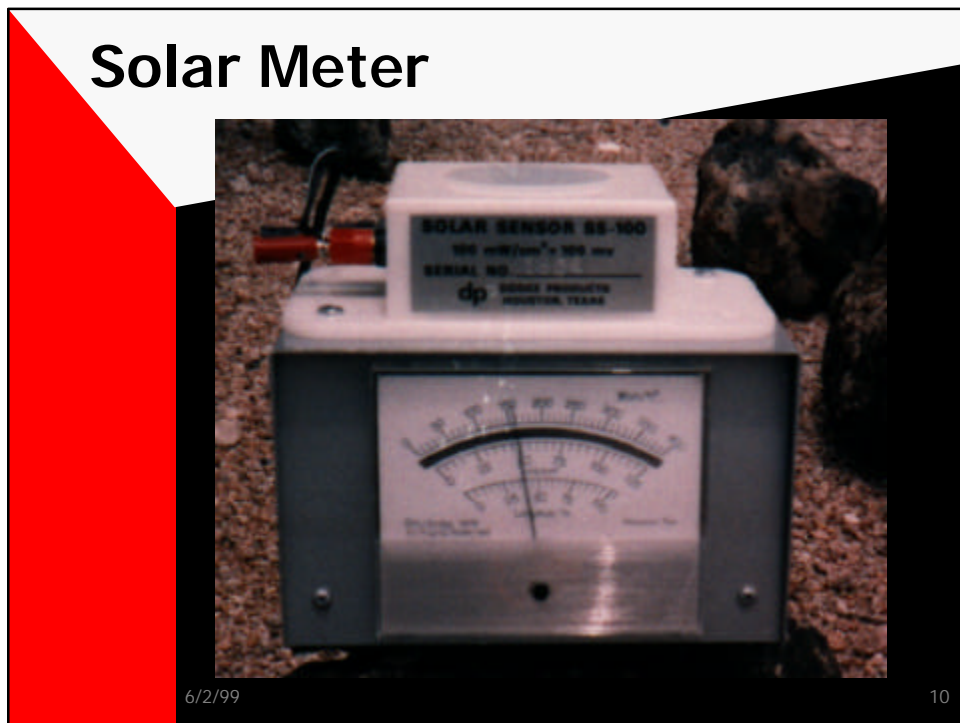
6/2/99

8

## Target Bench



## Solar Meter



# Glass Study

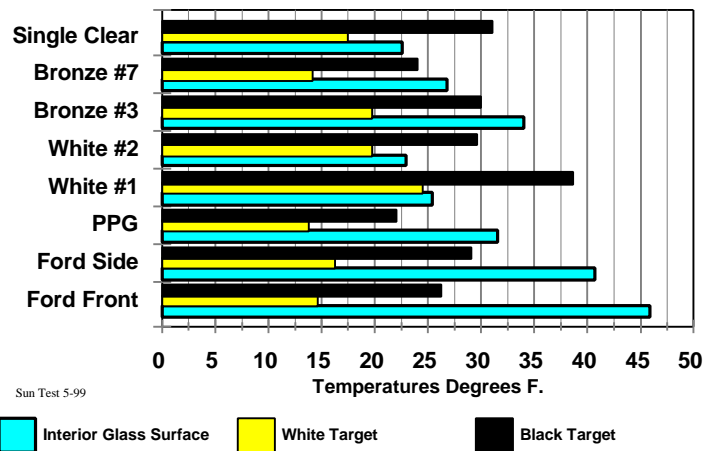
- Soak (No Air Flow)
- Air Flow Over Target Area
- Data
  - Black Target Temperature
  - White Target Temperature
  - Inside Glass Surface Temperature
  - Solar Radiation

