CoolCab Truck Thermal Load Reduction

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DOE Vehicle Technologies Program
Advanced Vehicle Testing Activity
CoolCab Project

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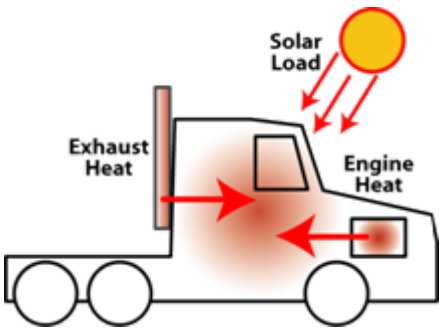
THE CHALLENGE

Trucks idle for driver comfort. Idling consumes more than $2 billion in fuel per year for long-haul trucks.

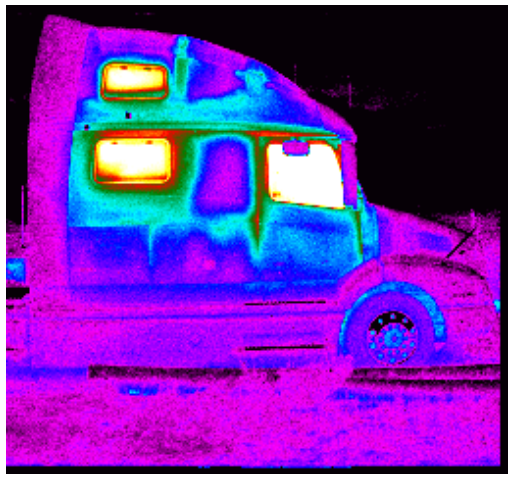


Varying thermal conditions inhibit the use of idle reduction technologies.

THE SOLUTION

Design efficient thermal management systems that keep the cab comfortable without the need for engine idling.

