MiniSShot

ProtoSShot-M Mark III Rocket Motor

Thermal Label Mapping and Results from Static Firing July 25th, 2009

Rev. 2009/09/03

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Introduction

The document illustrates the mounting locations for the thermal measurement labels to be mounted on the ProtoSShot-M Mk.III rocket motor.

Results indicating the post-firing label temperature indications are provided in the Appendix.

Labels

Omega Irreversible Temperature Monitoring Labels

Omega P/N	Temperature Ratings							
TL-5-340	°F	340	350	360	370	**380**		**YELLOW**
	°C	171	177	182	188	193		
TL-5-450	°F	450	465	480	490	**500**		**GOLD**
	°C	232	241	249	254	260		
6MB-175/79	°F	175	200	225	250	275	**300**	**RED**
	°C	78	93	107	121	135	149	

Adhesive Backs for Easy Mounting for
Temperatures Above -40°C/°F
 Indicator Turns Black When Exposed

Specifications (TL series)
Accuracy: Up to 99°C (210°F) is ±1°C (1.8°F)
From 100°C (212°F) to 154°C (309°F) is ±1.5°C (2.7°F)
From 160°C (320°F) to 280°C (536°) is ±1% and ±1°C (1.8°F)

Typical appearance of TL series label.


Typical appearance of MB series label.

