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Analysis of the Thermal Shielding Properties of Camouflage Materials

John G. Bennett, Erik S. Polsen
U.S. Army TARDEC

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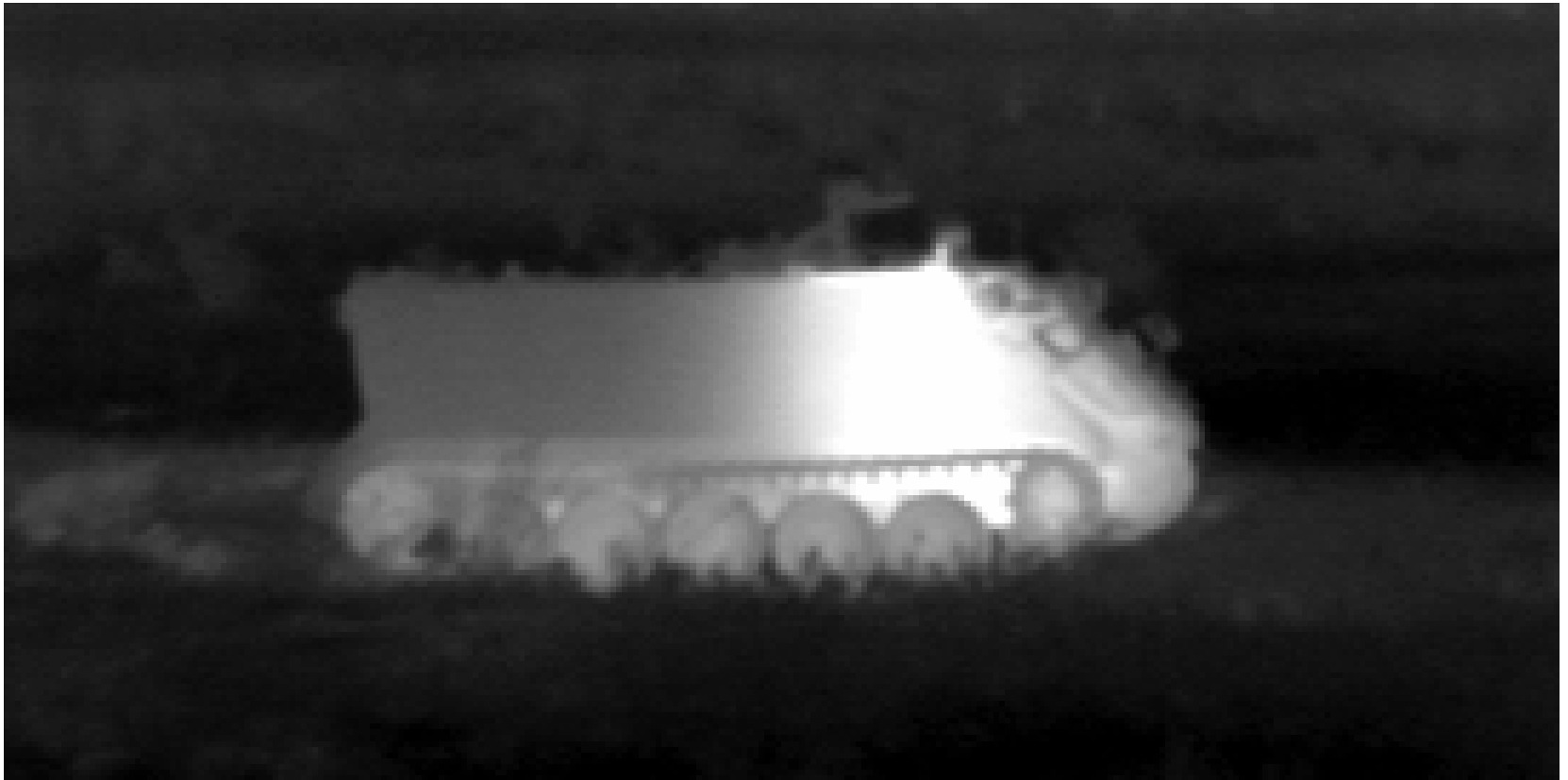
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Summary