Solar Reflective Glazings

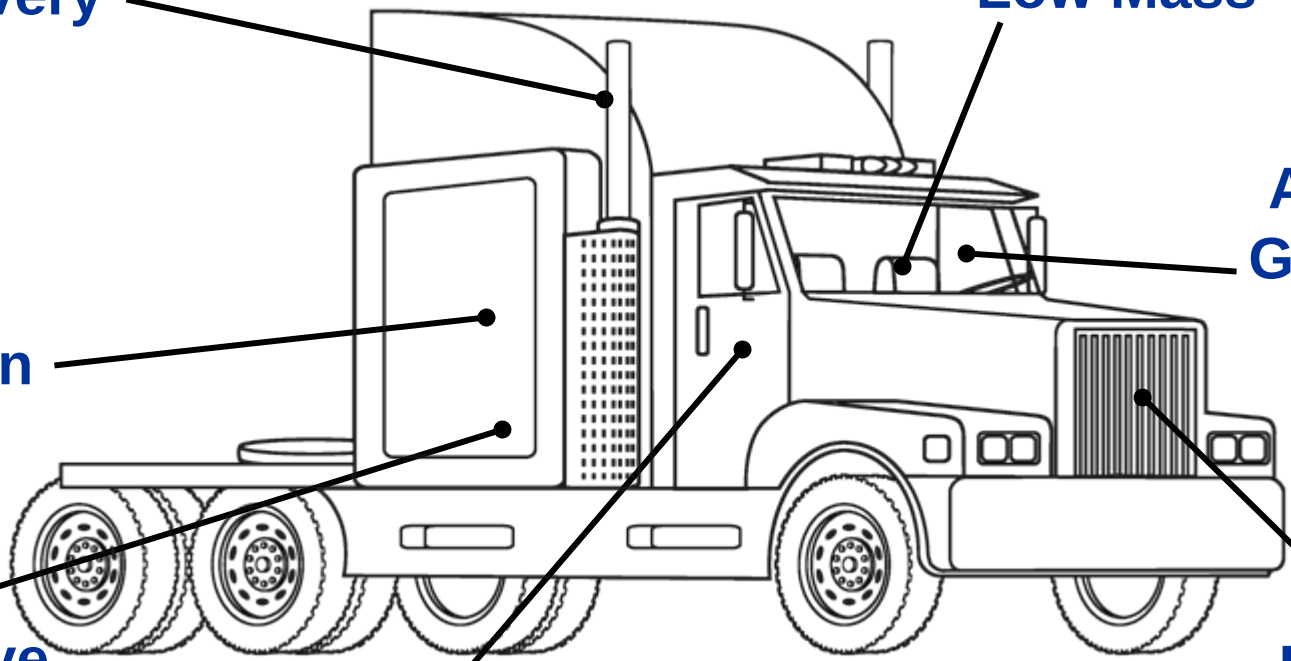


Thermal Comfort Evaluation

NREL infrared testing identified potential to reduce heating and cooling loads with improved insulation.

- 1500W for typical heating – 20% improvement over baseline
- Reducing the load will enable idle reduction technologies
- 838 million gallon savings potential with no idling

CoolCab – Advanced Technologies

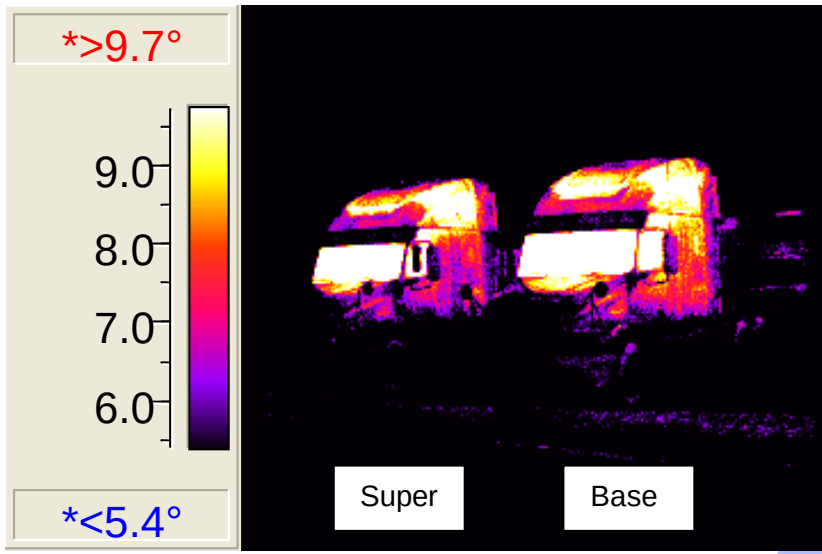


Accomplishments

Project	Dates
Light-Duty Vehicle A/C Systems	1998-2007
Idle Reduction Technology Validations	2003-2006
Infrared Image Testing – Schneider National	2005
Truck Cabin Test – Volvo	2006
Truck Cabin Test – International	2007

Infrared Image Test – Schneider National

- **Investigate potential for improving cab efficiency**
- **Qualitative comparison**
  - **Identify high heat loss areas**
  - **Note areas with greatest potential for improvement**