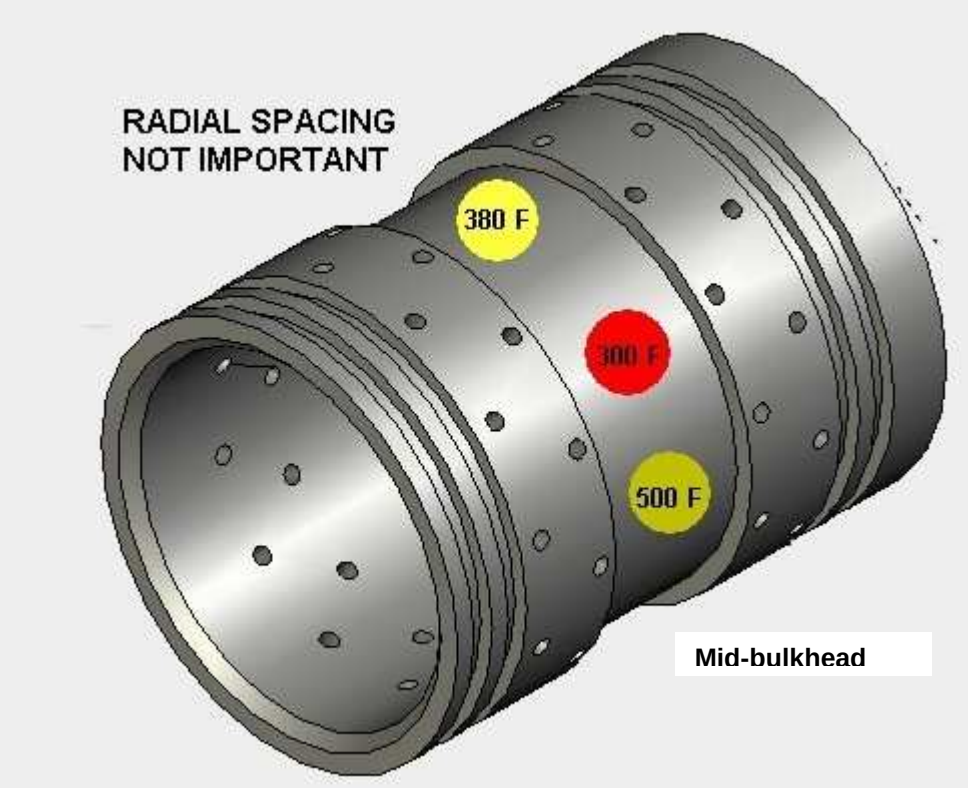


Figure 1 – Labels 300-1, 380-1, 500-1

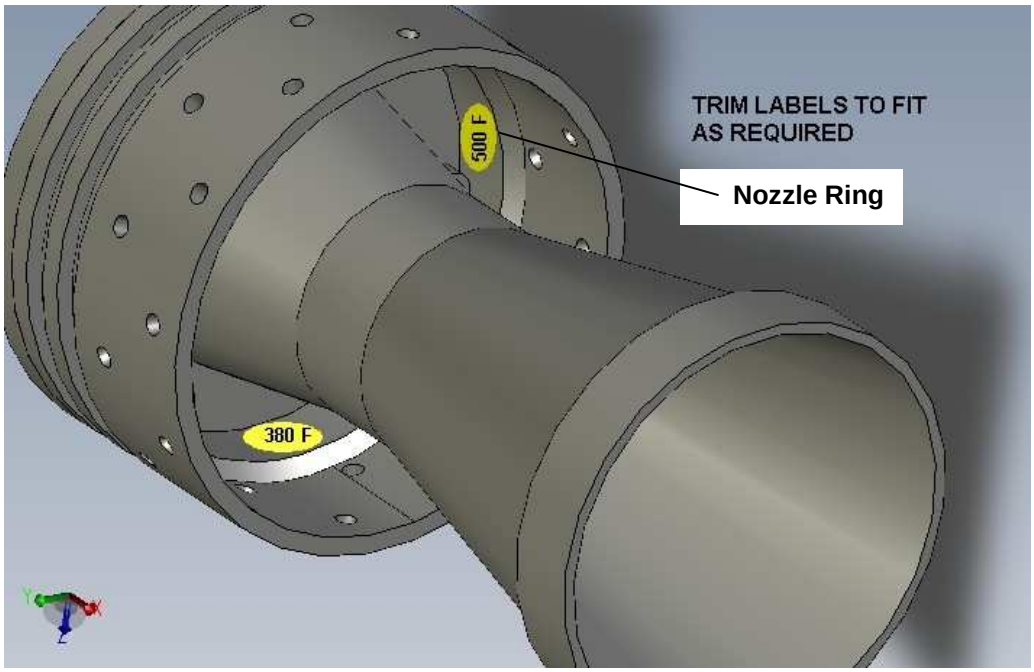


Figure 2 – Labels 380-2, 500-2

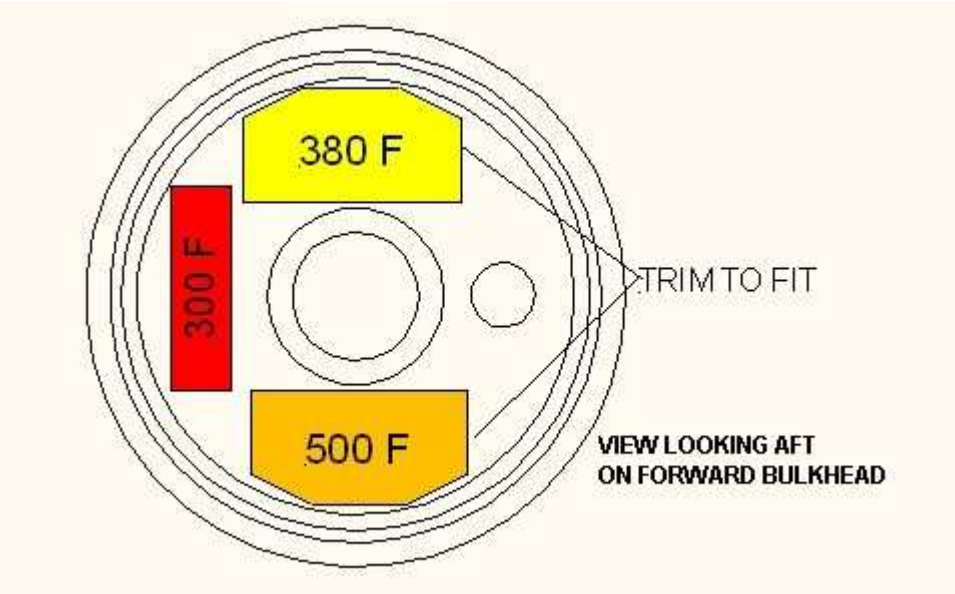


Figure 3 – Labels 300-2, 380-3, 500-3

