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REPRODUCIBILITY OF TEMPERATURE MEASUREMENTS

FROM MODEL TESTING

by

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Research On

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At the suggestion of Dr. Maurice Wilden of the Jet Propulsion Laboratory, California Institute of Technology, the reproducibility of both the steady and transient temperature data obtained from scale models was examined by repeating the experiments described in an earlier report, " Results of Transient Thermal Modeling of Simple Structures in a Simulated Space Environment", which was submitted to JPL in early December, 1967. Since, among the three system geometries selected for study, configuration (c) had the most complicated heat flow paths, it was decided to repeat measurements using both the 1/2-scale and 1/4-scale models of that configuration. The heater power was adjusted to within 0.1% of that used in the corresponding earlier tests and the shroud temperature conditions were also roughly duplicated. (There are five thermocouples installed in the liquid nitrogen cooled shroud at suitable locations; the largest deviation which always occurred at the topmost couple was kept within 10°R). Results showed that both the steady and transient temperature data could be very satisfactorially reproduced. Since all surfaces of the system were coated with Cat-A-Lac 463-3-8 flat black paint, the observed good reproducibility of the measured temperatures also provided evidence of the highly stable emittance of the paint as we had previously reported.

## TEST RESULTS

The indicated steady state temperatures of eleven thermocouples installed on each plate of the system configuration (c) and obtained during the repeated tests are compared with those recorded in earlier tests in Table I and II, respectively for the low and high heater power. The

thermocouple number refers to location of the measurement station as illustrated in Fig. 1 of the original report, ME-TR-JPL-951660-1. The average deviation in temperature readings shown in the tables is calculated without regard to their sign. It is seen that the reproducibility is quite satisfactory, being of the order of 2°R for the 1/2-scale model and 1°R for the 1/4-scale model.

The extent of reproducibility of measured transient temperature data at various thermocouple locations is illustrated in four groups of figures. Those obtained from the 1/2-scale model are shown in Figs. 1-1 to 5 and 2-1 to 5; those from the 1/4-scale model are shown in Figs. 3-1 to 5 and 4-1 to 5. It is indeed gratifying and, perhaps, even somewhat surprising to find such a high degree of reproducibility as revealed in these figures.

TABLE ]	Ľ	REPRODUCIBILITY OF STEADY STATE TEMPERATURE DATA FROM
		1/2- AND 1/4-SCALE MODELS - CONFIGURATION (c)
		AT LOW HEATER POWER

Thermocouple		1/2-Scale Mc	odel	:	1/4-Scale Mo	odel		
	previous	repeated	difference	previous	repeated	difference		
Number	test	test		test	test			
(A) Material (1)								
1,	589.7	588.3	-1.4	592.3	592.7	+0.4		
2	586.7	585.3	-1.4	589.7	589.7	0		
$3_{7}^{\perp}$	584.0	580.7	-3.3	587.3	587.7	+0.4		
47	581.3	580.7	-0.6	583.3	583.7	+0.4		
5	579.3	574.0	-5.3	581.3	581.7	+0.4		
6,	571.7	570.7	-1.0	572.7	572.7	0		
$7^{\perp}_{7}$	571.0	570.0	-1.0	571.7	573.3	+1.6		
8,	565.3	564.3	-1.0	568.0	568.3	+0.3		
9 <sup>1</sup>	564.0	563.7	-0.3	567.7	568.0	+0.3		
	558.3	557.3	-1.0	562.3	562.7	+0.4		
	554.0	554.0	0	556.3	557.7	+1.4		
Average deviation: 1.5 Average devia					age deviatio	on: 0.5		

<b>(</b> B)	Material	(2)
		$\sim$

1 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	614.3 594.0 593.0 585.7 584.3 561.3 561.3 546.0 543.3 531.0	616.7 594.7 596.7 588.3 586.3 564.3 563.3 563.3 549.0 545.7 534.0	47776000400 477760000400	604.3 586.3 586.3 582.7 581.3 557.3 557.0 541.3 539.3 526.0	602.3 587.7 588.0 584.0 583.3 558.3 558.3 558.3 543.3 543.3 541.0 527.3	-2.0 +1.4 +1.7 +1.3 #1.3 +1.3 #1.0 +1.3 +1.3 +1.3 +1.3 +1.3 +1.3 +1.3 +1.3
11-2	523.3	526.3	+3.0	517.0	517.7	+0.7
Average deviation: 2.5				Aver	age deviatio	on: 1.5

- Note: (a) All temperatures are in degree R (b) Repeated tests were conducted approximately three months after the previous tests (c) The averages were computed without regard to sign