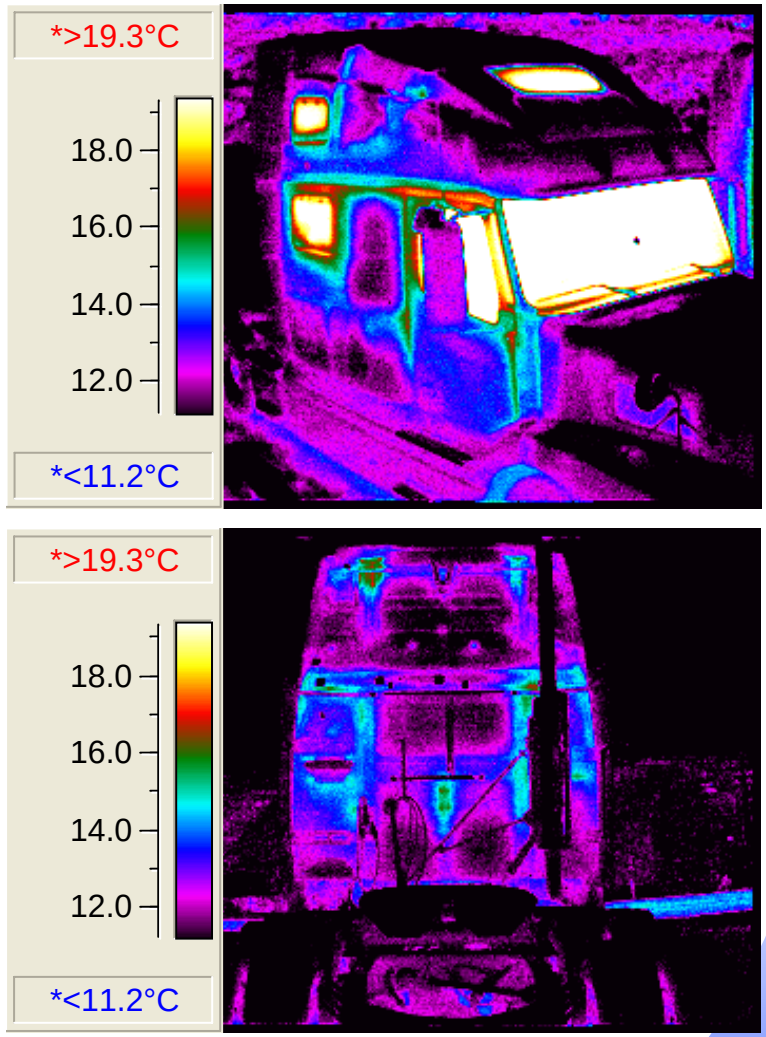


CoolCab Testing with Volvo

- **Volvo truck at NREL for testing**
  - **77-inch sleeper cab**
  - **On-board idle reduction technologies**
    - **Bergstrom battery electric A/C**
    - **Airtronic diesel-fired heater**
- **Objectives**
  - **Quantify truck cabin heat transfer**
  - **Identify potential areas for improvement**
- **Approach**
  - **Co-heat tests to determine UA**
    - **Measure effect of sleeper curtain and window shades**
    - **Insulate windows to quantify loss**
  - **Measure air exchange rate**
  - **Solar soak tests**
    - **Soak with windows insulated**
  - **Infrared imaging**

Volvo Test Results

- **Heat transfer**
  - **UA = overall heat transfer Coefficient = 65 W/K**
  - **15% reduction (improvement) with sleeper curtain closed**
  - **20% reduction with windows covered**
- **Solar heat soak**
  - **ΔT = temperature rise above Ambient = 15ºC**
  - **ΔT = 5ºC with windows covered**
- **Air leakage rate**
  - **~1 air change per hour**

