Instrumentation Laboratory
MASSACHUSETTS INSTITUTE OF TECHNOLOGY
Cambridge, Massachusetts

G. Silver
with
file LM
Temp / CDS

THERMAL LABORATORY MEMORANDUM NO. 292

TO: William Stameris

FROM: Charles Jurgelewicz

DATE: 17 September 1969

SUBJECT: L/M Maximum Coolant Temperature Increase Proposed by LM.

GAEC desires to put a water boiler bypass in the LM10-LM14 Vehicle to conserve water during extended missions on the moon. To accomplish this, they are requesting a change in the ICD cooling requirements per the attached ICRA No. 10-273.

The proposed changes are summarized as follows:

1. The coolant flow rate is changed from 33 ± 5 lbs/hr to 30-100 lbs/hr.

2. The maximum coolant temperature during IMU/LGC standby mode changed from 50° F to 80° F. The minimum coolant temperature remained at 32° F.

3. During the operate mode, the maximum coolant temperature changed from 50° F for a structure range of 30 to 130° F to maximum coolant temperature as a function of structure temperature as shown in Figure 6 of the ICRA. The minimum coolant temperature remained at 32° F. (Refer to Figure I for coldplate arrangement in the LM Vehicle.)

The increase in coolant flow and the increase in coolant temperature during standby are acceptable but the coolant changes for the operate mode are not.

An acceptable curve is shown in Figure II for maximum coolant temperature as a function of structure in a zero gravity environment. The constraining item is the IMU. The curve was based on maximum buss voltage, zero gravity and a vacuum environment surrounding the IMU. The IMU thermal interchange with the ambient is only through radiation and conduction to structure.

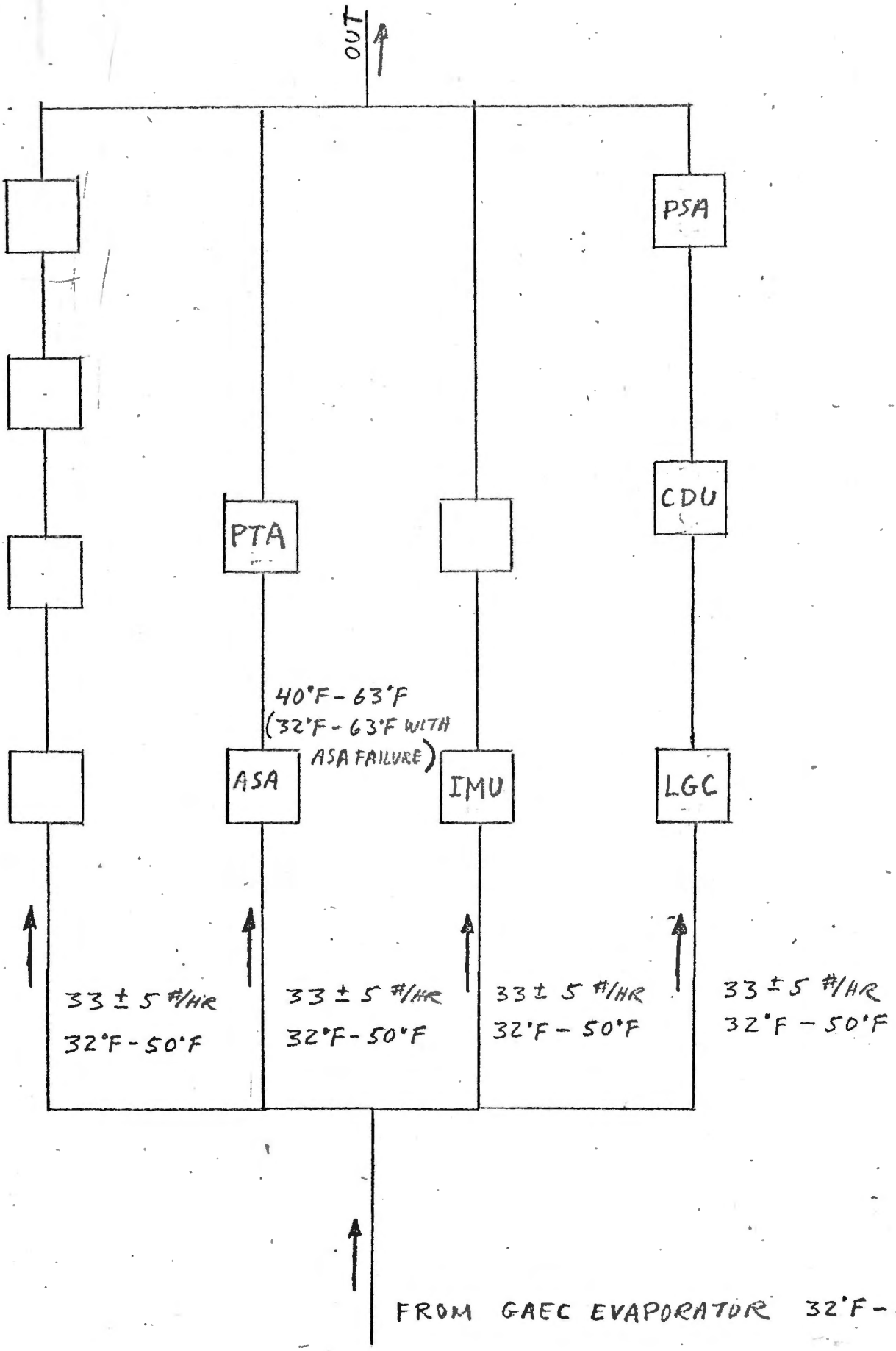
Silicon devices in the PSA and PTA electronics packages are at the maximum reliability limit for junction temperatures (105° C) when the maximum coolant temperature from the evaporators is at 70° F which is coincidental with the maximum IMU limit. The PIPA scale factor resistors on the other hand will not exceed 45° C (113° F).