6/2/99

11

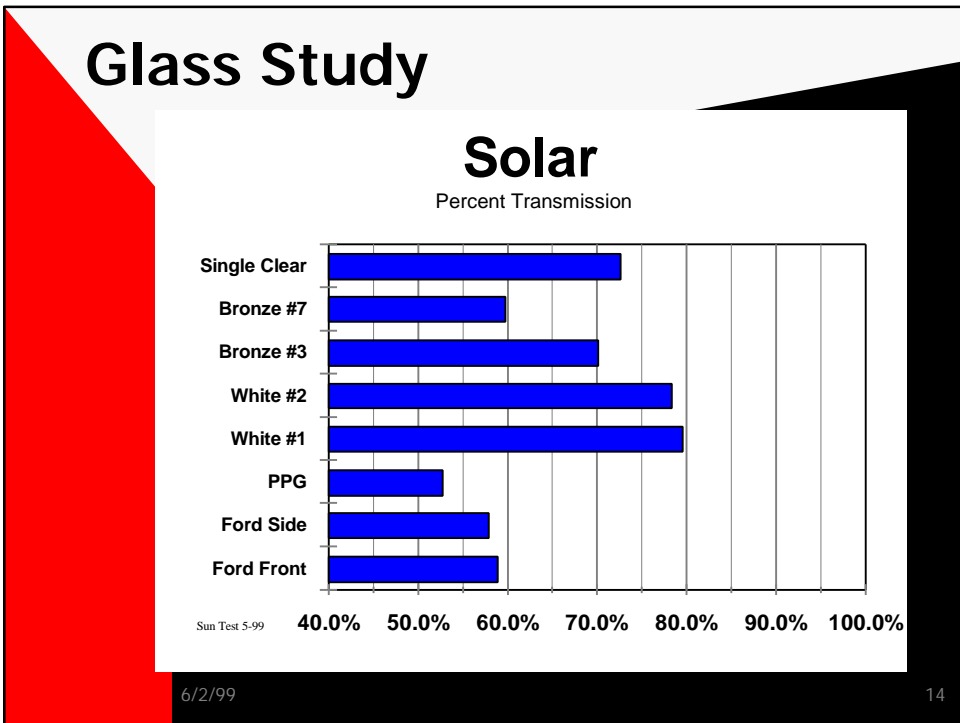
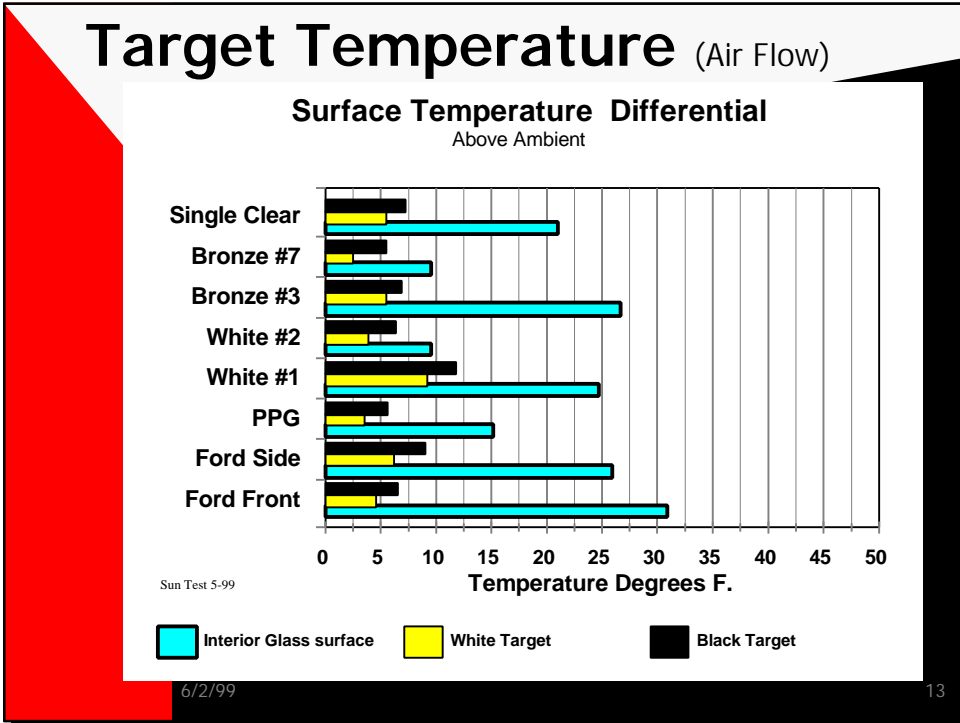
# Target Temperature (No Air Flow)