TABLE II	REPRODUCIBILITY OF	STEADY S	STATE TEMPERATUR	E DATA F	ROM
	1/2 - AND 1/4 - SCALE	MODELS ·	- CONFIGURATION	(c)	
	AT HIGH	HEATER ]	POWER		

Thermocouple	1/2-Scale Model			1/4-Scale Model		
Number	previous test	repeated test	difference	previous test	repeated test	difference
				<u> </u>		
Lanutra		<b>(</b> A)	) Material (	1)		1000-
1,	745.0	744.0	-1.0	753.3	751.7	-1.6
21	739.3	737.7	-1.6	746.7	745.0	-1.7
31	734.0	728.8	-5.2	741.0	739.7	-1.3
4	727.3	727.0	-0.3	729.7	728.3	-1.4
51	724.0	719.3	-4.7	726.3	725.0	-1.3
67	707.3	706.3	-1.0	707.3	706.3	-1.0
7	706.3	705.7	-0.6	706.7	705.7	-1.0
	694.3	693.3	-1.0	694.7	694.0	-0.7
97	685.3	691.0	+5.7	693.7	692.7	-1.0
101	675.0	678.3	+3.3	682.3	681.0	-1.3
	671.0	671.0	0	671.3	670.3	-1.0
Average deviation: 2.2				Avera	age deviatio	on: 1.2

## (B) Material (2)

1 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	793.7 750.7 750.0 739.0 736.7 691.7 692.0 662.7 657.8 639.0 626.7	795.3 753.3 755.0 741.7 738.0 694.7 693.7 665.0 661.3 642.0 629.0	11.6 +2.6 +5.0 +2.7 +1.3 -1.7 -1.7 -1.7 -1.7 -1.3 -5 -5 -5 -5 -5 -5 -5 -5 -5 -5 -5 -5 -5	785.3 739.3 741.0 736.0 733.0 686.0 685.7 655.7 652.7 632.0 617.7	782.3 737.7 740.7 735.3 732.3 685.3 684.3 655.0 652.3 630.7 616.3	-3.0 -1.6 -0.3 -0.7 -0.7 -0.7 -1.4 -0.7 -0.4 -1.3 -1.4
Average deviation: 2.6				Avera	age deviatio	on: 1.1

Note: (a) All temperatures are in degree R

(b) Repeated tests were conducted approximately three months after the previous tests

(c) The averages were computed without regard to sign



FIG. I-I REPRODUCIBILITY OF TRANSIENT TEMPERATURE MEASUREMENTS FROM MODEL TESTING (1/2-SCALE MODEL)



FIG. I-2 REPRODUCIBILITY OF TRANSIENT TEMPERATURE MEASUREMENTS FROM MODEL TESTING (12-SCALE MODEL)



FIG. I-3 REPRODUCIBILITY OF TRANSIENT TEMPERATURE MEASUREMENTS FROM MODEL TESTING (12-SCALE MODEL)

Sec. 5

с. F



FIG. 1-4 REPRODUCIBILITY OF TRANSIENT TEMPERATURE MEASUREMENTS FROM MODEL TESTING (1/2-SCALE MODEL)



Prototype Time, min

FIG. I-5 REPRODUCIBILITY OF TRANSIENT TEMPERATURE MEASUREMENTS FROM MODEL TESTING (1/2-SCALE MODEL)



Prototype Time, min

FIG. 2-1 REPRODUCIBILITY OF TRANSIENT TEMPERATURE MEASUREMENTS FROM MODEL TESTING (12-SCALE MODEL)







FIG. 2-3 REPRODUCIBILITY OF TRANSIENT TEMPERATURE MEASUREMENTS FROM MODEL TESTING (-2-SCALE MODEL)



FIG. 2-4 REPRODUCIBILITY OF TRANSIENT TEMPERATURE MEASUREMENTS FROM MODEL TESTING (<sup>1</sup>/<sub>2</sub> - SCALE MODEL)

1.3



FIG. 2-5 REPRODUCIBILITY OF TRANSIENT TEMPERATURE MEASUREMENTS FROM MODEL TESTING (1/2 - SCALE MODEL)

















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FIG. 4-1 Reproducibility of Transient Temperature Measurements from Model Testing ( $\frac{1}{4}$ -scale Model)

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Temperature Measurements from Model Testing (<u>1</u>-scale Model)



1. 1. Car

FIG. 4-3 Reproducibility of Transient Temperature Measurements from Model Testing (<u>1</u>-scale Model)