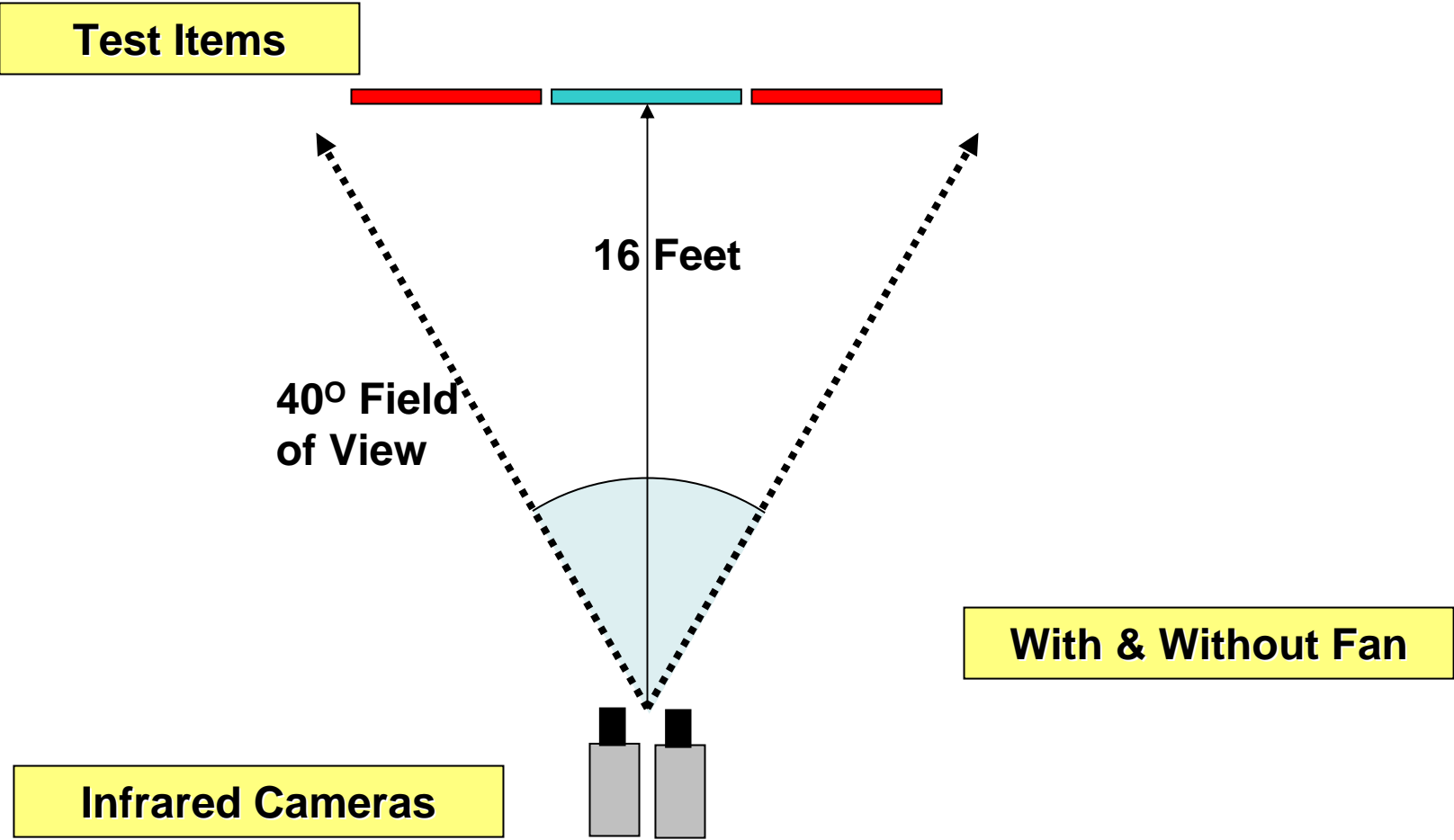
- Thermal Shielding
- Measurement Techniques
- Analysis Techniques
- Results
 - Still Air
 - Flowing Air
- Conclusion

