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A PERFORMANCE AND RELIABILITY MODEL FOR THERMAL BARRIER COATINGS

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A modeling technique for predicting the performance and reliability of TBC's is being developed at Solar Turbines Incorporated. The concept combines experimental coating property data with finite element analyses to predict the thermal and mechanical behavior of coating systems in service. A key feature of Solar's approach is the use of a four point flexure test to estimate coating strength distributions and to predict coating failure probability.

This model has been used to evaluate the effect of physical variations on coating performance in high heat flux rocket engine applications for NASA. Current work, promoted by Caterpillar Tractor Company for diesel engine applications, is being conducted to measure coating strength as a function of temperature, and future work will document strength degradation with time at temperature. Solar's interest lies in the application of TBC's to gas turbine engine components.

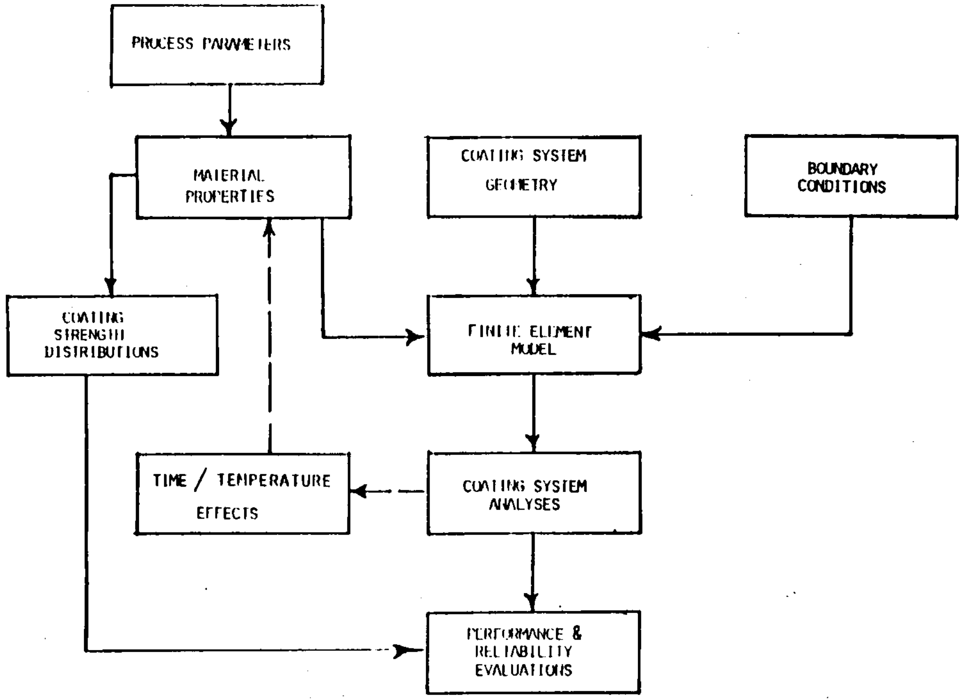

Figure 1. - TBC model development.