Soak Surface Temperature Differential Above Ambient



6/2/99

12



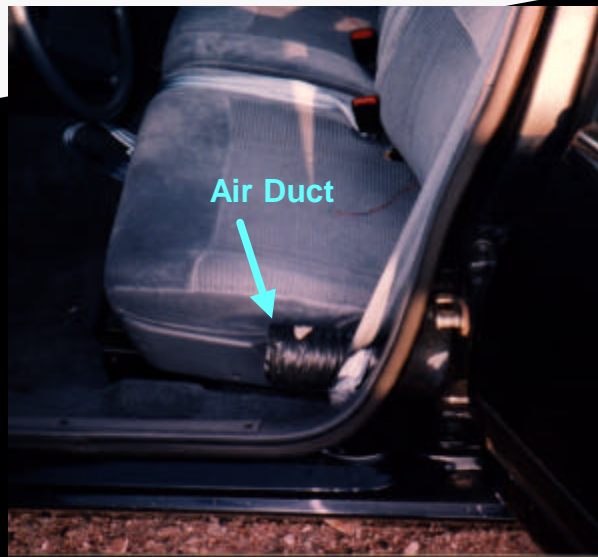
# Ventilation

- **Methods**
  - Force Air Into Vehicle
  - Remove Air From Vehicle
- **Locations**
  - Floor Area
  - Rear Package Shelf
  - Defroster
  - Panel Outlets