The Problem: Hot Areas Need Thermal Shielding

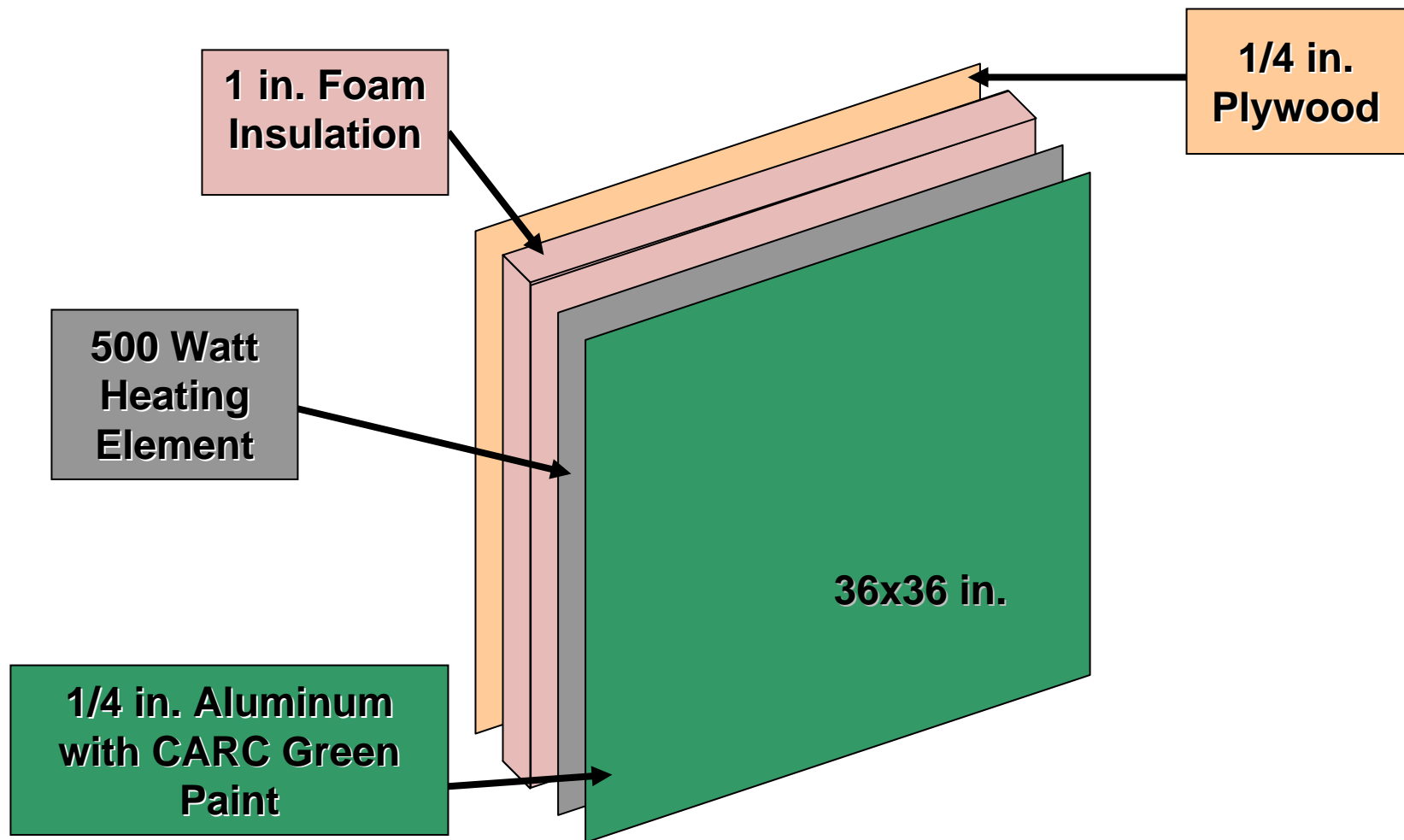


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Measurement Techniques: Test Setup