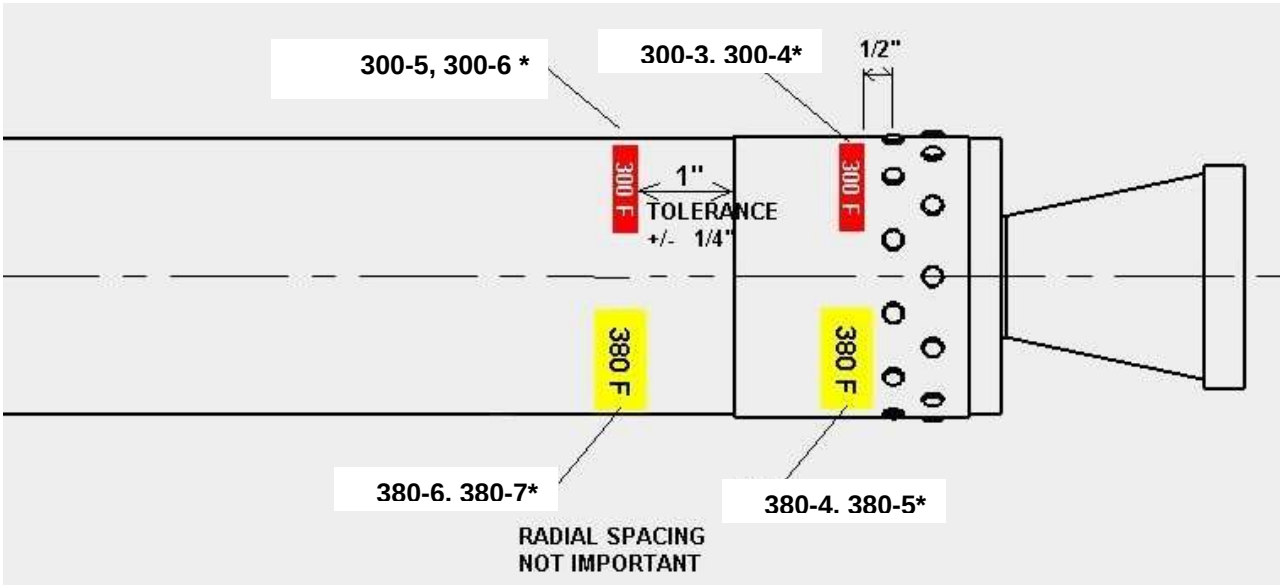


Figure 4
(labels marked with asterisk place on opposite side)

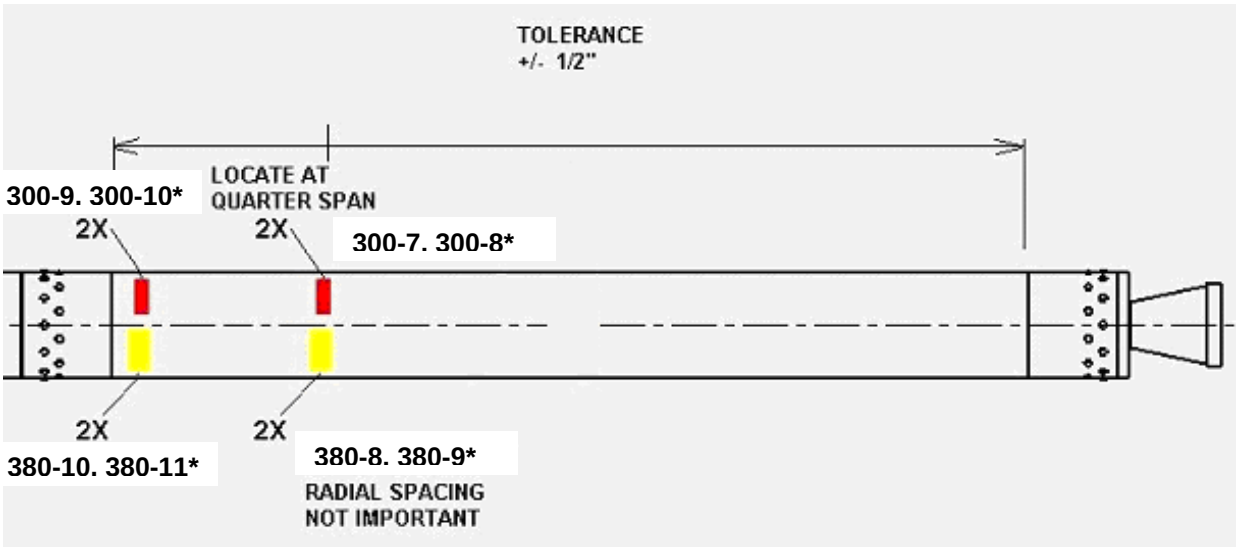


Figure 5
(labels marked with asterisk place on opposite side)