6/2/99

15

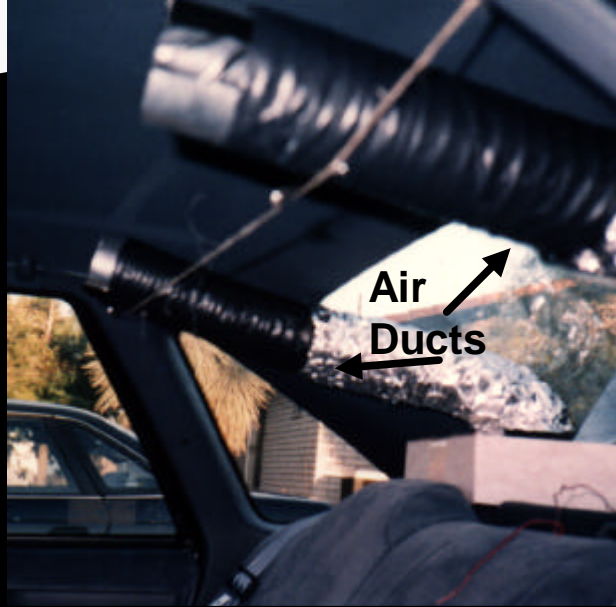
# Floor Air Duct



6/2/99

16

## Rear Package Shelf Air Duct



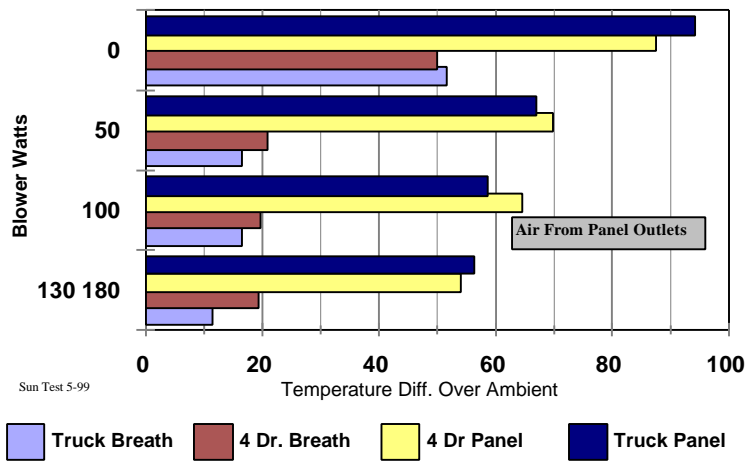
6/2/99

17

## Ventilation

### Vehicle Soak Ventilation Study

White/tint glass Ambient 85 -90 F



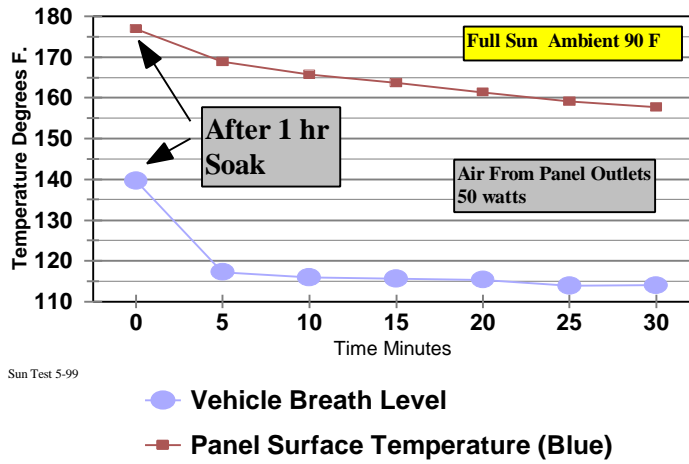
Sun Test 5-99

6/2/99

18

# Ventilation

## Parked Ventilation Study White/Tinted Windows -- 4 dr Sedan

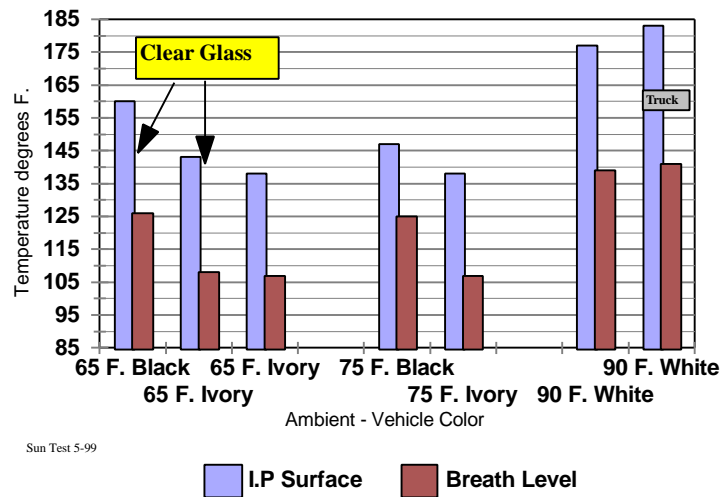