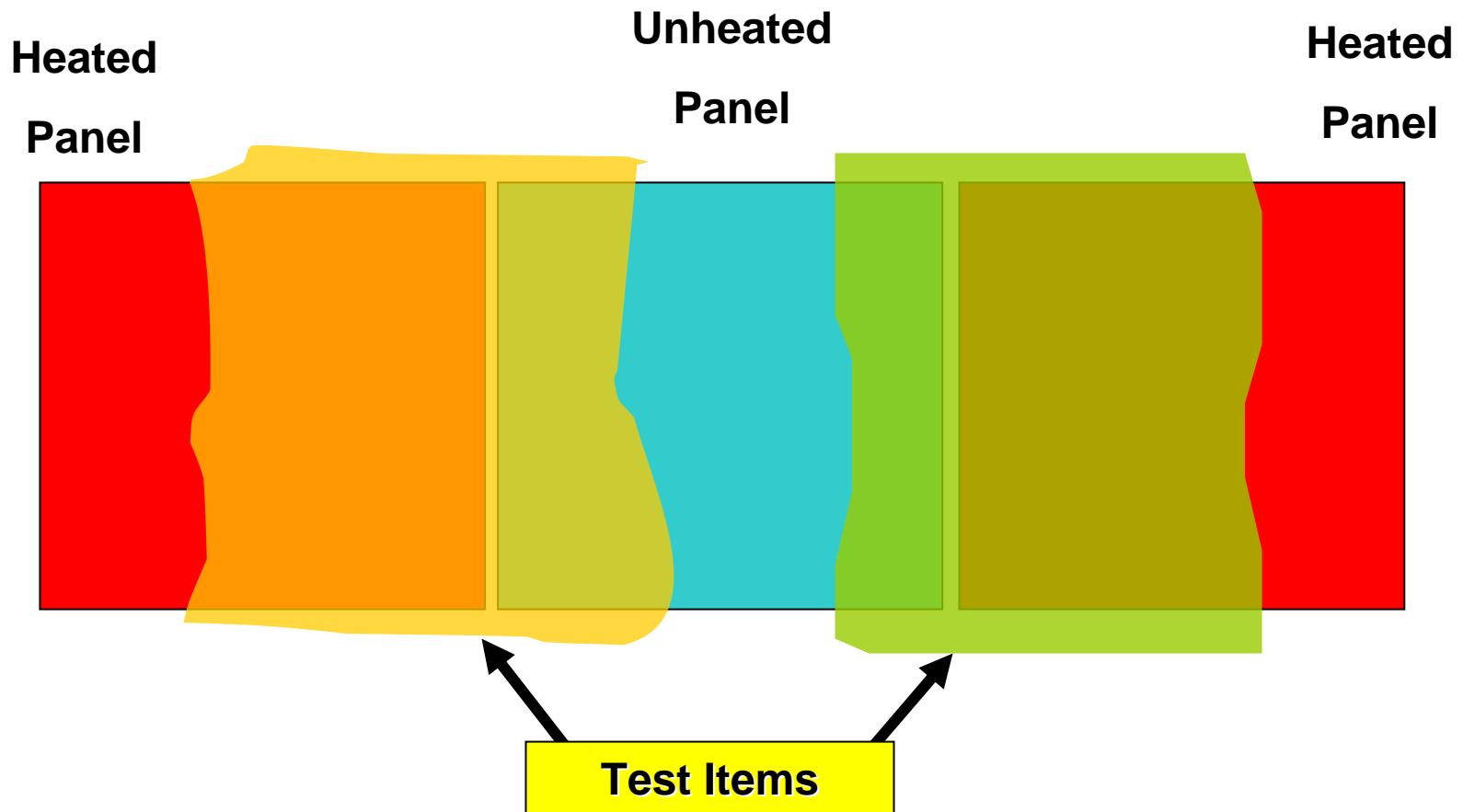


Measurement Techniques: Construction of Heated Panels



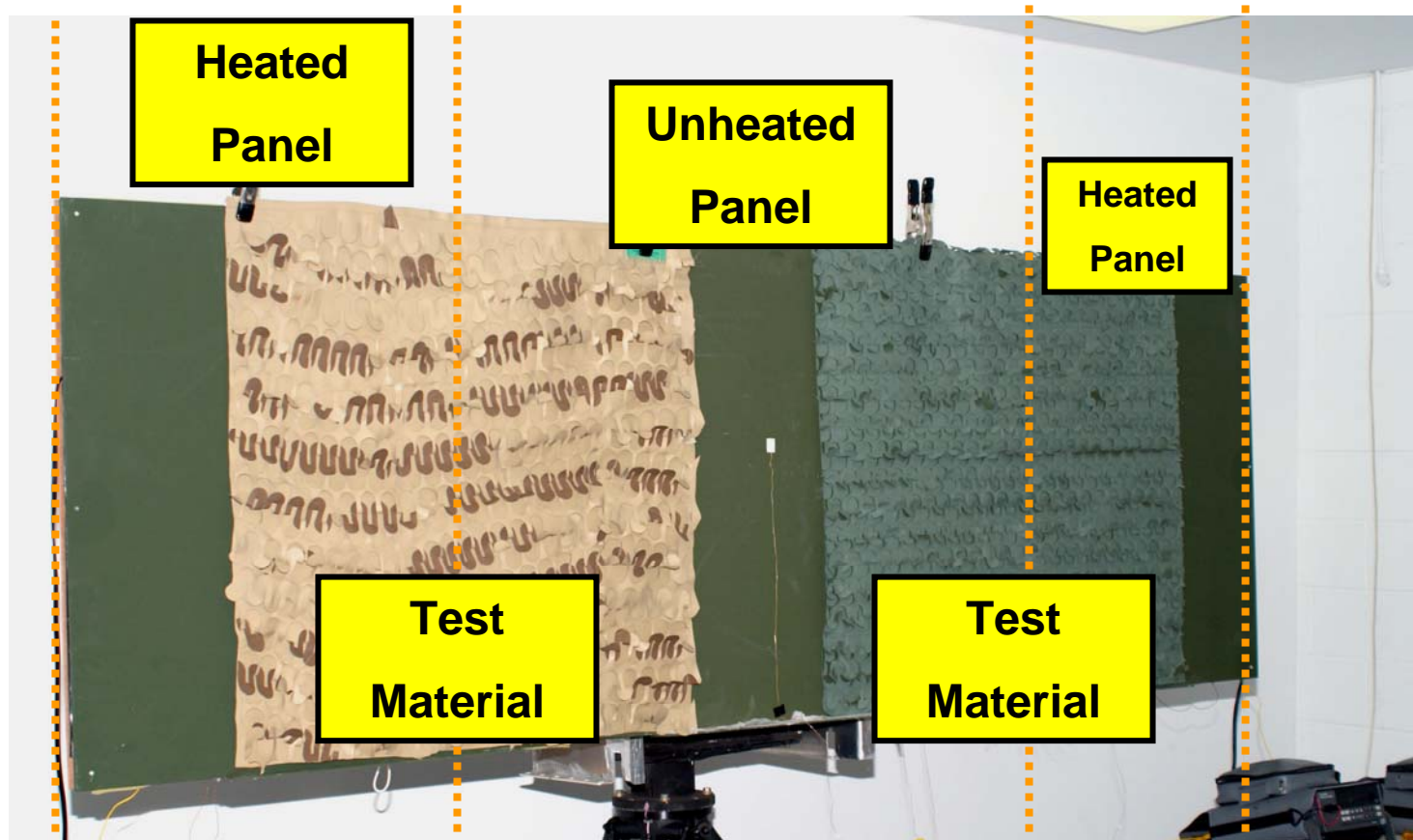
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Measurement Techniques: Test Setup



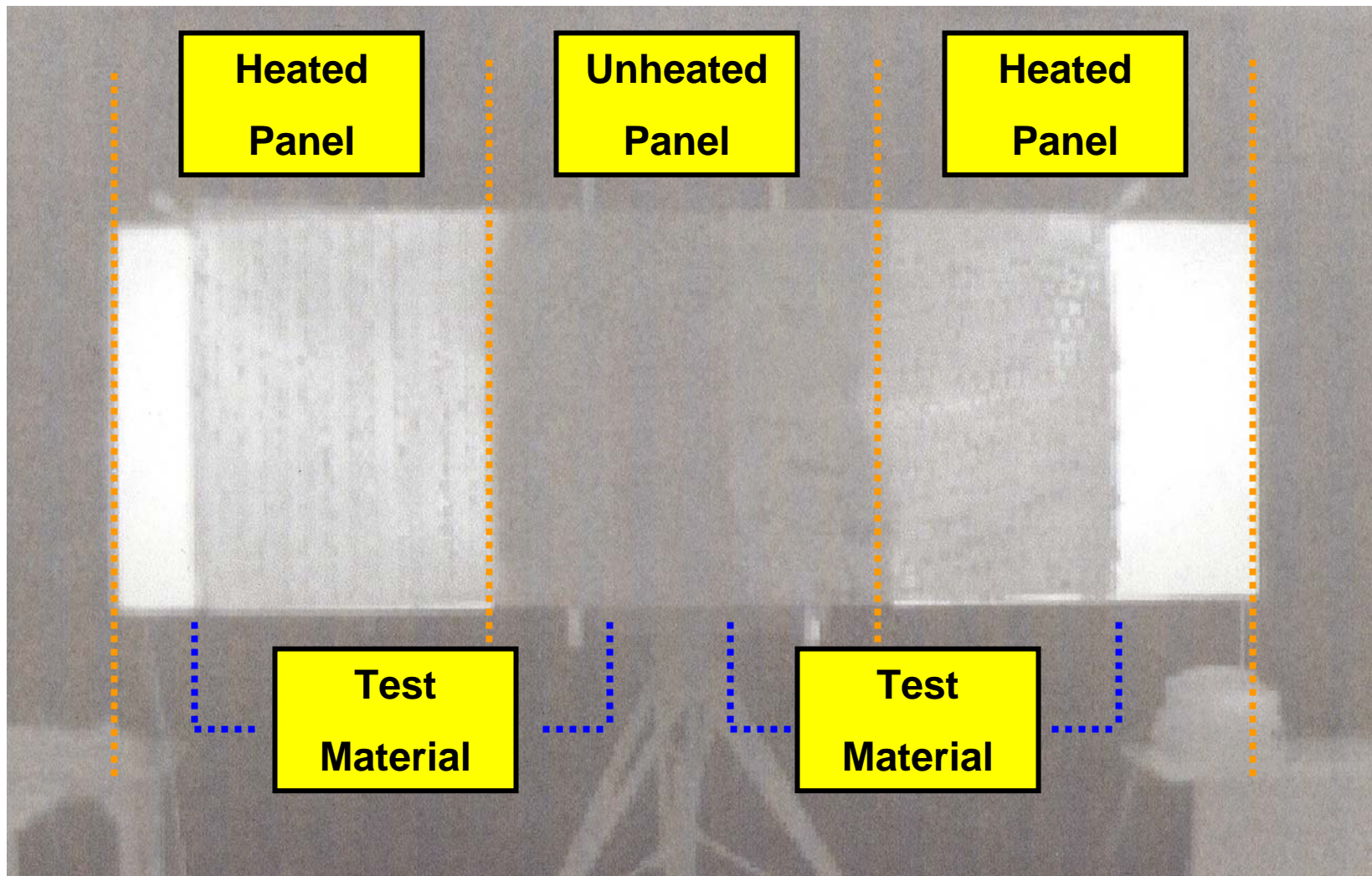
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Measurement Techniques: Arrangement of Test Items