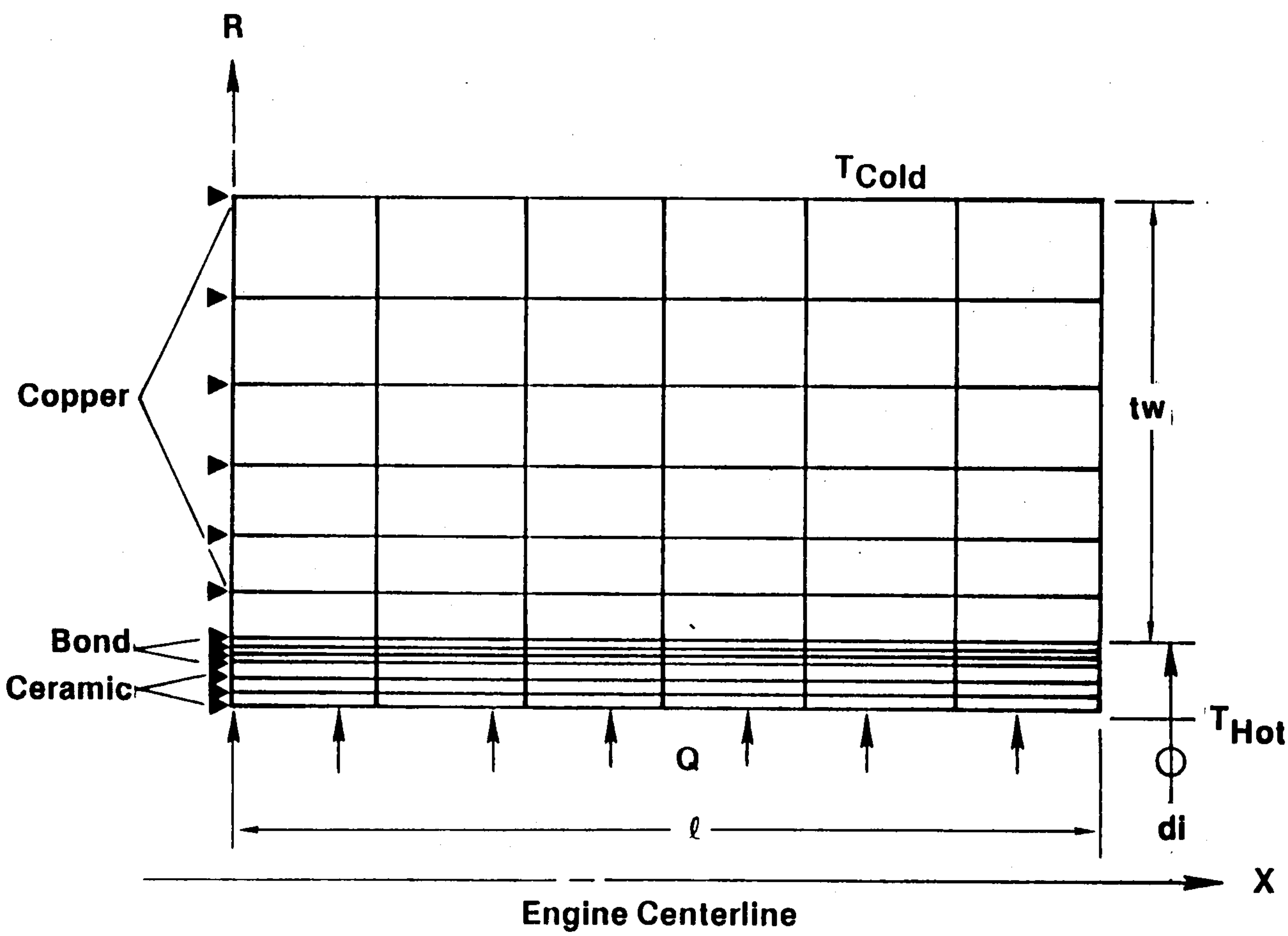

Figure 2. - Two-dimensional finite-element model of simulated rocket chamber wall.