6/2/99

19

# Ambient Effect

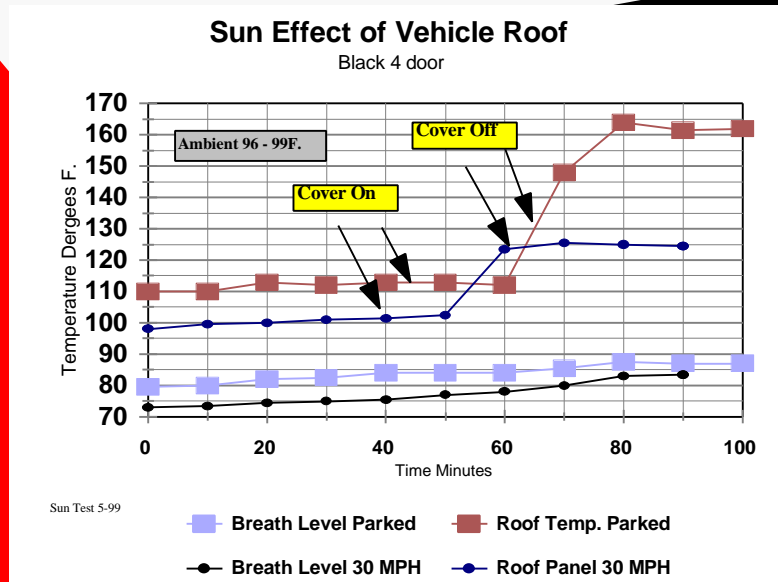
## Soak Condition Different Ambients



6/2/99

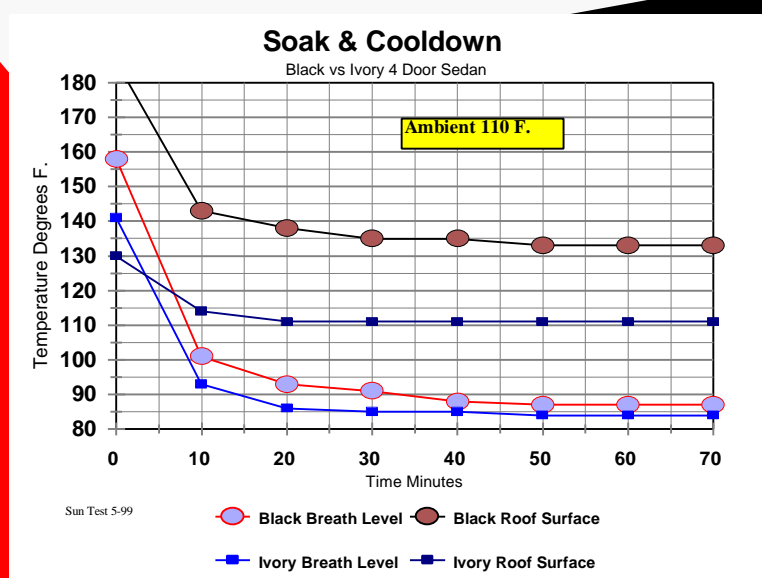
20

# Solar Effect On Vehicle



21

# Effect of Vehicle Color

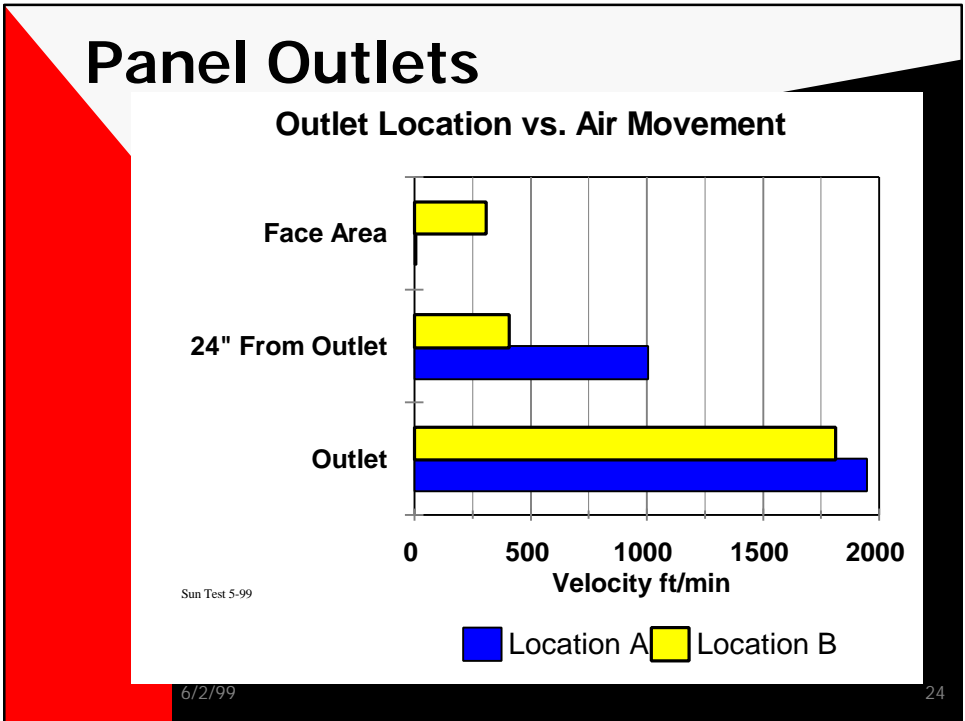


22

# Panel Outlets

- **Outlet**
  - Velocity 2000 FPM
  - Supply at least 90% system air flow to outlets