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Measurement Techniques: Arrangement of Test Items

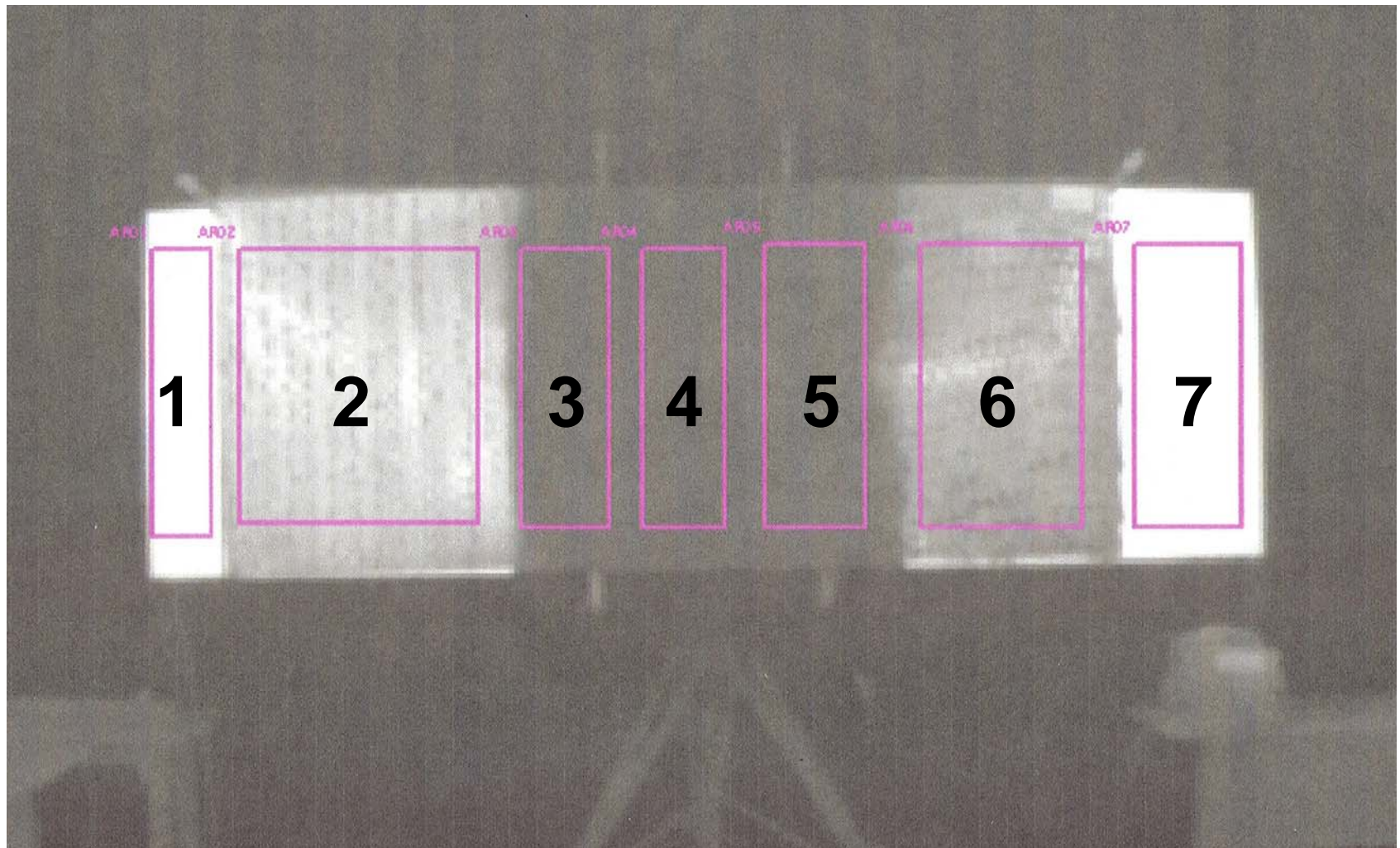


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Measurement Techniques: Test Procedure