It is necessary, however, for the systems people to give their inputs as to the effect on system performance under the proposed new maximum coolant temperature limits (Figure II), if any, before any changes to the ICD are made.

The PGNS system must be requalified for any increased coolant temperatures that exceed the present ICD limits.

Charles Jurgelewicz

CJJ/jcc
Enclosures: Figures I, II
Distribution: G. Edmonds
J. Gilmore
E. Hickey
A. Laats
R. Lones
G. Silver
N. Sears

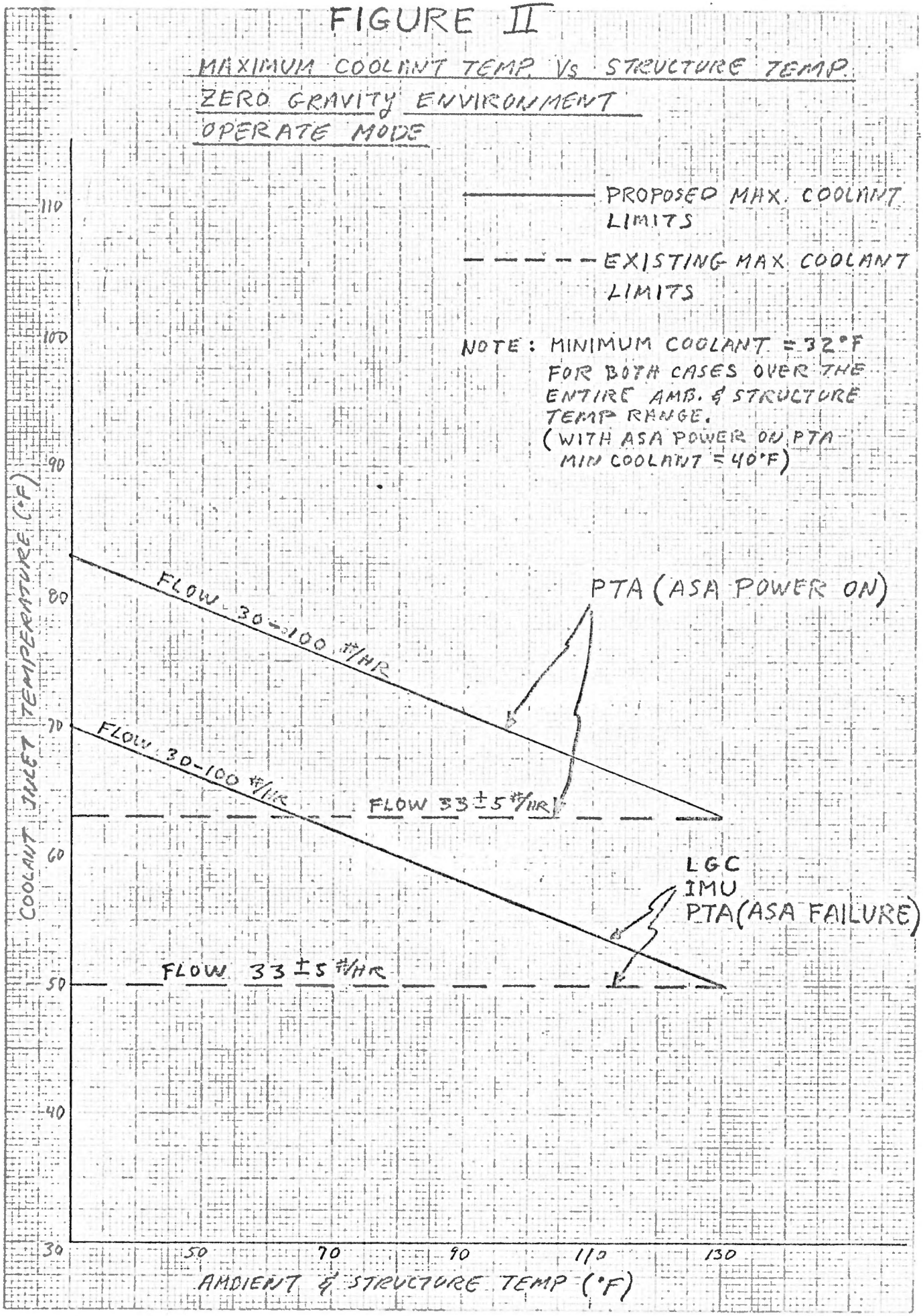


COLDPLATE ARRANGEMENT IN LM VEHICLE
WITH EXISTING COOLANT FLOW RATES & TEMP.

FIGURE I

FIGURE II

MAXIMUM COOLANT TEMP. Vs STRUCTURE TEMP.
ZERO GRAVITY ENVIRONMENT
OPERATE MODE



FORM 1 R

ICRA - INTERFACE CHANGE REQUEST AND AUTHORIZATION

Title of Change: PGNS Coolant Requirements (LMMP)

ICRA No. 10-273

Page 1 of 4

Date: 8-21-69

Effectivity: (a) LM Vehicle LM-10 thru LM-14
(b) G&N System

Source: System or Subsystem LM Thermodynamics

References

Initiator J. Rizzuto/R. Belchem

Coordinate With Interface Document No.(s) LIS-510-10001 B

Change Required to PGNCS P&I Spec. Yes X No
(If required, attach proposed changes)

Problem:

