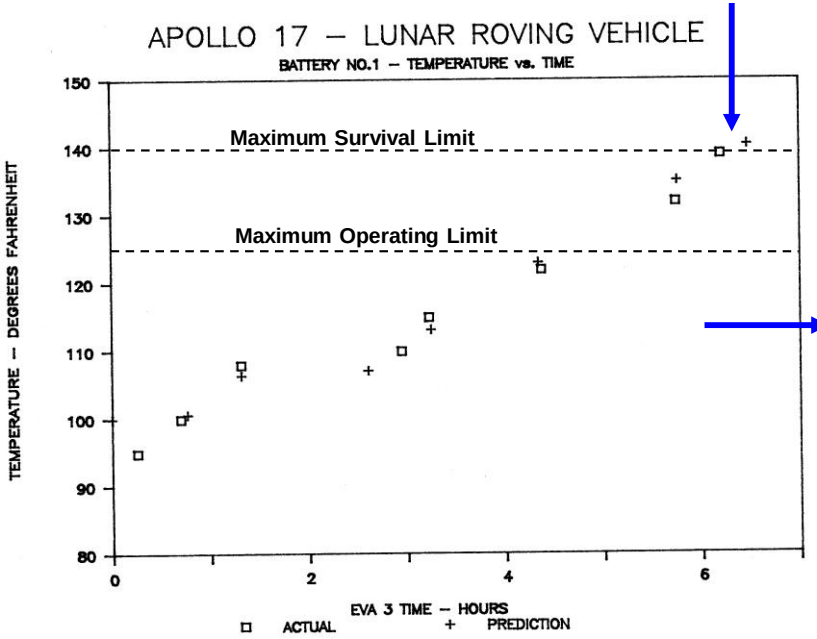
Apollo Lunar Roving Vehicle (LRV) - Forward Chassis Thermal Analyzer Model Correlated with Thermal/Vacuum Testing and Used for Mission Support

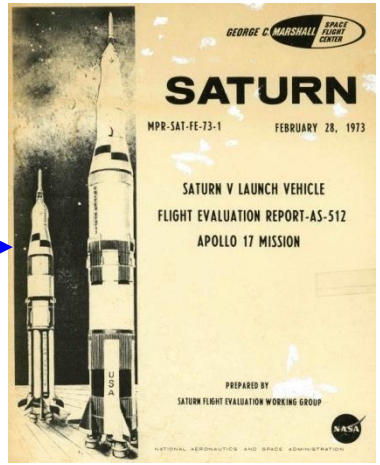
LRV-3 REAL-TIME THERMAL ANALYZER
INPUT MODE

ACTUAL DATA **********			
BEG DRIVE	_____	EVA TIME	_____
SEG DIST	_____	OUT TIME	_____
NAV ON	_____	LCRU ON	_____
BAT1 AMPHR	_____	BAT2 AMPHR	_____
BAT1 TEMP	_____	BAT2 TEMP	_____
STATUS	_____	COOLDOWN	_____
SUN ANGLE	_____	HEADING	_____
ALP B1+SPU	_____	ALP B2+DCE	_____
LM DIST	_____	LM TEMP	_____
LTX	_____	UTX	_____
LTY	_____	UTY	_____
COMPUTED DATA **********			
BAT1 TEMP	_____	BAT2 TEMP	_____
SPU TEMP	_____	DGU TEMP	_____
DCE TEMP	_____	SPU WX MLT	_____
DCE WX MLT	_____	RAIL TEMP	_____

- Flexible, Responsive Mission Support Analysis Needed
- Forward Chassis And Viewed Components Modeled
  - 19 Node Model Derived From LUROVA And Used For Apollo 16 And Apollo 17 Mission Support
- Included Full Battery Power Switching, Variable Radiator Dust Coverage, And LM Proximity Effects (17)
- Used For Real-Time And Pre-EVA Sortie Predictions

