GAEC desires to put a water boiler bypass in the IM10-IM14 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 IM 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 bus 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 FGNS system must be requalified for any increased coolant temperatures that exceed the present ICD limits.

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

Charles Jurgelewicz
COLDPLATE ARRANGEMENT IN LM VEHICLE WITH EXISTING COOLANT FLOW RATES & TEMPS

FIGURE I
FIGURE II

MAXIMUM COOLANT TEMP VS STRUCTURE TEMP
ZERO GRAVITY ENVIRONMENT
OPERATE MODE

- PROPOSED MAX. COOLANT LIMITS
- EXISTING MAX. COOLANT LIMITS

NOTE: MINIMUM COOLANT = 32°F
FOR BOTH CASES OVER THE ENTIRE AMB. & STRUCTURE TEMP. RANGE.
(WITH ASA POWER ON, PTA MIN COOLANT = 40°F)

FLOW: 30 ± 100 FPM

FLOW: 33 ± 5 FPM

FLOW: 33 ± 5 FPM

PTA (ASA POWER ON)

LGC IMU
PTA (ASA FAILURE)
ICRA - INTERFACE CHANGE REQUEST AND AUTHORIZATION

Title of Change: IONS Coolant Requirements (IMMP)  
ICRA No. 10-273  
Page 1 of 4  
Date: 8-21-69

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

Source: System or Subsystem IM Thermodynamics

Initiator: J. Rizzuto/R. Balchem

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 IONS coolant requirements for the IMMP missions.

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

Approvals:

MIT/IL  
GAEC  

DATE  
8/21/69
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:
DEVELOPMENT: Vehicle Effectivity: IM-10 thru IM-14

Change From: 1.2.3.1 Coolant Flow Rate:....
to: 1.2.3.1.1 Coolant Flow Rate (All Vehicles except IM-10 thru IM-14):....
Add: 1.2.3.1.2 Coolant Flow Rate (IM-10 thru IM-14): The IGC, 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 IGC, CDU and LPSA coolant loop will be 30 to 100 lbs/hr. The flow rate to the PTA coolant 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 IM-10 thru IM-14):....
Add: 1.2.3.2.2 Coolant Temperature Variations (IM-10 thru IM-14): The minimum coolant inlet temperature to the IGC/CDU/PSA coolant loop during manned phases of the mission will be 32°F. The minimum coolant inlet temperature to the PTA coolant plate will be +40°F. In the event of a loss of power in the IM Abort Sensor Assembly (ASA), the coolant inlet temperature to the PTA will be +32°F. The maximum coolant inlet temperature to the IGC/CDU/PSA coolant loop will depend on structure temperature as shown in Figure 6. When the PGNS is in the IMU standby/IGC standby mode the maximum coolant inlet temperature to the IGC/CDU/PSA coolant loop will be +93°F. When the PGNS is in the IMU standby/IGC 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 IM-10 thru IM-14)
Flow Rate = 30 to 100 lbs/hr. (IM-10 thru IM-14)

Add: Figure 6
FIGURE 6

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

COOLANT INLET TEMP. (°F)

PTA (ASA POWER ON)
LGC
IMU
PTA (ASA FAILURE)

AMBIENT AND STRUCTURE TEMP. (°F)
1.6 Ground Cooling Requirements

<table>
<thead>
<tr>
<th>Operating Mode</th>
<th>IMU Coolant Inlet Temp. °F</th>
<th>IGC Coolant Inlet Temp. °F</th>
<th>PTA Coolant Inlet Temp. °F</th>
<th>IMU Coolant Flow Rate lbs/hr</th>
<th>LGC Coolant Flow Rate lbs/hr</th>
<th>PTA Coolant Flow Rate lbs/hr</th>
<th>Max. Allowable Ambient &amp; Struct. Temp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>IMU or LGC in operate mode</td>
<td>32-60</td>
<td>32-60</td>
<td>32-65</td>
<td>28-76</td>
<td>28-76</td>
<td>28-76</td>
<td>90°F*</td>
</tr>
<tr>
<td>IMU in standby mode, IGC in standby mode</td>
<td>32-100</td>
<td>32-100</td>
<td>32-100</td>
<td>28-76</td>
<td>28-76</td>
<td>28-76</td>
<td>130°F</td>
</tr>
<tr>
<td>IMU in standby, IGC off</td>
<td>32-109</td>
<td>32-109</td>
<td>32-109</td>
<td>0-76</td>
<td>0-76</td>
<td>0-76</td>
<td>130°F</td>
</tr>
<tr>
<td>IMU off, LGC off, Portable Temp Controller Supplies IMU heater Pwr.</td>
<td>32-109</td>
<td>32-109</td>
<td>32-109</td>
<td>0-76</td>
<td>0-76</td>
<td>0-76</td>
<td>130°F</td>
</tr>
</tbody>
</table>

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

1.7 IM-1 Coolant Flow Rate: The coolant flow rate for IM-1 flight operation of the FGNS (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.