- **Location**
  - **Provide User Ability To Adjust**
    - Full Air (No vane closure - reduced air flow)
    - No Uncontrolled leakage (Adjusted off occupant)
  - **Air Temperature Affected By Hot Panel Surface**

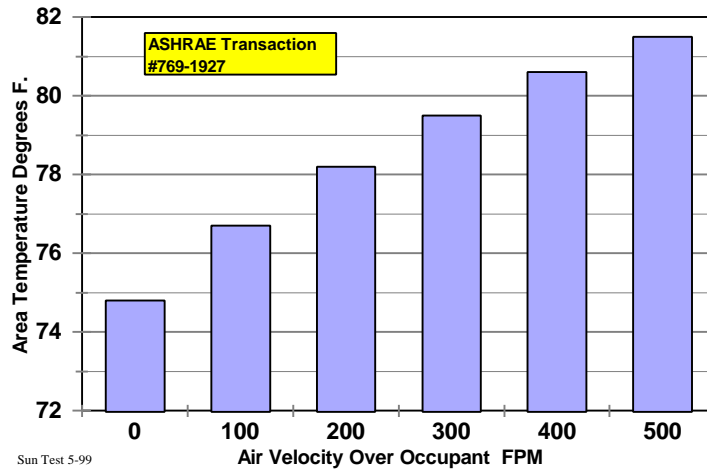
6/2/99 23



# Panel Outlets

71 Degree F. Effective Temperature

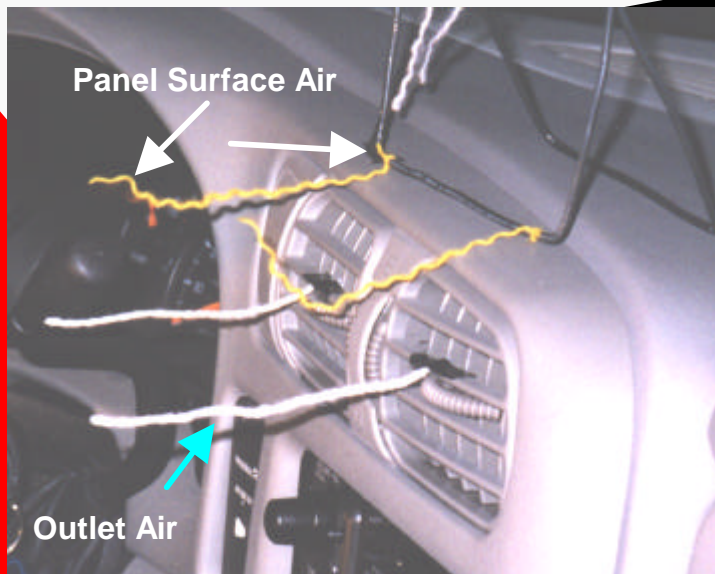
98% People Comfort (no sun)