LRV Forward Chassis Components Modeled





Mission Reports

Accurate, Responsive Predictions Provided

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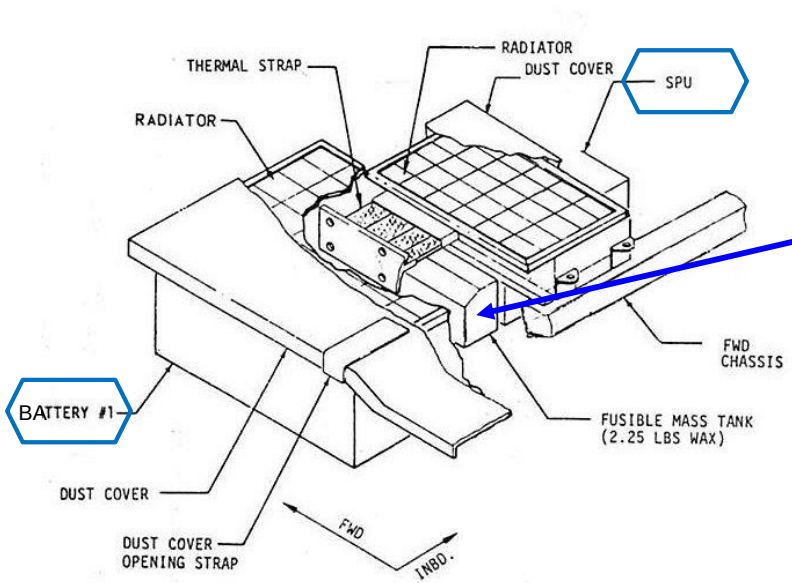
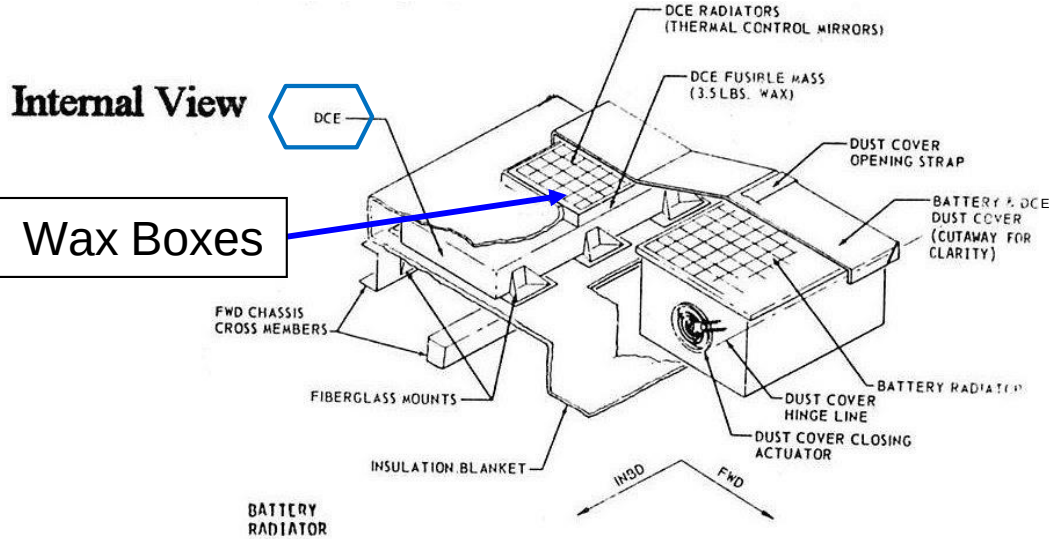
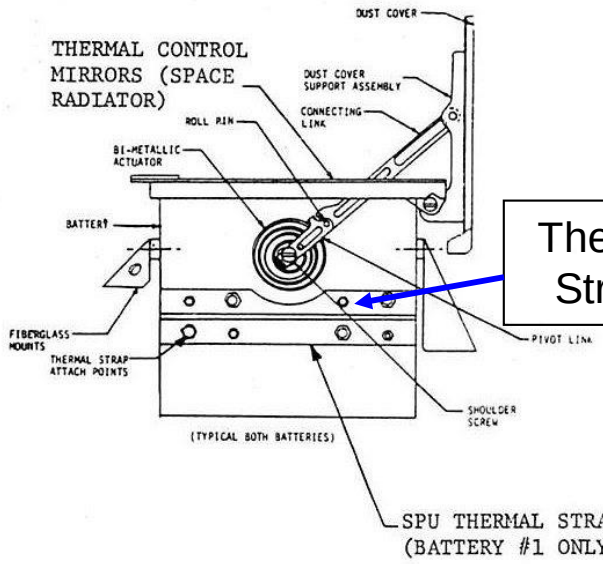
LRV Forward Chassis Electronics Thermal Model