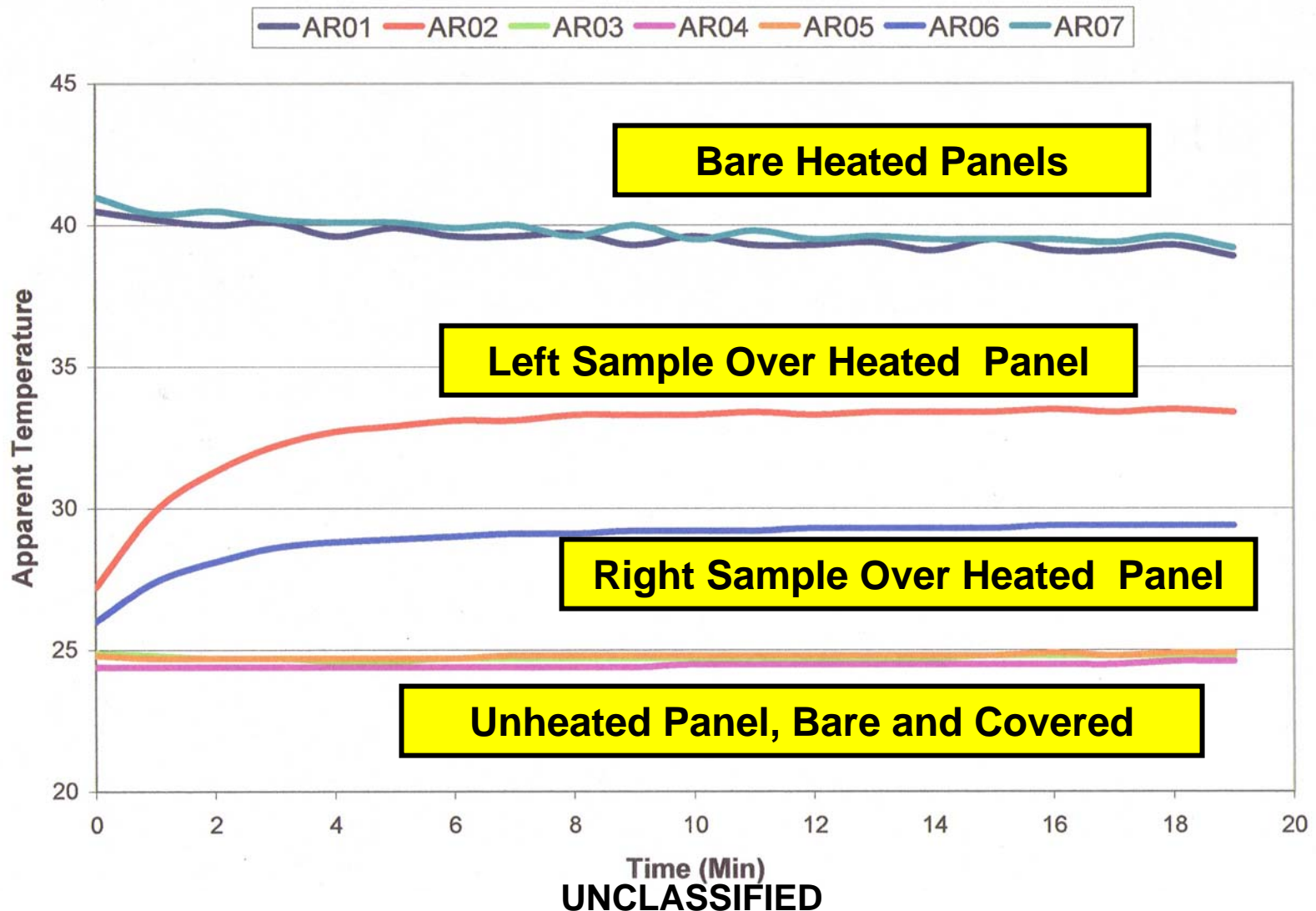
- Allow both panels to stabilize ($\sim 115^{\circ}\text{F}$ without fan)
- Hang test articles on test fixture
- Take thermal imagery (3-5 and 8-12 μm) every minute for 20 minutes
- Repeat test for all test articles with forced convective cooling

Measurement Techniques: Areas of Interest (AOI's)



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Measurement Techniques: Typical Results



Parameter Estimation

Choose parameters for best least-squares fit to

$$T(t) = T_{final} - (T_{final} - T_{initial})e^{-\frac{t}{\tau}}$$

where the parameters are

$T_{initial}$ = Initial Temperature (measured value)

T_{final} = Ultimate Temperature (fitted parameter)