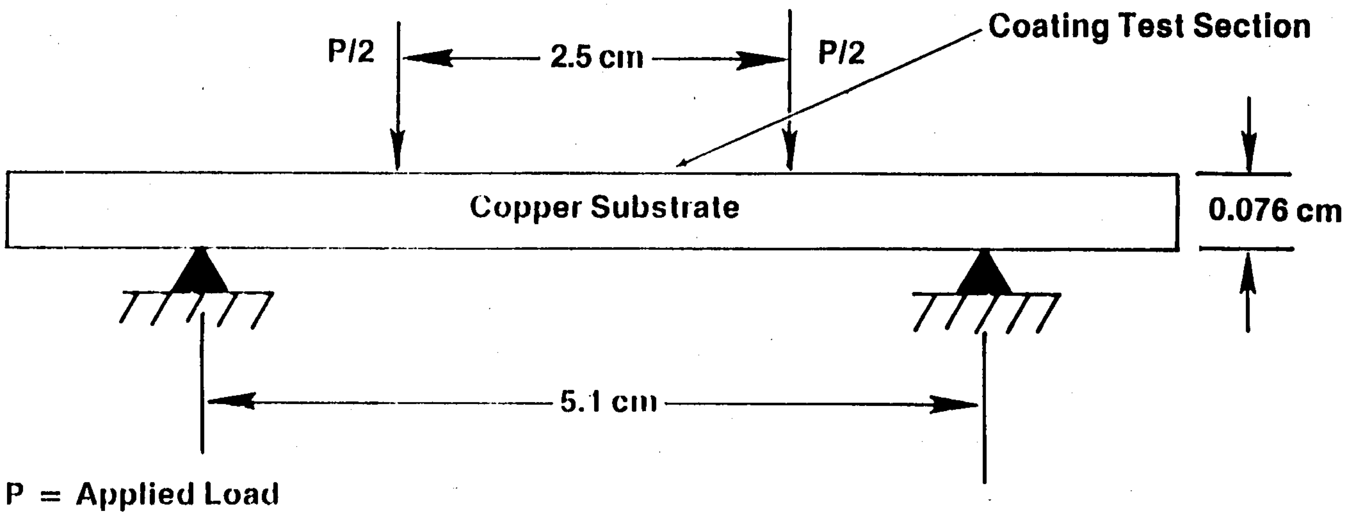

Figure 3. - Schematic of four point flexure test.

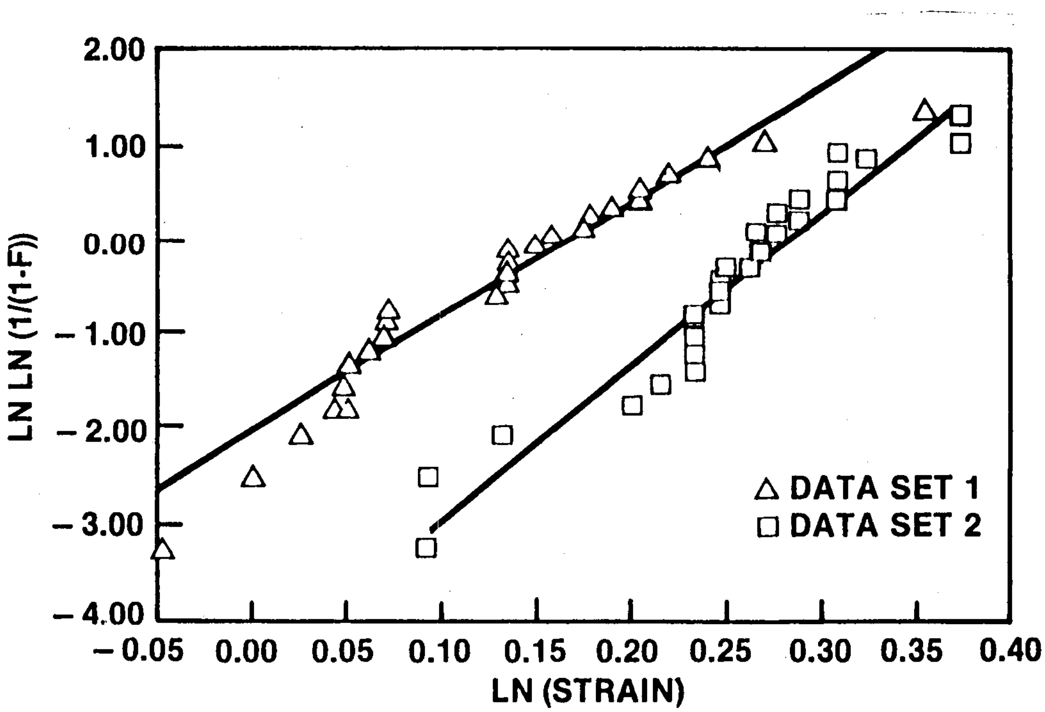

Figure 4. - Coating strength Weibull plots.