The reconfiguration of the ECS loop to accommodate a W/B bypass requires revisions to the PGNS coolant requirements for the LMMP missions.

Proposed Solution - See ICRA sheet(s) 2,3,4

Approvals:

MIT/IL		DATE
GAEC	JDM	DATE 8/22/69

AUTHORIZED SIGNATURES	REPRESENTING	DATE
[signature]	GAEC	8/22/67
	MIT	

INTERFACE REVISION NOTICE

INTERFACE CONTROL DOCUMENT

GRUMMAN AIRCRAFT ENGINEERING CORPORATION BETHPAGE, L. I., NEW YORK

CODE IDENT NO.	IRN NO: LIS-510-10001 B- Sheet 1 of 3
26512	ICRA NO: 10-273 Page 2 of 4
ICD NO. LIS-510-10001 B	
CCA NO.	DATE

ICD TITLE
Thermodynamic Requirements of PGNS Equipment

THIS DOCUMENT SPECIFIES TECHNICAL REQUIREMENTS BETWEEN ALL PARTIES AFFECTED HEREIN. NOTHING CONTAINED IN THIS DOCUMENT SHALL BE DEEMED TO ALTER THE TERMS OF ANY CONTRACT OR PURCHASE ORDER BETWEEN GAEC AND THE ADDRESSEE.

DESCRIPTION: Vehicle Effectivity: LM-10 thru LM-14

Change From: 1.2.2.1 Coolant Flow Rates: ----
To : 1.2.2.1.1 Coolant Flow Rates (All vehicles except LM-10 thru LM-14): ....
Add : 1.2.2.1.2 Coolant Flow Rates (LM-10 thru LM-14): The mass flow rate of the environmental control coolant to the IMU cooling loop during manned phases of the mission will be 30 to 100 lbs/hr. During unmanned translunar flight, there will be no coolant flow to the IMU.