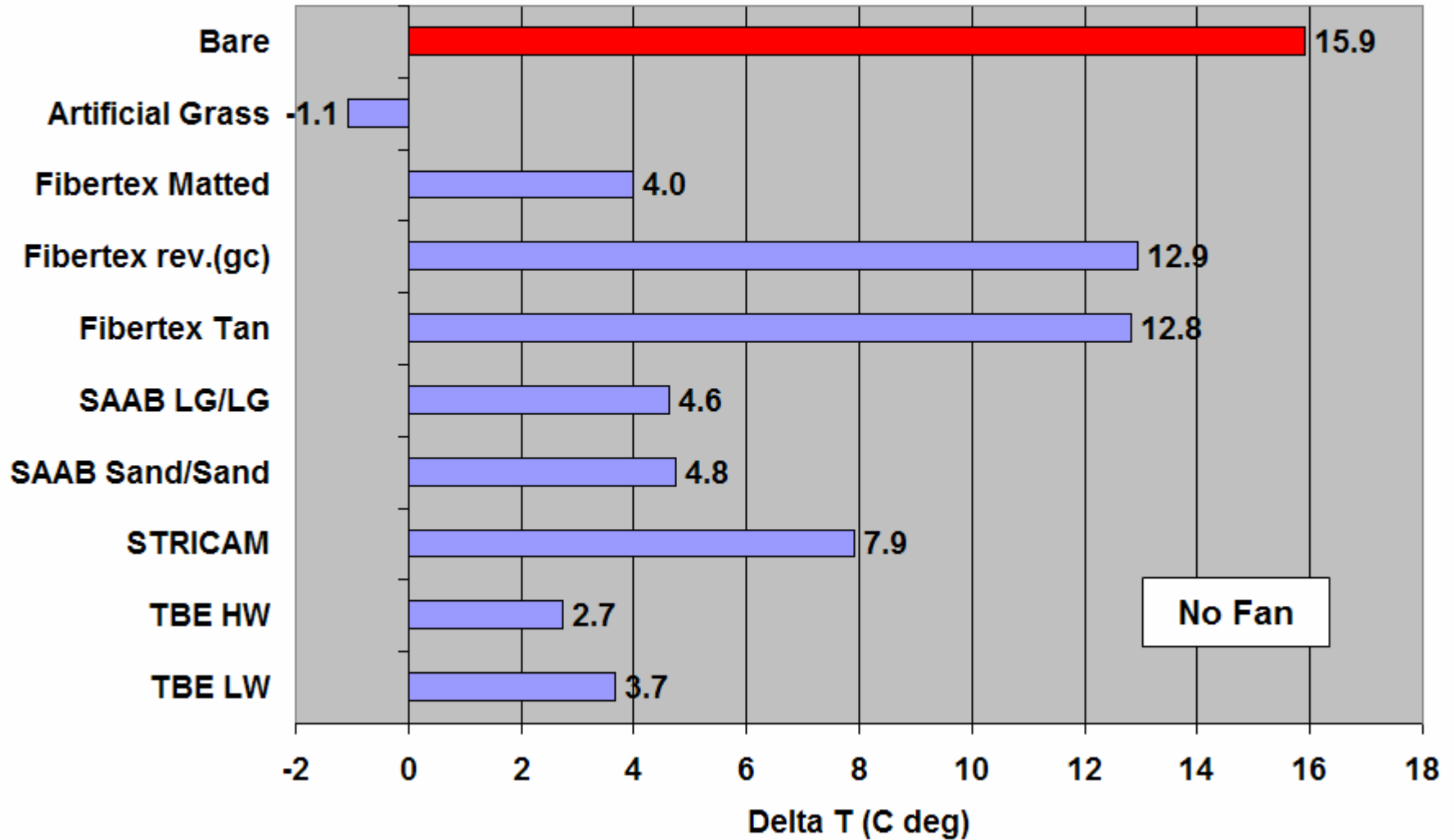
τ = Time Constant (fitted parameter)

Temperature Difference

Compare final temperature of covered heated panel with temperature of unheated panel:

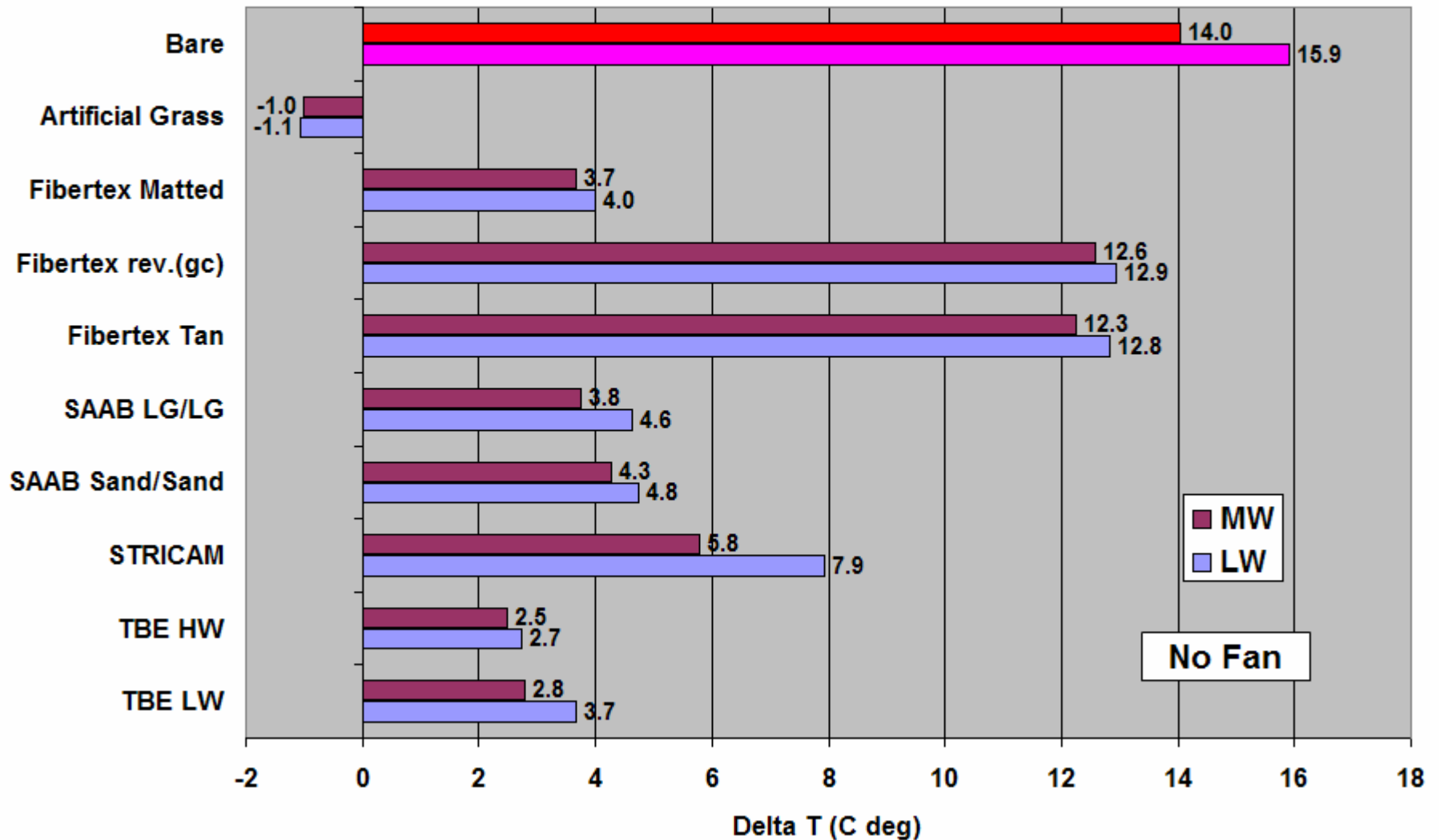
$$\Delta T = T_{final} - T_{unheated\ panel}$$

