LSPE EXPLOSIVE PACKAGE STOWAGE AND DEPLOYMENT THERMAL CONSTRAINTS

This ATM revision presents a supplement to the study of the LSPE High Explosive Package and transport frame stowage thermal constraints subsequent to LM touchdown and prior to lunar deployment. In addition, lunar deployment thermal constraints are presented for deployment of the individual H. E. packages. This revision is meant to accompany the original ATM-1002.

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1.0 INTRODUCTION

ATM 1002 dated April 23, 1971, presented the results of a thermal analysis of the LSPE transport frame and High Explosive package stowed aboard the LRV tool pallet. There was concern that the explosive packages would not attain the minimum operating temperature required for proper safe-arm and thermal battery timer operation if the LRV were exposed to a shade environment for an extended length of time. Maximum time of exposure as determined by the thermal analysis was 25 minutes.

A letter from LSPO in answer to Action Item 134, "Thermal Design Requirements for LSP on LRV" indicated the maximum time of shade exposure could be 45 minutes. This "Revision A" to ATM 1002 presents the results of a study to determine possible areas of conservatism in the orginal analysis and or possible design fixes to hardware to allow 45 minute shade exposure. In addition, this revision answers a request to reiterate LM and LRV iterim stowage and lunar deployment thermal constraints and contingency action required in the event that the high explosive packages should be exposed to shade for a longer period of time than required per the LSPO letter referenced above.

2.0 SUMMARY

The original transport frame assembly design is not capable of withstanding the 45 minutes of shade exposure required during LRV interim stowage. Redesign of the transport frame support fittings-high explosive base plate interface allows for 45 minutes of shade exposure aboard LRV with no detrimental effects to the HE mechanism.

The requirement that the safearm and thermal battery timers be at +40°F minimum operating temperature immediately at the time of their deployment and maintained above that temperature at all times during their operation demands the following thermal requirements and constraints on HE package stowage between EVA-1 and EVA-2 and on deployment of individual packages on the lunar surface:

1. LSPE transport frame assemblies and LM right hand pallet must be placed on the lunar surface facing the sun a minimum of 10 hours prior to EVA-2. (This action is required to keep the explosive packages within acceptable temperature limits. If the assumption is made that LM landing orientation places Quad III in the sun, and the Quad III thermal blanket remains in place, the explosive package temperature could be as low as 28°F at the start of EVA-2 per GAC-ICD-22314 Figure 2. If the thermal blanket is removed after landing the explosive temperature could reach 267°F or greater in direct sunlight. On the other hand, removal of the explosive packages and placement in the sun will control the temperature range between 147°F and 181°F. Stowage design limit maximum temperature is 185°F.)

2. The second transport frame to be deployed during EVA-3 must remain in the sun on the LM pallet until it is stowed aboard LRV during EVA-3.

3. The LSPE high explosive packages will be at minimum operating temperature at the time of lunar deployment after a maximum of 45 minutes of shade exposure aboard LRV at anytime during EVA activity.

4. Exposure to shade aboard LRV in excess of 45 minutes must be followed by a minimum exposure to sunlight as indicated in Figure 1 of this ATM 1002 Revision A.

5. High Explosive packages which are removed from their transport frames for operational lunar deployment must be placed in the sun at the time of deployment and in a location such that they will remain in the sun throughout their operational mission (i. e., from initial deployment until lunar noon).

6. High Explosive packages cannot be deployed in any holes or craters of wall slope greater than + 5° from the horizonal.

7. Misalignment of the top surface of the high explosive package upon lunar deployment must not exceed 12 degrees with the horizonal.

3.0 INTERIM STOWAGE ABOARD LRV DURING EVA'S

The Lunar Surface Project Office reply to Action Item 134 (see ref.) indicates the possibility of 45 minutes total shade exposure during the LRV, EVA mission. The original LSPE transport frame and High Explosive package design was capable of withstanding a total exposure of 25 minutes before reaching minimum deployment temperature as indicated in the original ATM 1002. Redesign of the high explosive package baseplate-transport frame mounting pins to resist heat leak to the transport frame results in a design capable of withstanding the 45 minutes of exposure required.

Figures 2 and 3 indicate temperature time profiles of the HE baseplate, LSPE transport frame, and LM tool pallet. Figure 2 indicates

results based on sun/shade exposures according to the timeline obtained from LSPO. The initial temperature of the LSPE transport frame assembly is 147°F. This is the temperature of an assembly upon its removal from the LM right hand pallet stowed on the lunar surface. The temperature of the HE baseplate drops from 97°F to 44.5°F as a result of the LRV exposure to 45 minutes of shade.