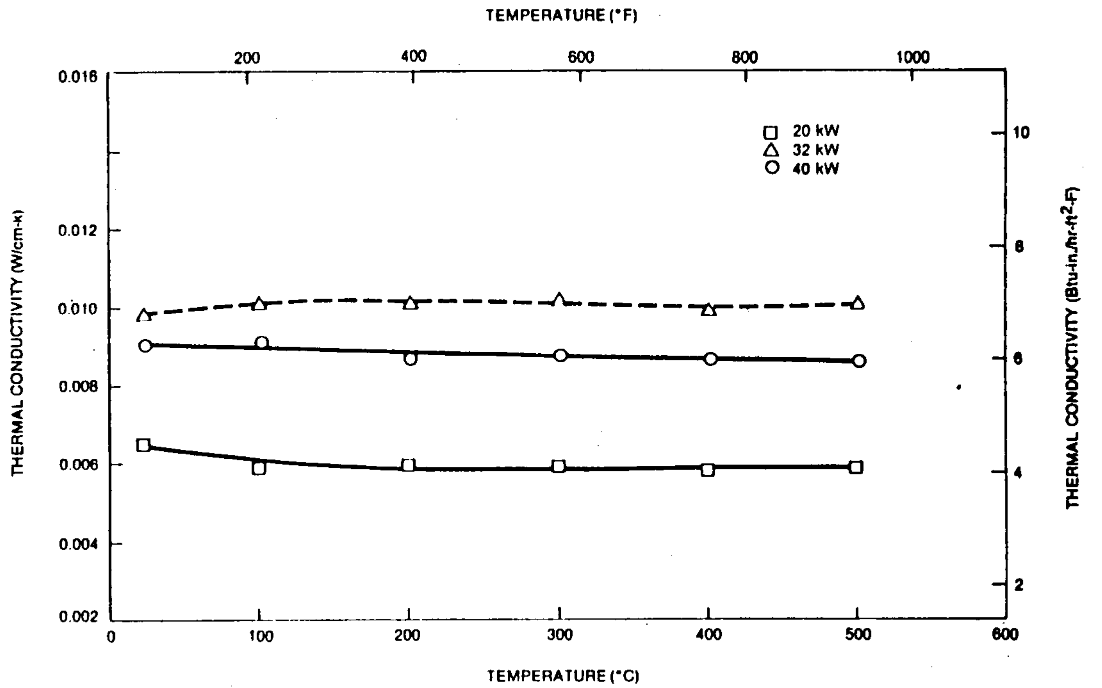

Figure 5. - Thermal conductivity of $ZrO_2Y_2O_3$ layers.

