

# NASA Langley's Aerothermodynamic Capabilities for Entry, Descent, and Landing

Aerospace Engineering · Answer Key · 30 Questions

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**1. What is the primary focus of the review presented in this document?**

- A) Hypersonic flight research
- B) Mid to low lift-to-drag ratio vehicle geometries for EDL**
- C) Winged craft development
- D) Propulsion demonstrations

**2. Which of the following is NOT listed as a critical area within the aerothermodynamic environment for EDL missions?**

- A) Aerodynamics
- B) Thermodynamics
- C) Structural Integrity**
- D) Heat-transfer

**3. According to the text, which method is often prohibitively expensive for defining EDL aerothermodynamic environments?**

- A) Ground-test experimentation
- B) Computational Fluid Dynamics (CFD) simulations
- C) Flight-testing**
- D) Wind tunnel testing

**4. What is a primary role of wind tunnel testing in recent years, in addition to its customary role?**

- A) Replacing CFD simulations entirely
- B) Providing high-fidelity data for computational model development and validation**
- C) Focusing solely on vehicle design
- D) Reducing the need for flight-testing

**5. Which NASA LaRC facility is currently mothballed and non-operational?**

- A) 31-Inch Mach 10 Air Tunnel
- B) 20-Inch Mach 6 Air Tunnel
- C) 15-Inch High-Temperature Mach 6 Air Tunnel
- D) 20-Inch Mach 6 CF4 tunnel**

**6. The 31-Inch Mach 10 Air Tunnel is primarily employed in which types of studies?**

- A) Heat-transfer and boundary-layer transition studies
- B) Instrumentation development and diagnostics
- C) Aerodynamic and fluid-mechanics studies**
- D) CFD model development

**7. Which LaRC wind tunnel is primarily used for heat-transfer and boundary-layer transition studies due to its wide Reynolds number operating range?**

- A) 31-Inch Mach 10 Air Tunnel
- B) 20-Inch Mach 6 Air Tunnel**
- C) 15-Inch High-Temperature Mach 6 Air Tunnel
- D) 20-Inch Mach 6 CF4 tunnel

**8. The 15-Inch Mach 6 High-Temperature Air Tunnel is considered a leg of which larger facility?**

- A) 20-Inch Mach 6 Air Tunnel
- B) Unitary Plan Wind Tunnel
- C) 31-Inch Mach 10 Air Tunnel**
- D) CF4 Tunnel

**9. What is a key characteristic of the 20-Inch Mach 6 CF4 tunnel that allows it to simulate high-temperature, reacting air at lower Mach numbers?**

- A) Lower shock density ratio
- B) Perfect-gas properties
- C) Higher shock density ratio**
- D) Lower operating temperature

**10. The NASA Langley Unitary Plan Wind Tunnel (UPWT) is a closed-circuit, continuous-flow pressure tunnel with how many separate legs?**

- A) One
- B) Two**
- C) Three
- D) Four

**11. Which measurement technique provides global heat-transfer information with an order-of-magnitude more data points than discrete-gage techniques at a fraction of the cost?**

- A) Infrared thermography
- B) Pressure-sensitive paint
- C) Temperature-sensitive paint
- D) Phosphor thermography**

**12. What does Pressure-Sensitive Paint (PSP) measure?**

- A) Surface temperature
- B) Surface pressure**
- C) Heat-transfer rates
- D) Flow-field velocity

**13. Which technique is employed to obtain surface flow-field patterns by observing the movement of oil on a model's surface?**

- A) Schlieren systems
- B) Laser-induced fluorescence
- C) Oil flow visualization**
- D) Pitot probes

**14. What type of measurement technique is generally more expensive and provides less spatial resolution but is often necessary for temporal data?**

- A) Global surface measurement techniques
- B) Discrete surface measurement techniques**
- C) Flow-field diagnostics
- D) Model fabrication methods