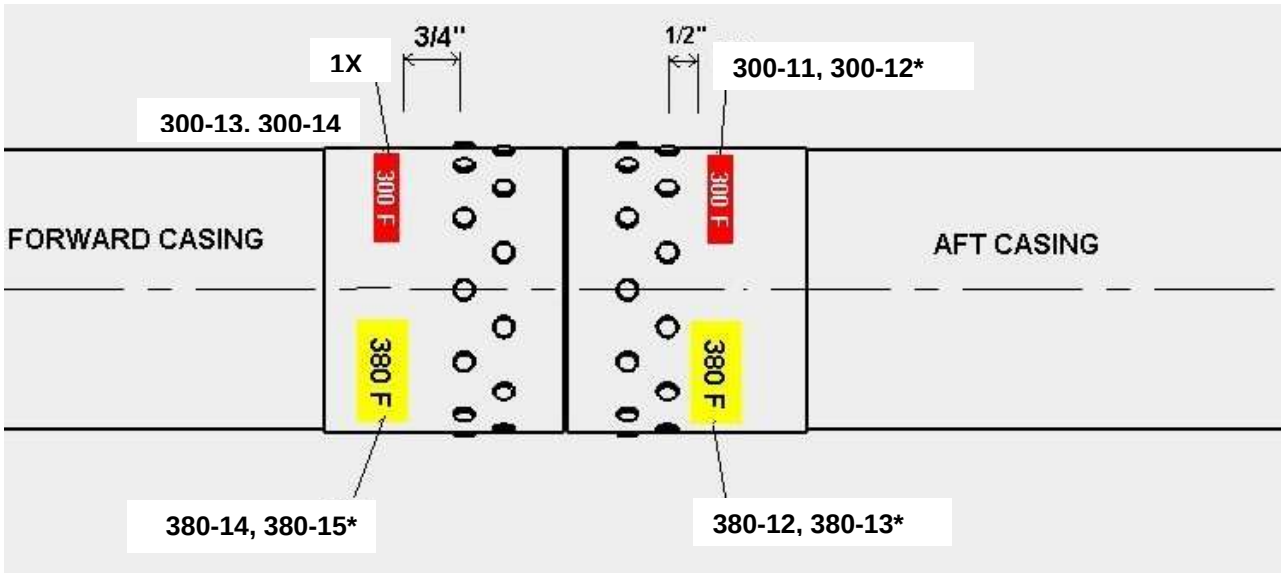


Figure 6
(labels marked with asterisk place on opposite side)