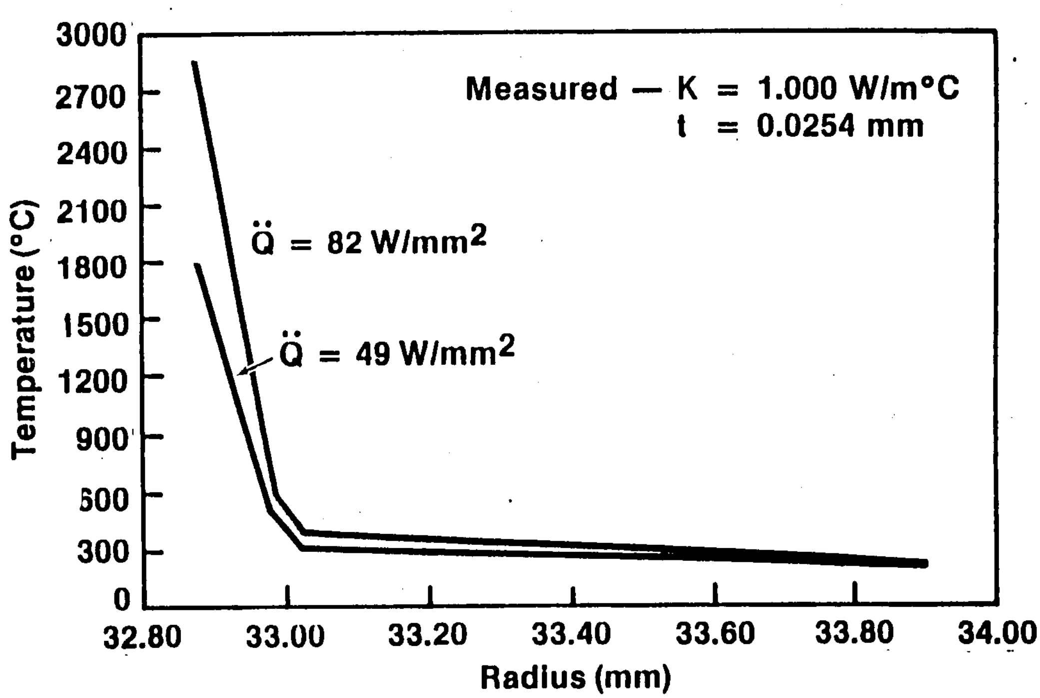

Figure 6. - Predicted coating temperature profile.

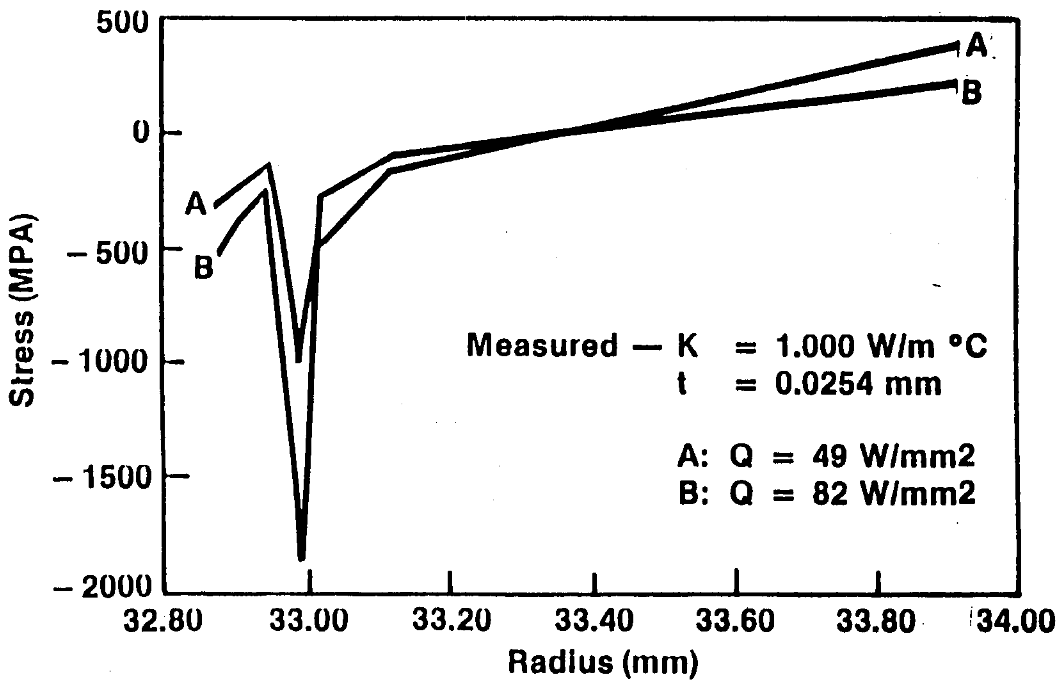

Figure 7. - Predicted hoop and axial coating stress profile.