**15. Which of the following is NOT a discrete surface temperature and heat-transfer measurement technique mentioned?**

- A) Thin-film resistance heat-transfer gages
- B) Coaxial thermocouples
- C) Infrared thermography**
- D) Thin-skin calorimeter gages

**16. What type of balances are typically used for aerodynamic force and moment measurements?**

- A) Strain-gage balances**
- B) Pressure transducers
- C) Thermocouples
- D) Laser velocimeters

**17. Which technique is available for visualization of flow-field shock structures in all tunnels?**

- A) Laser vapor screening
- B) Schlieren systems**
- C) Planar laser-induced fluorescence (PLIF)
- D) Pitot probes

**18. What is the primary role of the LAURA code at NASA Langley?**

- A) Supersonic flow simulations
- B) Boundary-layer transition prediction
- C) Hypersonic conditions simulations**
- D) Aerodynamic trim-tab design

**19. Which computational solver uses unstructured grids to deal with complex topologies?**

- A) LAURA
- B) FUN3D**
- C) OVERFLOW
- D) LASTRAC

**20. What was a critical design consideration for the Mars Science Laboratory (MSL) entry vehicle due to its size, angle of attack, and entry velocity?**

- A) Laminar flow on the leeside
- B) The possibility of turbulent flow on the leeside**
- C) Low heating rates
- D) Minimal aerodynamic loads

**21. What issue was investigated using global phosphor thermography in the LaRC 20-Inch Mach 6 Air Tunnel for the MSL entry vehicle?**

- A) RCS jet interactions
- B) MMRTG breakup analysis
- C) Heat shield attachment-point cavities**
- D) Turbulent aeroheating

**22. The MSL heat-shield cavity correlations were developed in terms of the ratio of cavity diameter to boundary-layer height versus what other parameter?**

- A) Mach number
- B) Reynolds number
- C) Momentum thickness Reynolds number**
- D) Stagnation temperature

**23. For the MSL turbulent aeroheating studies, which algebraic turbulence model was adopted as the design method?**

- A) Cebeci-Smith
- B) Baldwin-Lomax**
- C) LAURA
- D) FUN3D

**24. Why was aerodynamic force-and-moment testing performed in the LaRC UPWT for the MSL entry vehicle?**

- A) To verify expected hypersonic performance
- B) To verify expected supersonic performance**
- C) To study RCS performance
- D) To analyze MMRTG breakup

**25. What was the general finding regarding the maximum interaction effects of the MSL Reaction Control System (RCS) jets?**

- A) They exceeded 50% of the RCS-generated torques
- B) They were less than 30% of the RCS-generated torques**
- C) They were negligible
- D) They required significant design changes

**26. What is the Orion Multi-Purpose Crew Vehicle (MPCV) being developed as?**

- A) A Mars rover
- B) A lunar lander
- C) A re-entry vehicle for human missions beyond Low Earth Orbit**
- D) A satellite for Earth observation

**27. For the Orion vehicle, a turbulent flow design environment has been specified due to its large size, high-angle of attack, and high entry velocity. What experimental studies were conducted to obtain turbulent aeroheating data?**

- A) Discrete heat-transfer measurements
- B) Global phosphor thermography**
- C) Infrared thermography
- D) Pressure-sensitive paint

**28. What type of material is the Orion heat shield manufactured from?**

- A) Titanium
- B) Aluminum
- C) Avcoat (an ablative material)**
- D) Ceramic

**29. What was the primary purpose of the IRVE-3 mission?**

- A) To demonstrate a Mars lander
- B) To test a hypersonic inflatable aerodynamic decelerator (HIAD)**
- C) To return solar wind particles to Earth
- D) To develop a new propulsion system

**30. What phenomenon was investigated in the LaRC 20-Inch Mach 6 Air Tunnel for the IRVE-3 mission due to the flexible aeroshell's expected deformation?**

- A) RCS jet interactions
- B) Boundary-layer transition and heating**
- C) Wake-flow structure
- D) Aerodynamic trim-tab effectiveness