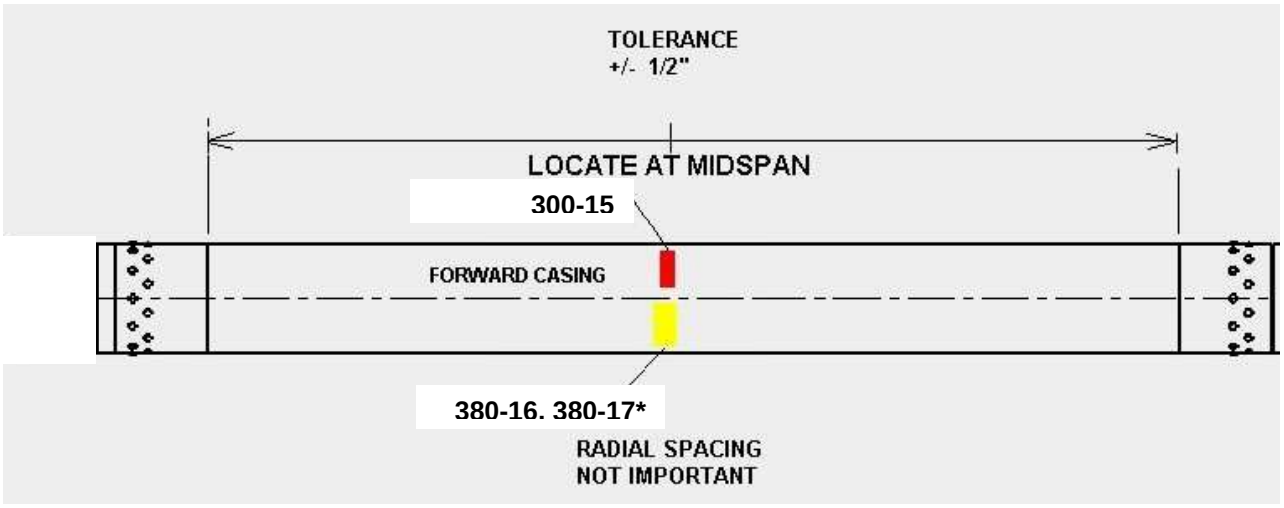


Figure 7
(labels marked with asterisk place on opposite side)

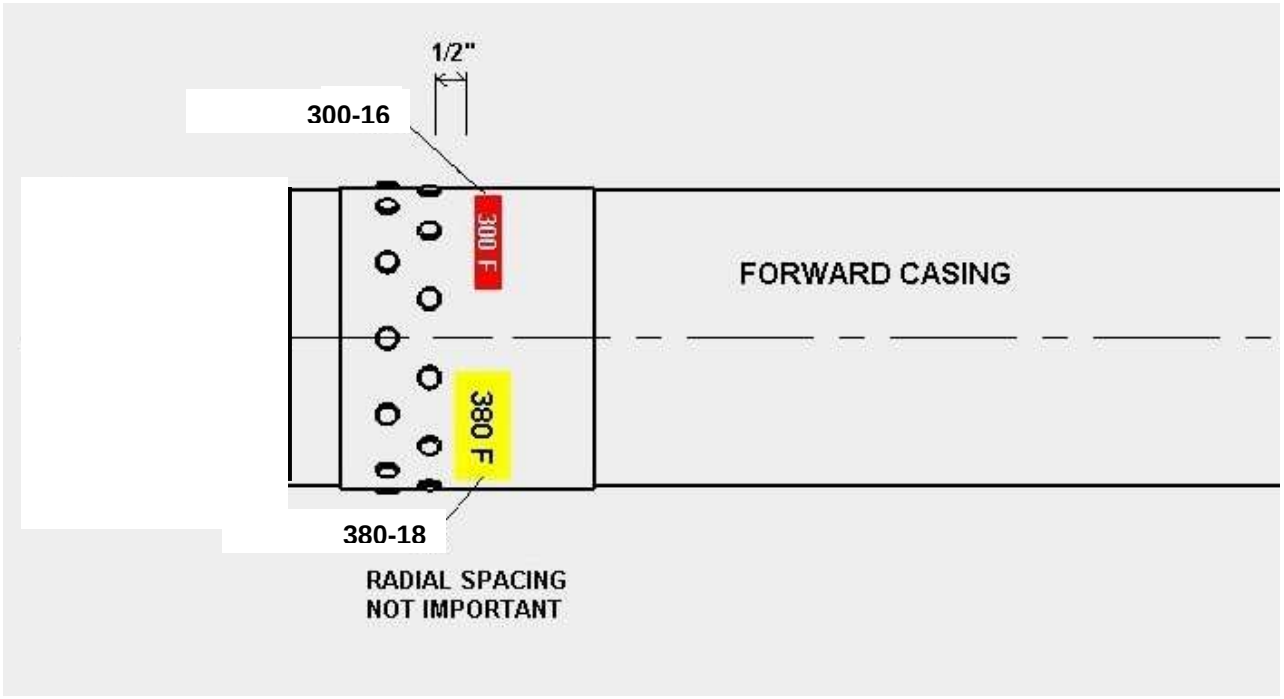


Figure 8

Capturing real-time temperature readings from the Thermal Labels.

Effort should be made to capture real-time readings by the use of two or more video camcorders trained on the rocket motor.

One camera should be positioned on a tripod and aimed at the aft end of the motor nearest the Nozzle to capture as many labels as possible in the range 300-3 through 300-6 and labels 380-4 through 380-7 (refer to Figure 4).

A second camera should be positioned on a tripod and aimed at the mid section of the motor just aft of the Mid-bulkhead to capture as many labels as possible in the range 300-7 through 300-12 and labels 380-8 through 380-13 (refer to Figures 5 & 6).