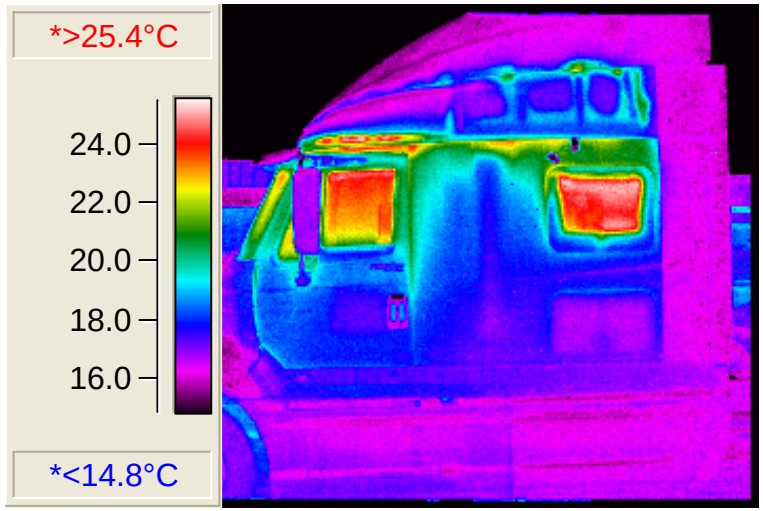


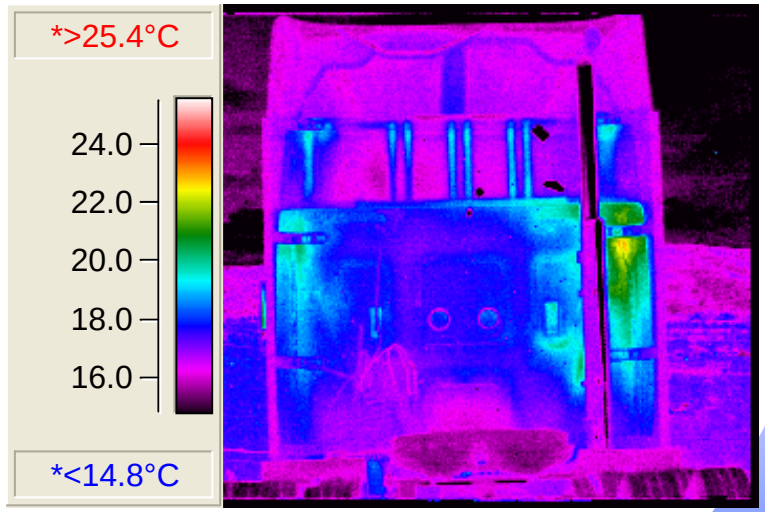
CoolCab Testing with International

- **International truck at NREL**
  - **ProStar sleeper cab tractor**
  - **Electric HVAC system with battery APU**
- **Objectives**
  - **Quantify truck cabin heat transfer**
  - **Predict HVAC system load requirements**
- **Began spring 2007**

International Test Results

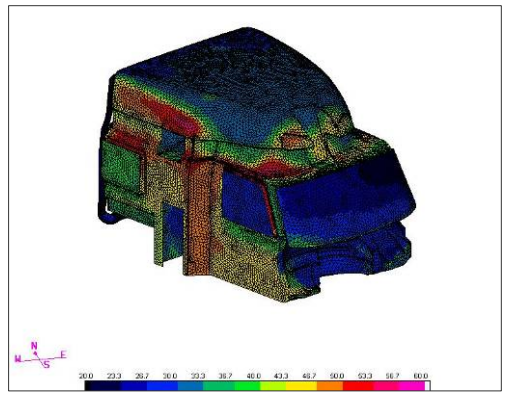
- **Heat transfer**
  - **UA = overall heat transfer Coefficient = 50 W/K**
  - **20% reduction (improvement) with sleeper curtain closed**
  - **25% reduction with arctic curtain**
  - **13% reduction with windows covered**
- **Solar heat soak**
  - **∆T = temperature rise above Ambient = 11ºC**
  - **∆T = 7ºC with windows covered**
- **Air leakage rate**
  - **~0.5 air change per hour**