Figure 3 indicates temperature decays occuring after the transport frame assemblies have attained thermal equilibrium atop the LRV tool pallet. The HE baseplate will drop to 42.0°F as a result of 45 minutes of shade exposure.

Figure 1 is the result of a study of contingency action in the event that the LRV were to be exposed to a shaded environment for more than 45 minutes. Contingency action would require additional sun exposure of the transport frame assemblies before activation of the high explosive timers in accordance to the curve in Figure 1.

4.0 LUNAR DEPLOYMENT CONSTRAINTS

The high explosive thermal design is dependent upon package deployment in the sun. Deployment in the shade would result in the high explosive timer temperature dropping below the +40°F minimum operating temperature needed for proper operation.

The high explosive packages must not be deployed in any holes or craters where the local slope is greater than 5 degrees from the horizonal. Locating the package in such a hole would increase the effect of the lunar view factor resulting in the baseplate maximum temperature exceeding the +180°F maximum allowable operating temperature.

The high explosive packages must be deployed in a upright position. Misleveling of the top will result in an increase of absorbed sunlight at high sun angles. Misleveling greater than 12 degrees will result in a maximum temperature in excess of +180°F.

REFERENCES

(1) Bendix ATM-1002, April 23, 1971

(2) NASA Letter EH3/4-22/L187/B answer to Action Item 134, "Thermal Design Requirements for LSP on LRV".

Temperature-Time Decay of LSPE High Explosive Packages after Exposure to 45 Minutes of Shade during EVA 2. Timeline Received from LSPO per Action Item 134.