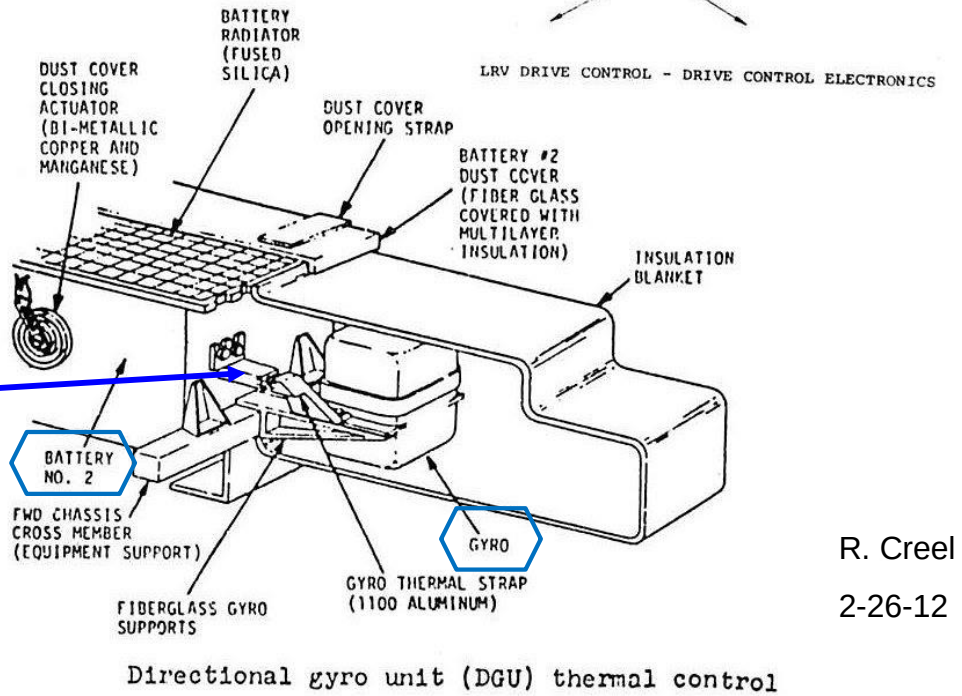


Wax Boxes





Thermal Straps



LRV DRIVE CONTROL - DRIVE CONTROL ELECTRONICS

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Signal Processing Unit And Directional Gyro Unit Strapped To 26.8 kg Batteries

Wax Boxes to Store Extra Component Generated Heat

LRV Component Temperature Limits – Deg. F

	Component	Minimum Survival	Minimum Operating	Maximum Operating	Maximum Survival
Electronics	Batteries*	-15	40	125	140
	Signal Processing Unit (SPU)	-65	30	130	185
	Directional Gyro Unit (DGU)	-80	-65	160	200
	Indicating Meters	-22	-22	160	160
	Position Indicator	-65	-22	185	185
	Drive Controller Electronics (DCE)	-20	0	159	180
Mobility	Traction Drive	-50	-25	400	450
	Suspension Damper	-70	-65	400	450
	Steering Motor	-50	-25	360	400
	Wheel	-250	-200	250	250