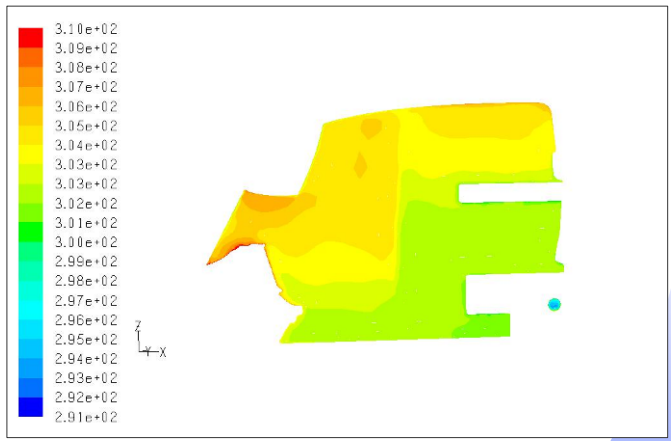




FY08 Work Plan – Thermal Modeling

- **Previously developed model for International**
  - **Fluent CFD**
  - **Radtherm**
- **Validate with test data**
  - **Solar soak air temperatures predicted within 3ºC**
  - **Apply multiple configurations**
- **Parametric runs – impact of enhanced thermal technologies**
  - **Baseline A/C case**
  - **Increased cab insulation**
  - **Solar reflective glass**



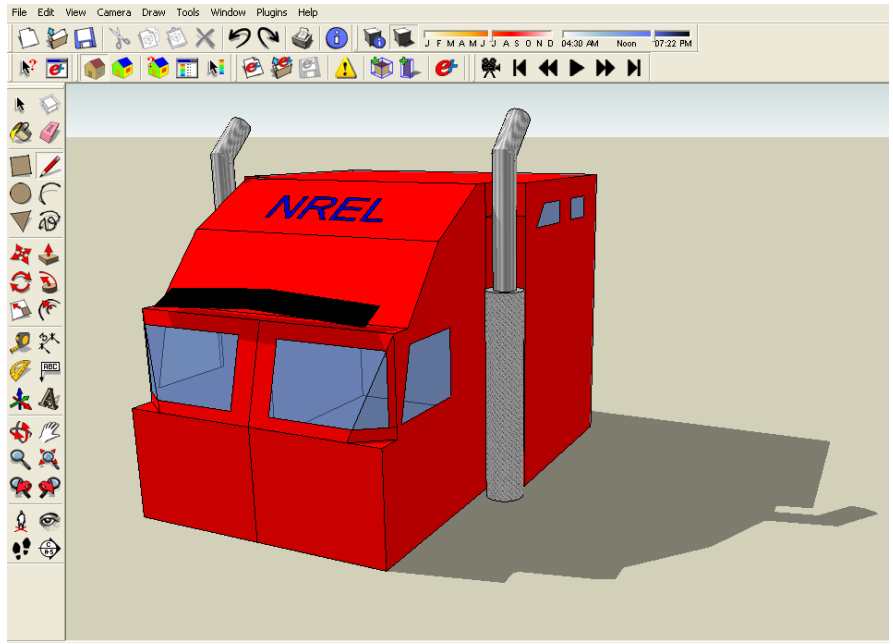


Class 8 CFD Analysis

	No Curtain	No Curtain 2X Insulation	No Curtain Shades	Curtain	Curtain 2X Insulation	Curtain Shades
Sleeper T (°F)	**73.1**	**73.1**		**73.9**	**74**	**73.9**
Sleeper BTU	**5548**	**3572**		**3161**	**2417**	**2712**
A/C inlet temp	**55.4**	**61.7**		**62.6**	**65.3**	**64.4**
A/C exit temp	**74**	**73.7**		**73.2**	**73.4**	**73.5**
Cab Temp (°F)	**74.2**	**74.3**		**119**	**134**	**115**
Delta Q (BTU)		**1976**			**744**	**449**
Delta Q %		**36.5 %**			**23.5 %**	**14.2 %**

FY08 – HVAC Load Calculation Tool

- **Input key parameters**
  - **Truck cab geometry**
  - **Material properties**
  - **Climatic conditions**
- **Outputs**
  - **Calculate heating and cooling loads**
  - **Estimate potential load reduction**



- **Working with industry to define requirements**
  - **Truck OEMs**
  - **Idle reduction technology manufacturers**
  - **21st Century Truck**

Contact Information

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www.nrel.gov/vehiclesandfuels/fleettest