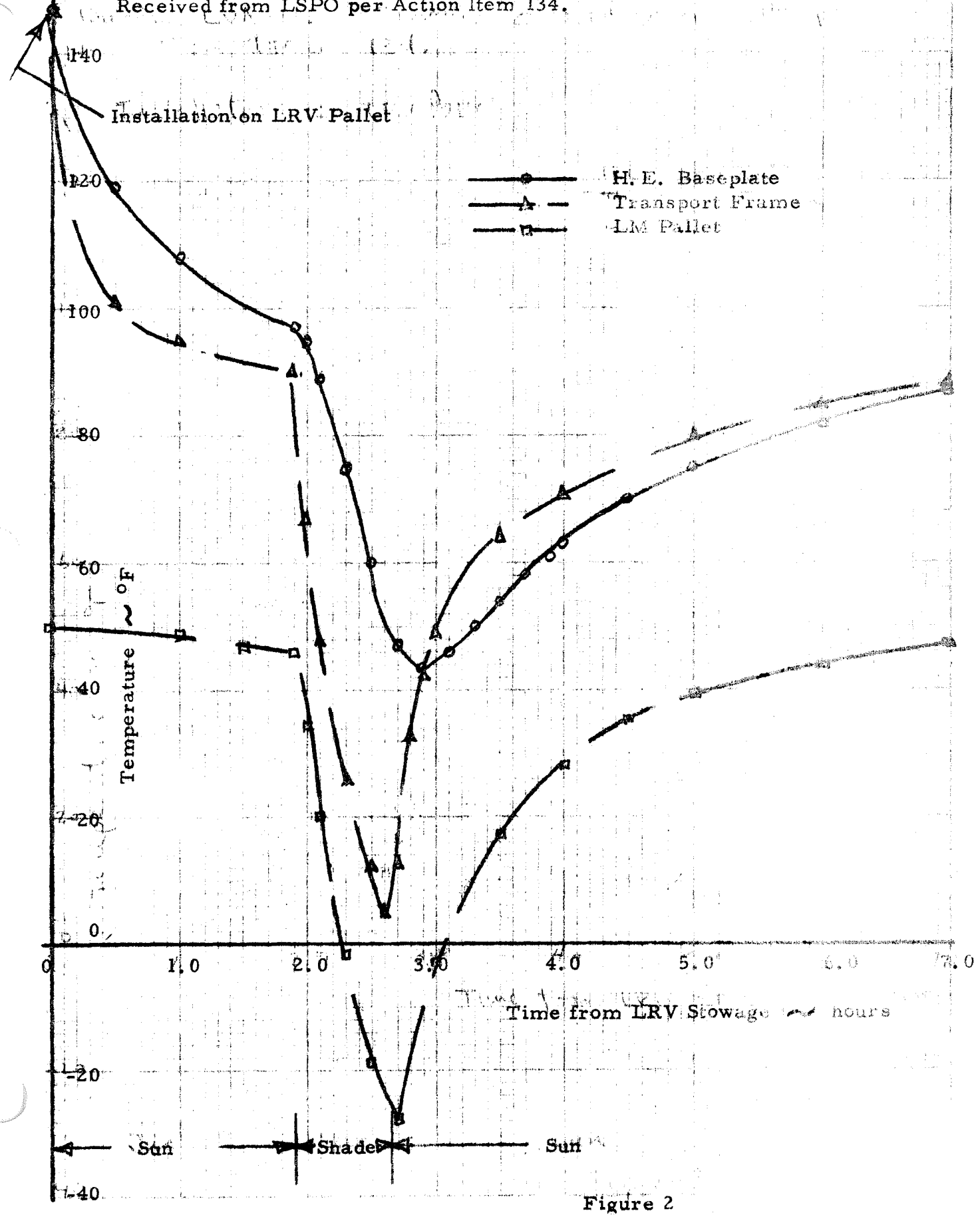
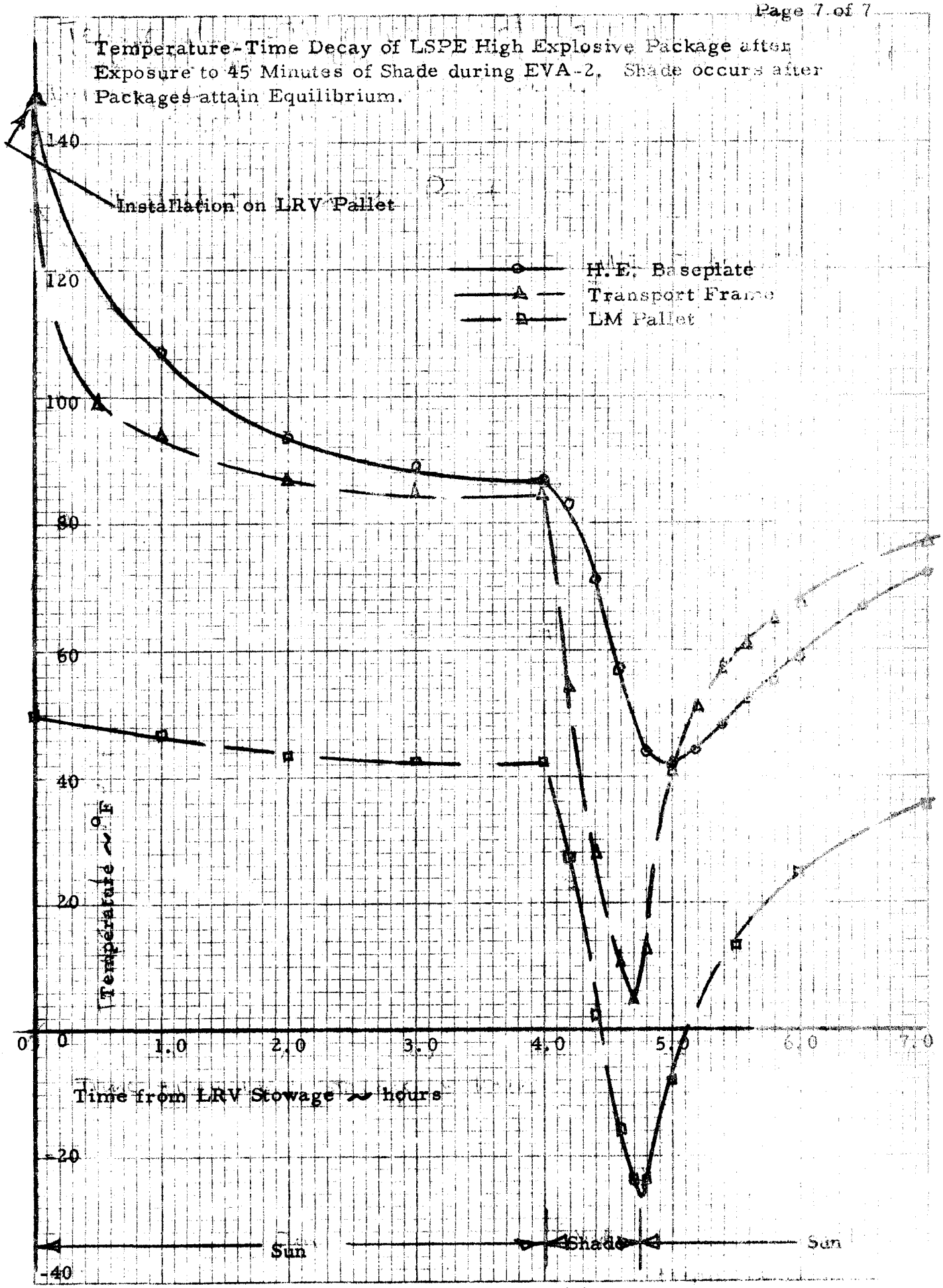


Figure 2

Temperature-Time Decay of LSPE High Explosive Package after Exposure to 45 Minutes of Shade during EVA-2. Shade occurs after Packages attain Equilibrium.