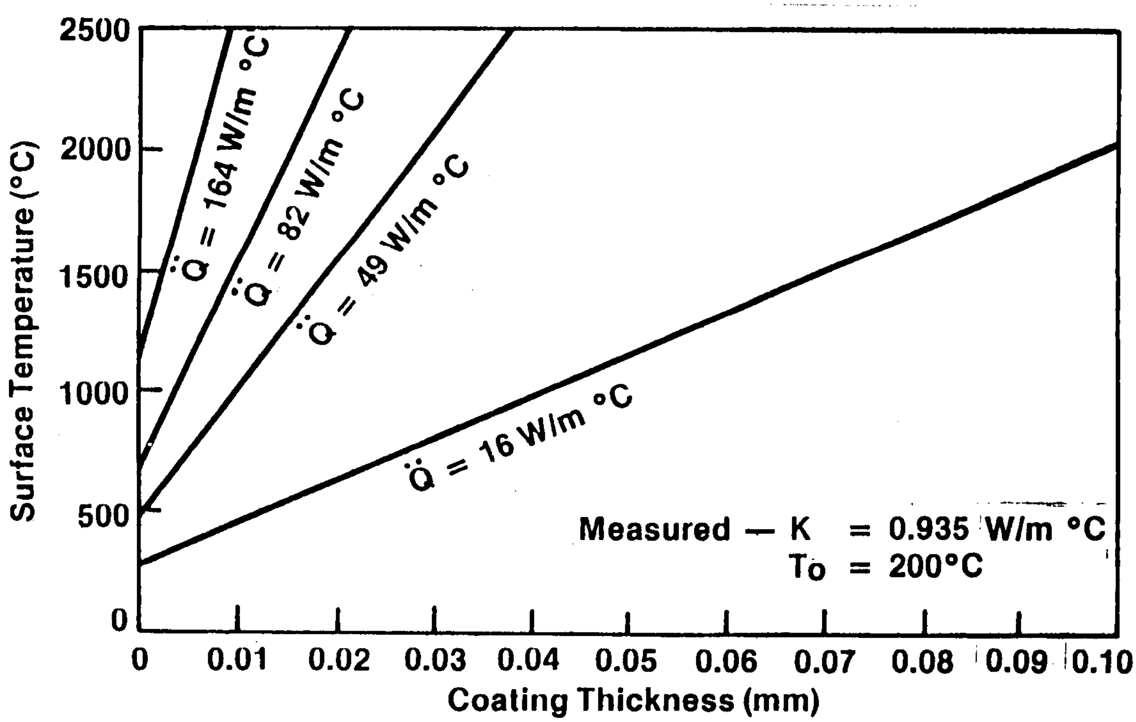

Figure 8. - Coating surface temperature vs. coating thickness.