Temperature Difference, Long Wave IR



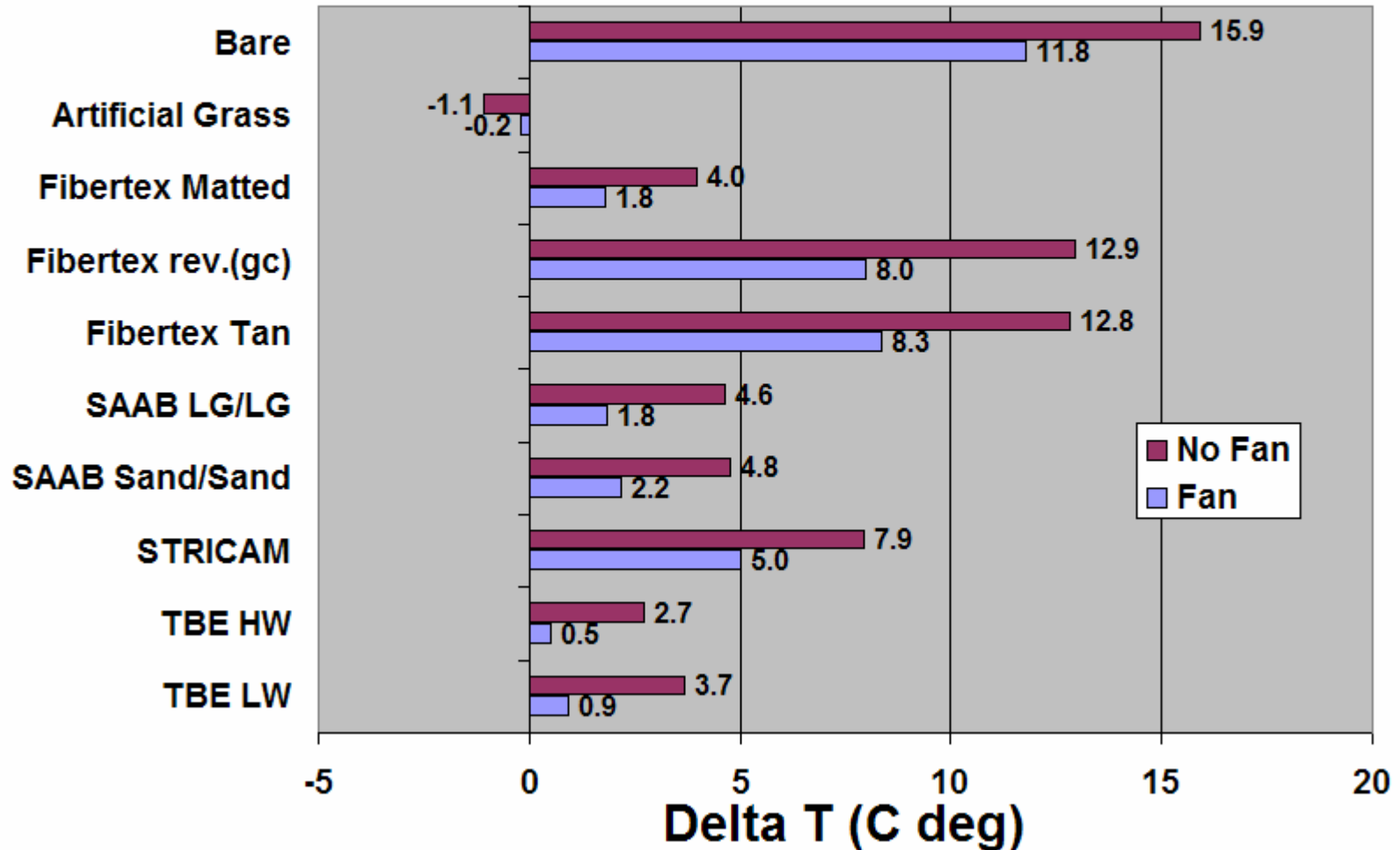
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Difference in Apparent Temperature Medium and Long Wave IR



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Temperature Difference, Long Wave IR, with and without Fan



Conclusion

- The techniques shown are suitable for evaluating the thermal shielding performance of camouflage materials
- Air flow has a strong influence on thermal shielding performance of camouflage materials.
- Future measurements should include control of air flow.
- Questions:
 - John Bennett, john.g.bennett@us.army.mil
 - Erik Polsen, erik.s.polsen@us.army.mil