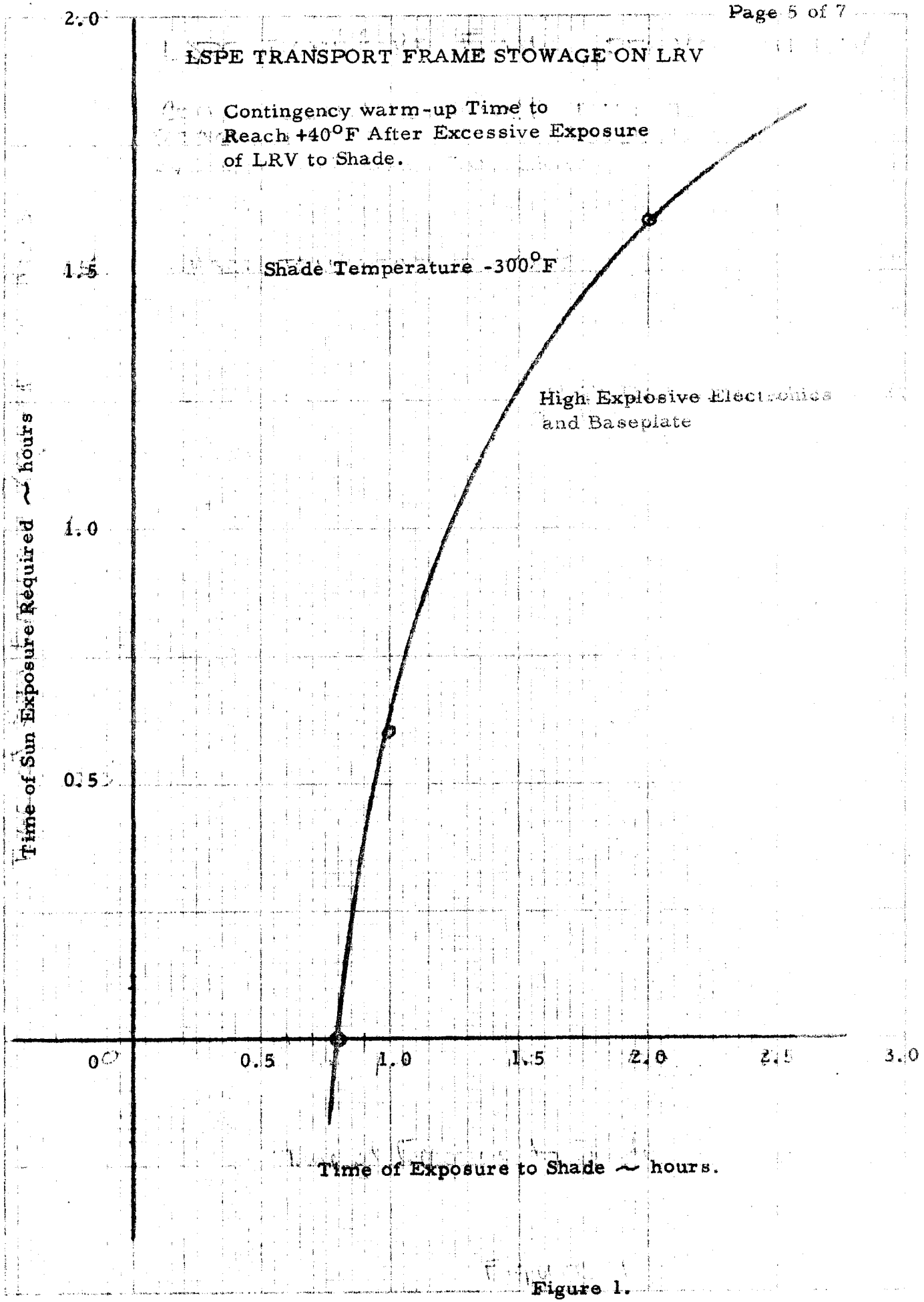

LSPE TRANSPORT FRAME STOWAGE ON LRV
Contingency warm-up Time to Reach +40°F After Excessive Exposure of LRV to Shade.
Shade Temperature -300°F
High Explosive Electronics and Baseplate
Time of Sun Exposure Required ~ hours
Time of Exposure to Shade ~ hours.
2.0
1.5
1.0
0.5
0
0.5
1.0
1.5
2.0
2.5
3.0

Figure 1.