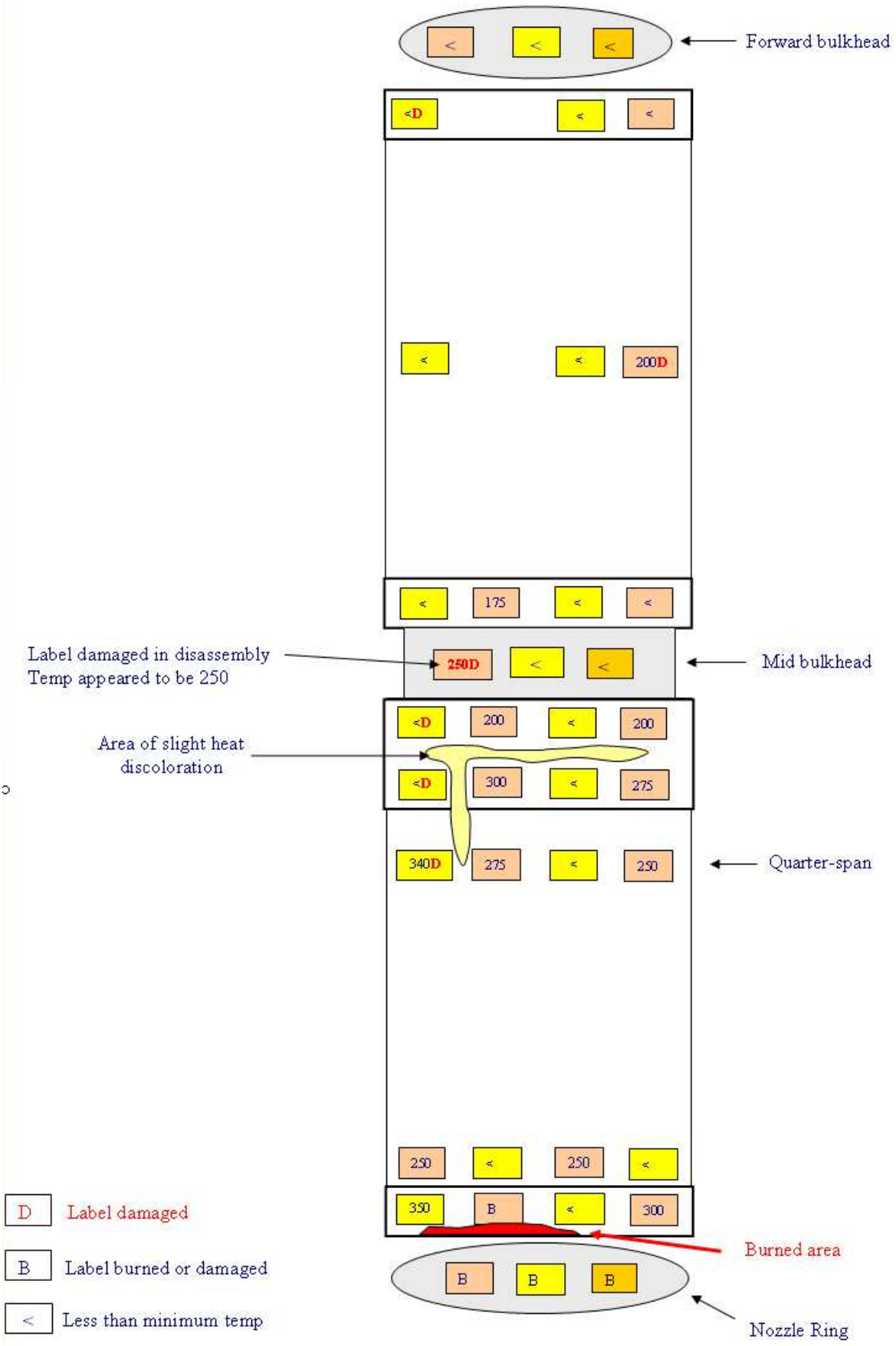
Two minutes worth of readings (commencing at motor ignition) should be taken as a minimum. As such, effort should be made by those participating in the test firing to avoid approaching the rocket motor immediately after firing for at least two minutes (or to carefully avoid getting between the camcorder and the motor during this time). The Team member responsible for the thermal label measurements should assume the responsibility of ensuring this restriction is followed by all personnel.

The temperature data from these recordings should be plotted as *label temperature* versus *time*, for each label successfully recorded. The results should be documented in the Appendix of this report.