Change From: 1.2.2.4 Coolant Temperature Variations: ....
To: 1.2.2.4.1 Coolant Temperature Variations (All vehicles except LM-10 thru LM-14): ....
Add: 1.2.2.4.2 Coolant Temperature Variations (LM-10 thru LM-14): The minimum coolant inlet temperature to the IMU will be 32°F.
The maximum coolant inlet temperature to the IMU will depend on structure temperature as shown in Figure 6.
When the PGNS is in the IMU standby/LGC standby mode the maximum coolant inlet temperature to the IMU will be +80°F.

REASON:

DRAWN BY:

IRN NO: LIS-510-10001 B-
Sheet 2 of 3

ICRA NO: 10-273
Page 3 of 4
ICD NO. LIS-510-10001 B

ICD TITLE
Thermodynamic Requirements
of PGNS Equipment

DESCRIPTION: Vehicle Effectivity: LM-10 thru LM-14

Change From: 1.2.3.1 Coolant Flow Rate: ....
to: 1.2.3.1.1 Coolant Flow Rate (All Vehicles except LM-10 thru LM-14): ....
Add: 1.2.3.1.2 Coolant Flow Rate (LM-10 thru LM-14): The LGC, CDU and LPSA cold plates are connected in series in the ECS loop. Figure 2 shows the flow pattern of the coolant through the equipment cold plates. The flow rate to the LGC, CDU and LPSA coolant loop will be 30 to 100 lbs/hr. The flow rate to the PTA cold plate will be 30 to 100 lbs/Hr. The coolant flow pattern through the PTA cold plate is shown in Figure 2. During unmanned translunar flight, there will be no coolant flow to the PGNS equipment cold plates.

Change From: 1.2.3.2 Coolant Temperature Variations: ....
To: 1.2.3.2.1 Coolant Temperature Variations (All vehicles except LM-10 thru LM-14): ....
Add: 1.2.3.2.2 Coolant Temperature Variations (LM-10 thru LM-14): The minimum coolant inlet temperature to the LGC/CDU/PSA coolant loop during manned phases of the mission will be 32°F. The minimum coolant inlet temperature to the PTA cold plate will be +40°F. In the event of a loss of power in the LM Abort Sensor Assembly (ASA), the coolant inlet temperature to the PTA will be + 32°F. The maximum coolant inlet temperature to the LGC/CDU/PSA coolant loop will depend on structure temperature as shown in Figure 6. When the PGNS is in the IMU standby/LGC standby mode the maximum coolant inlet temperature to the LGC/CDU/PSA coolant loop will be +80°F. When the PGNS is in the IMU standby/LGC standby mode the maximum coolant inlet temperature to the PTA will be +93°F.