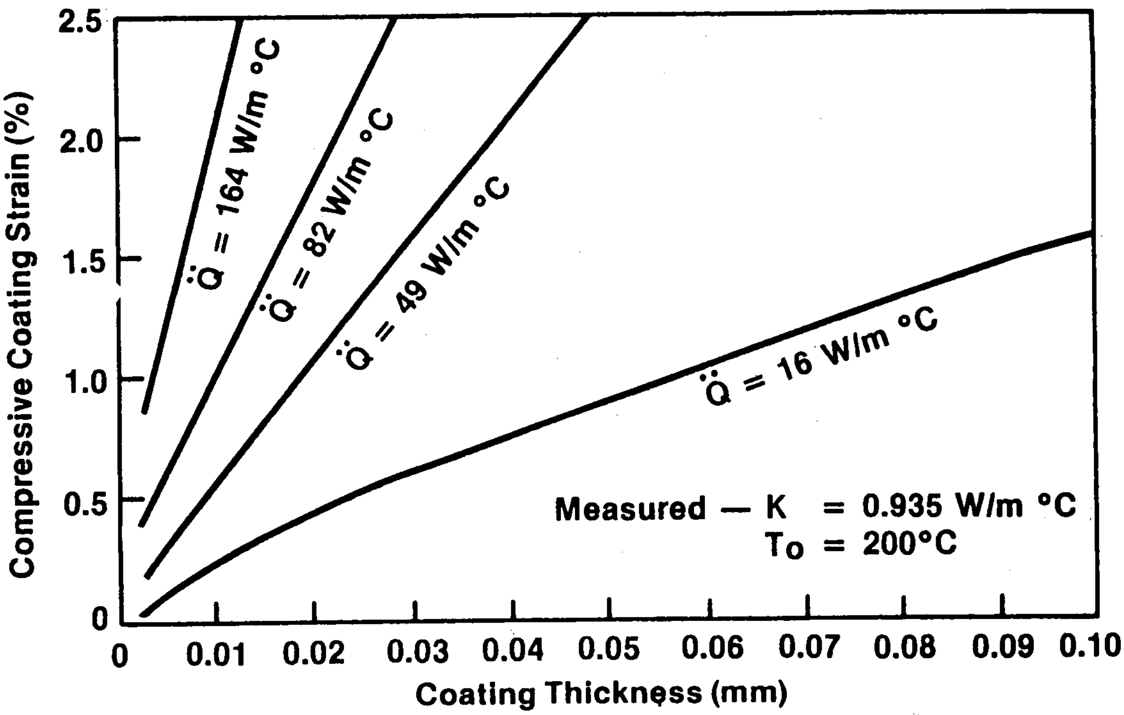

Figure 9. - Coating strain vs. coating thickness for various heat fluxes.

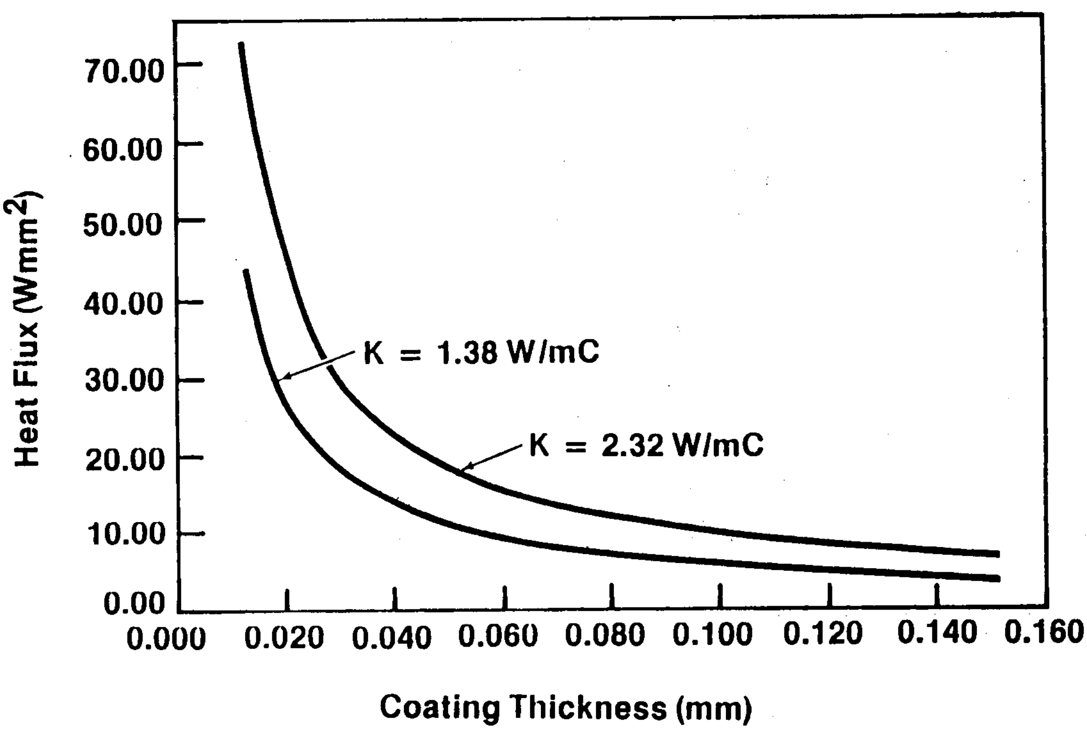

Figure 10. - Maximum heat flux vs. coating thickness for 95% survival probability.