*** 163 wt-hr/kg Stored Power per Battery**

LRV Forward Chassis Components Modeled

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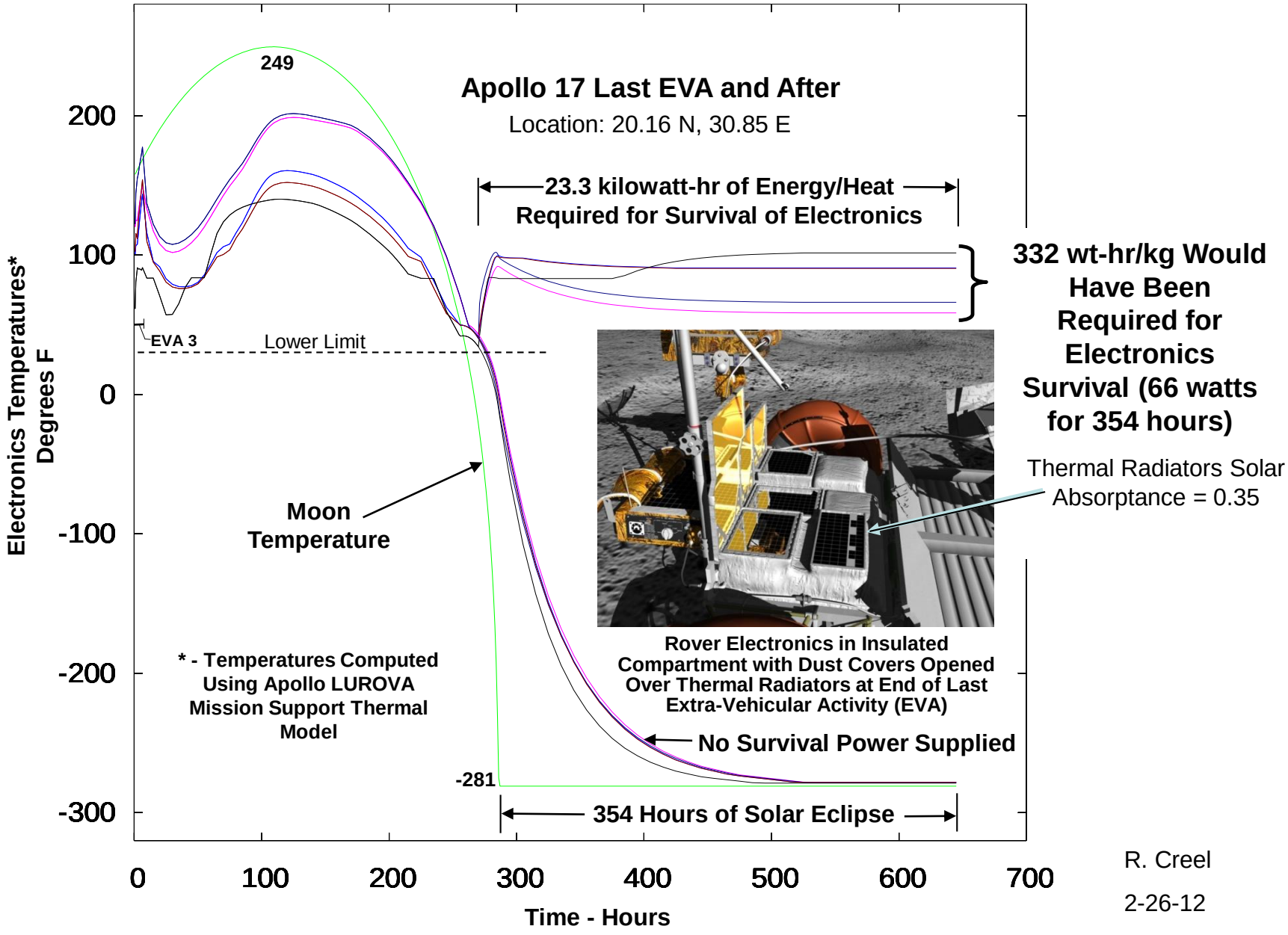
Apollo LRV – Power Needed for Future Extended Thermal Survival on Moon