APPENDIX: Results from July 25th, 2009 test firing

Table 1 – Post firing label readings

Figure	Label no.	Temperature (°F)	Notes
1 Mid-bulkhead	300-1	250	[3]
	380-1	<340	[1]
	500-1	<450	[1]
2 Nozzle Ring	380-2	-	[2]
	500-2	-	[2]
3 Fwd Bulkhead	300-2	<175	[1]
	380-3	<340	[1]
	500-3	<450	[1]
4 Aft Casing: aft end	300-3	-	[2]
	300-4	350	
	300-5	250	
	300-6	250	
	380-4	350	
	380-5	<340	[1]
	380-6	<340	[1]
	380-7	<340	[1]
5 Aft casing: quarter span & fwd end	300-7	275	
	300-8	250	
	300-9	275	
	300-10	300	
	380-8	340	[3]
	380-9	<340	[1]
	380-10	<340	[1][3]
	380-11	<340	[1]
6 Casings at Mid-bulkhead	300-11	200	
	300-12	200	
	300-13	175	
	300-14	<175	[1]
	380-12	<340	[3]
	380-13	<340	[1]
	380-14	<340	[1]
	380-15	<340	[1]
7 Forward casing, mid-span	300-15	200	[3]
	380-16	<340	[1][2]
	380-17	<340	[1][2]
8 Forward casing at Fwd bulkhead	300-16	<175	[1]
	380-18	<340	[1][3]
	380-19	<340	[1]
Notes			
[1]	No change, therefore temperature less than label minimum		
[2]	Label burned in post-firing flameout		
[3]	Label physically damaged		


Forward bulkhead
<D
<
<
<
<
200D
<
175
<
<
Label damaged in disassembly
Temp appeared to be 250
250D
<
<
Mid bulkhead
<D
200
<
200
Area of slight heat
discoloration
<D
300
<
275
340D
275
<
250
Quarter-span
250
<
250
<
350
B
<
300
Burned area
B
B
B
Nozzle Ring
D
Label damaged
B
Label burned or damaged
<
Less than minimum temp

A video camera was used to record a number of thermal labels during and immediately after the motor firing. The temperature versus time results for label 300-10 (see Fig.5) was extracted from the video recording and is shown in Table 2 and is plotted in Figure 10.

	Time (sec)	Temperature (ºF)	(ºC)
motor fires >	0	110	43
	18	175	79
	36	200	93
	86	223	106
	108	250	121
	134	275	135
	205	300	149

Table 2

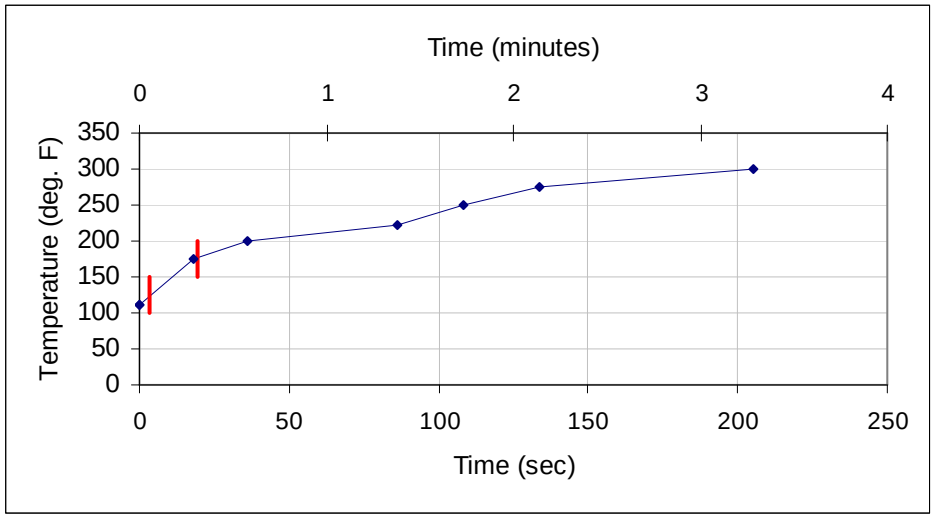


Figure 10 – Temperature vs time data for label 300-10. Red lines indicate burn-out of 1st and 2nd phases.