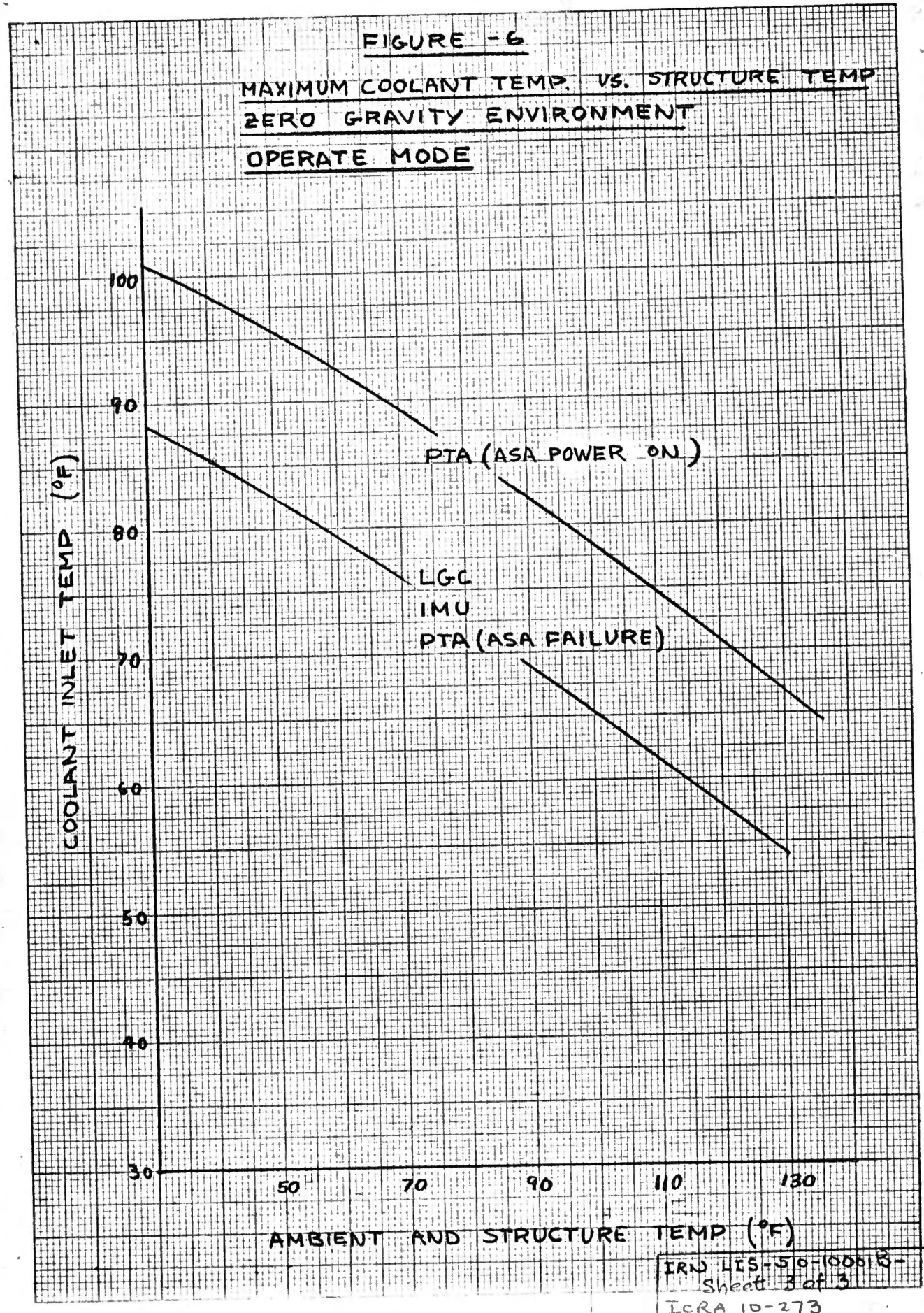
Figure 2: After Flow Rate = 33 ± 5 lbs/hr. (2 places)
Add: (All vehicles except LM-10 thru LM-14)
Flow Rate = 30 to 100 lbs/hr. (LM-10 thru LM-14)

Add: Figure 6

FNC 27 2 1-64

FIGURE -6

MAXIMUM COOLANT TEMP. VS. STRUCTURE TEMP
ZERO GRAVITY ENVIRONMENT
OPERATE MODE



IRN LIS-510-10001B-
Sheet 3 of 3
IcRA 10-273

1.6 Ground Cooling Requirements

Operating Mode	IMU Coolant Inlet Temp. °F	LGC Coolant Inlet Temp. °F	PTA Coolant Inlet Temp. °F	IMU Coolant Flow Rate lbs/hr	LGC Coolant Flow Rate lbs/hr	PTA Coolant Flow Rate lbs/hr	Max. Allowable Ambient & Struct. Temp.
IMU or LGC in operate mode	32-60	32-60	32-65	28-76	28-76	28-76	90° F*
IMU in standby mode, LGC in stand by mode	32-100	32-100	32-100	28-76	28-76	28-76	130°F
IMU in standby, LGC off	32-109	32-109	32-109	0-76	0-76	0-76	130°F
IMU off, LGC off. Portable Temp Controller Supplies IMU heater Pwr.	32-109	32-109	32-109	0-76	0-76	0-76	130°F

* For conditions where ambient or structure temperature exceeds 90°F, mission cooling requirements apply.

1.7 LM-1 Coolant Flow Rate: The coolant flow rate for LM-1 flight operation of the PGNS (LGC, CDU, PSA, IMU and PTA) shall be within the range of 28 and 66 lbs per hour. The same coolant inlet temperature range of 32°F to 50°F shall still apply.