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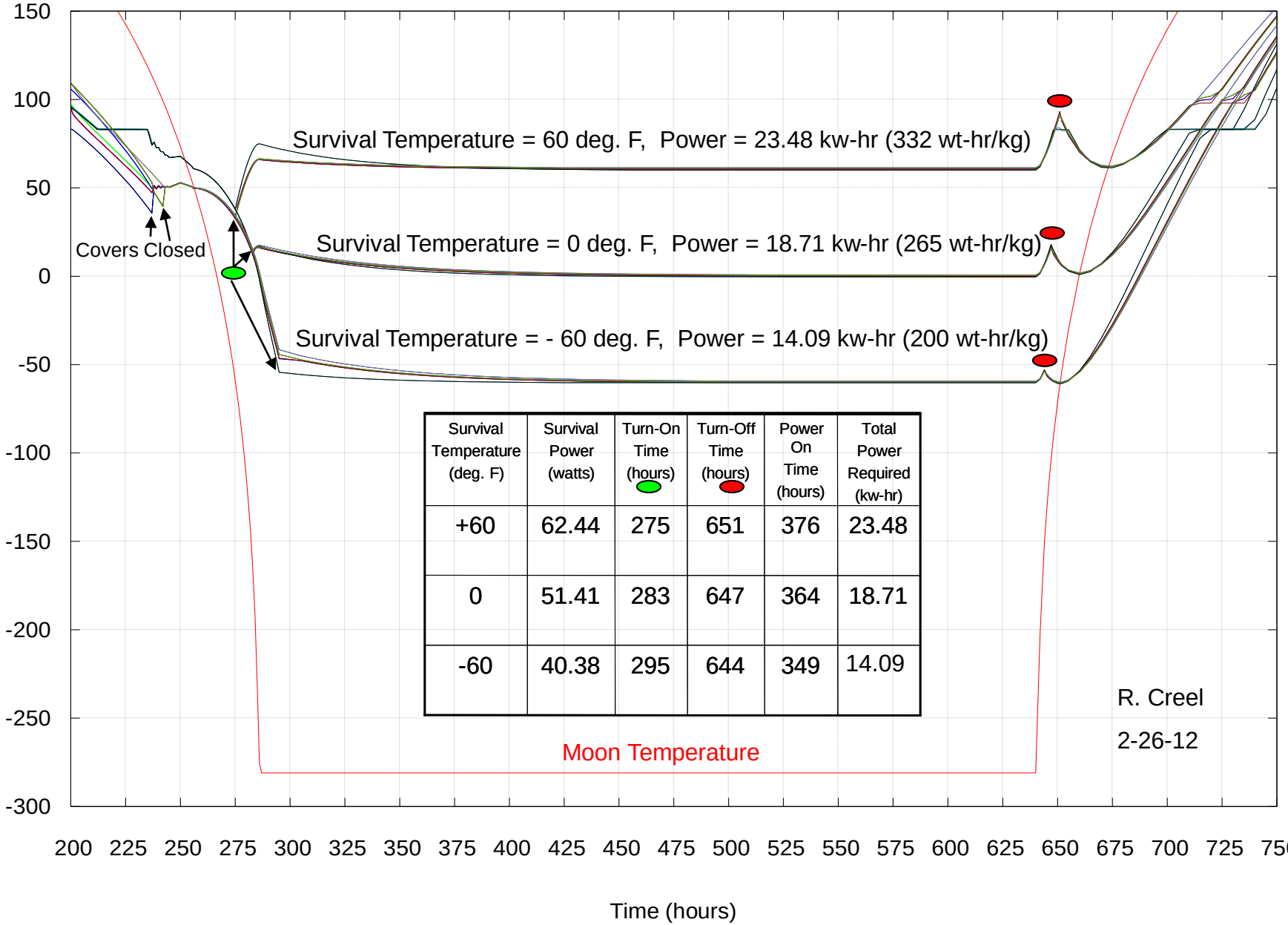
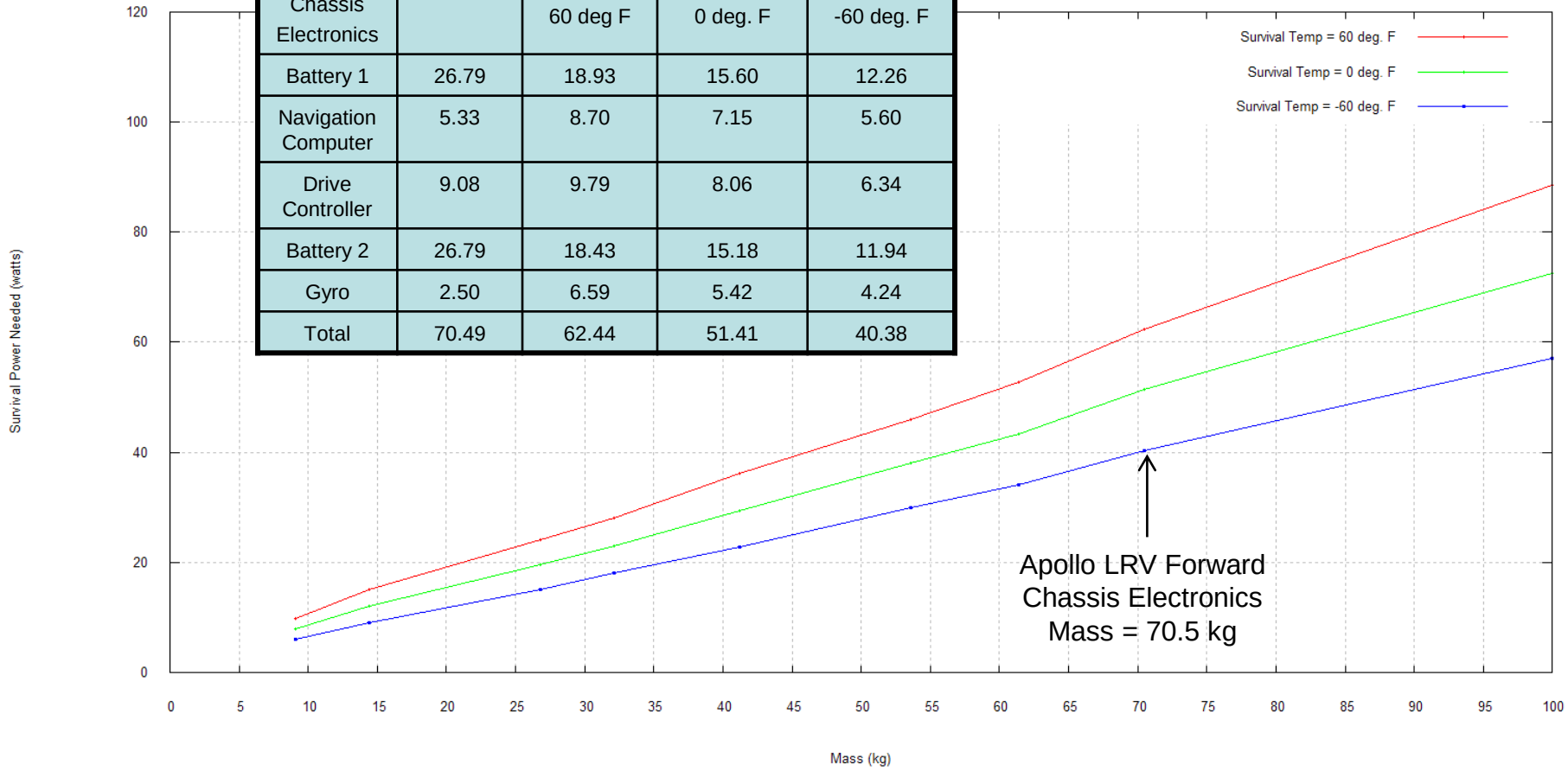
Apollo Lunar Roving Vehicle Forward Chassis Electronics (70.5 kg)
Temperature vs. Time With Applied Survival Power