6/2/99

25

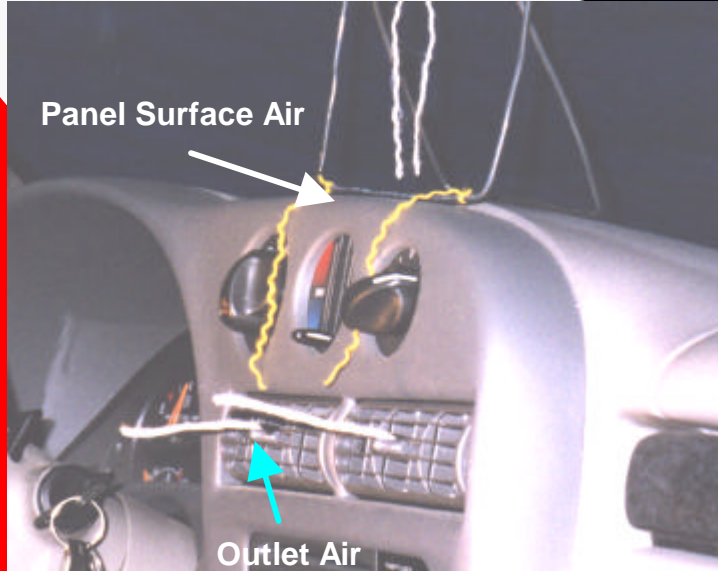
# Truck Center Outlets



6/2/99

26

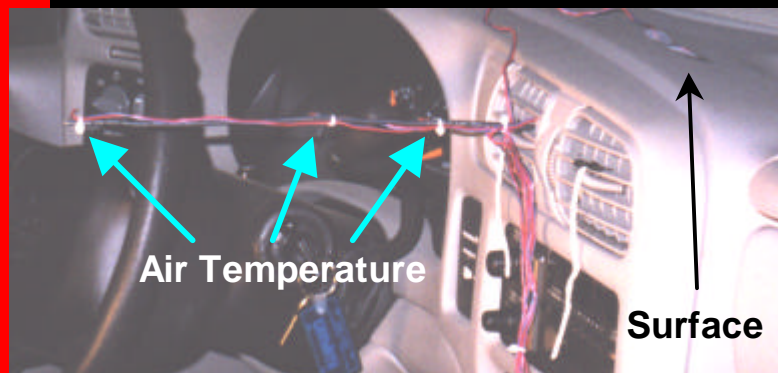
## Passenger Center Outlets



6/2/99

27

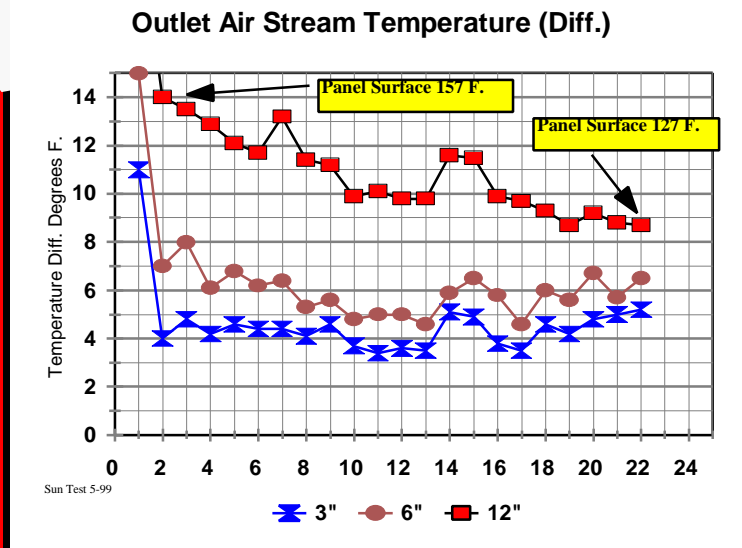
## Temperature Probe



6/2/99

28

## Panel Outlets



6/2/99

29

## Summary A/C Design Considerations

- **Vehicle Solar Heat Load**
  - **Vehicle Glazing**
    - Window location and total area
    - Clear vs. Tinted Glass
      - Unknown factors - glass temperature effect on colors
  - **Vehicle Colors**
    - Exterior Body Color
    - Instrument Panel Color and Area
    - Color and Area of Surface In Direct Sun

6/2/99

30

## Summary A/C Design Considerations

- **Panel Outlets**
  - Location
    - Provide Controllable Air Flow
    - Not Affected By Hot Surfaces
  - Provide Velocity For ET Occupant Cooling
- **Control Function**
  - Limit The Use Of 100% Recirculated Air
- **Body Leakage**
  - Reduce Body Leakage -- Body Exit Vents

6/2/99

31