Survival Temperature (deg. F)	Survival Power (watts)	Turn-On Time (hours)	Turn-Off Time (hours)	Power On Time (hours)	Total Power Required (kw-hr)
+60	62.44	275	651	376	23.48
0	51.41	283	647	364	18.71
-60	40.38	295	644	349	14.09

Nightrover Survival Power Needed vs. Mass
Using Apollo LRV Thermal Model

LRV Forward Chassis Electronics	Mass (kg)	Power (watts) for Survival Temperatures		
		60 deg F	0 deg. F	-60 deg. F
Battery 1	26.79	18.93	15.60	12.26
Navigation Computer	5.33	8.70	7.15	5.60
Drive Controller	9.08	9.79	8.06	6.34
Battery 2	26.79	18.43	15.18	11.94
Gyro	2.50	6.59	5.42	4.24
Total	70.49	62.44	51.41	40.38



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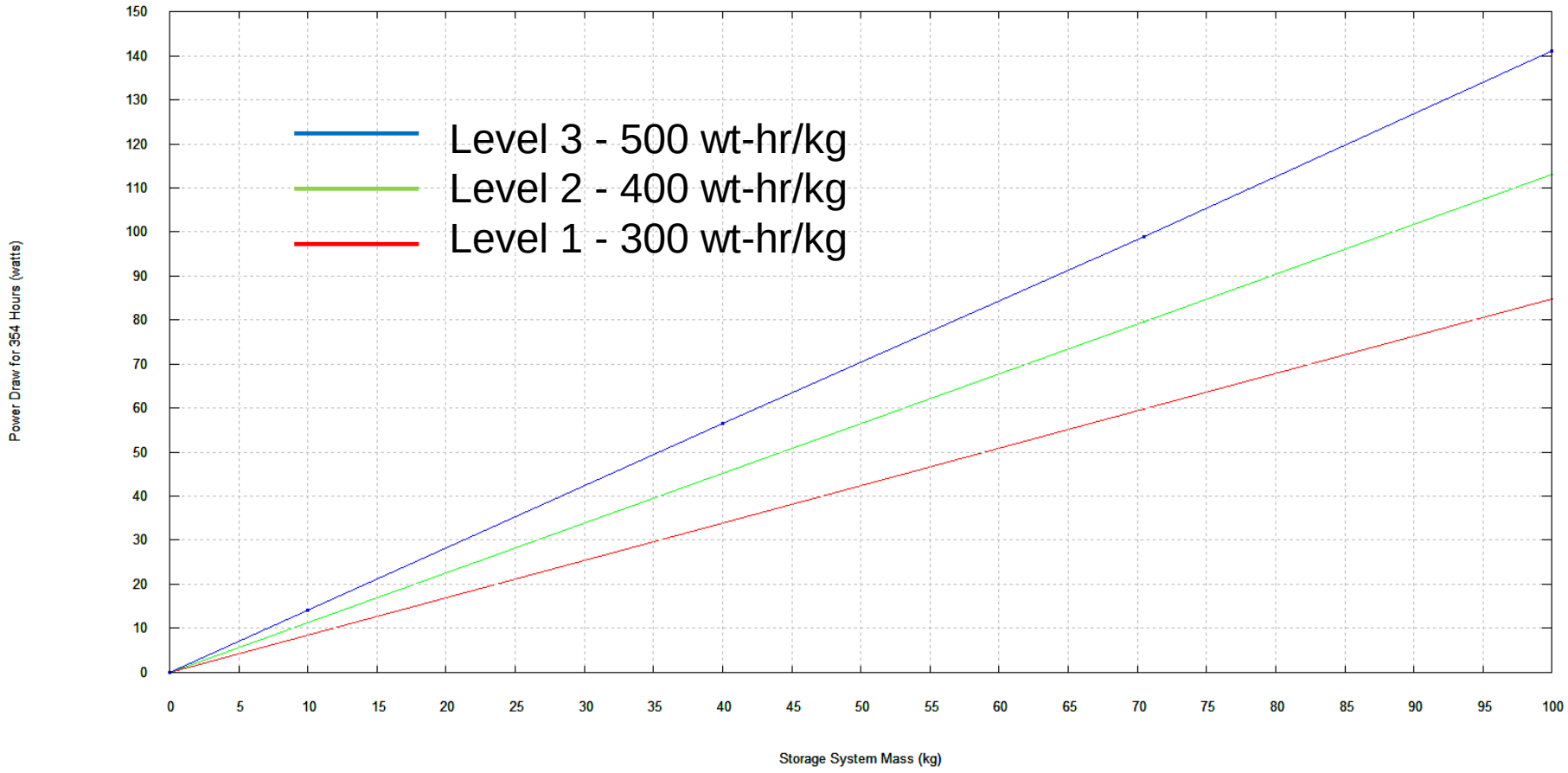
Nightrover – 354 Hour Qualification Round
Power Draw vs. Storage System Mass



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