LAUNCH MISSION RULES
INPUT DOCUMENT

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
### MSFC Launch Mission Rules

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<td>SV Upper Air Winds</td>
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W. G. Clarke  
Manager, Operations Engineering Office
PRELAUNCH SIMULATIONS OF THE SPACE VEHICLE RESPONSE TO UPPER AIR WINDS AT TIME OF LAUNCH WILL BE PERFORMED AT MSFC BY AN MSFC/MSC WIND MONITORING TEAM USING WIND DATA PROVIDED BY KSC. A C-BAND RADAR WILL BE UTILIZED TO TRACK JIMSPHERE BALLOONS RELEASED FROM THE LAUNCH AREA TO OBTAIN UPPER AIR WIND DATA FROM L-48 HOURS TO T+10 MINUTES ON A SCHEDULE AGREED TO BY KSC, MSFC, AND MSC. RESULTS OF THE WIND SIMULATIONS WILL BE TRANSMITTED VIA DATAFAX TO THE LAUNCH OPERATIONS MANAGER (OR TEST SUPERVISOR IN HIS ABSENCE) AT THE LAUNCH CONTROL CENTER. REPORTS WILL BE AVAILABLE AND PROVIDED AS CONSIDERED APPROPRIATE STARTING AT L-24 HOURS WITH A GO/NO-GO RECOMMENDATION TRANSMITTED PRIOR TO START OF CRYOGENIC LOADING. IF THE WIND SIMULATIONS INDICATE THAT WIND CONDITIONS ARE MARGINAL FOR LAUNCH, THE WIND MONITORING TEAM WILL REPORT THAT "LAUNCH WINDS ARE MARGINAL FOR LAUNCH" UPON RECEIPT OF THIS REPORT, THE LAUNCH OPERATIONS MANAGER WILL PLACE A CONTINGENCY PLAN INTO EFFECT WHICH WILL PROVIDE FOR A NEW JIMSPHERE RELEASE EACH HOUR. THE CONTINGENCY PLAN WILL REMAIN IN EFFECT UNTIL LIFTOFF HAS OCCURRED, THE LAUNCH IS SCRUBBED, OR A SUBSEQUENT REPORT STATES THAT "LAUNCH WINDS ARE NO LONGER MARGINAL FOR LAUNCH." THE WIND MONITORING TEAM WILL PROVIDE A REPORT TO THE LAUNCH OPERATIONS MANAGER FOR EACH JIMSPHERE RELEASE UNDER THE CONTINGENCY PLAN.

THE UPPER AIR WIND CHART ON PAGE I-3.1 PROVIDES GENERAL GUIDANCE AS TO WHEN SIMULATIONS ARE REQUIRED. VEHICLE LIMITS ARE NOT EXPLICITLY REFLECTED.
SKYLAB WIND BIASED WIND SPEED LIMITS AT 12 KILOMETERS ALTITUDE

NOTE:
- CONTROL SYSTEM FROM MSFC MEMO S&E-ASTR-SD-93-71, DATED 3 SEPTEMBER 1971.
- $\alpha$-$\beta$ LIMITS FROM MSFC MEMO S&E-ASTN-ADL (72-41) DATED 12 APRIL 1972.
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<tr>
<td>2-927A</td>
<td>12K20</td>
<td>TEMP, NOSE CONE COMPARTMENT INDICATION</td>
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<td>FROM START OF LMRD UNTIL T-24 HOURS</td>
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<td>12K24 (ALTERNATE)</td>
<td>TEMP, NOSE CONE COMPARTMENT INDICATION</td>
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<td>FROM T-24 HOURS UNTIL INITIATION OF AUTO SEQUENCE</td>
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**MISSION:** SA-513/SL-1  
**SECTION:** LAUNCH VEHICLE  
**STAGE/SUBSECTION:** FACILITY GSE  
**SYSTEM:**  

**REMARKS:** Nose cone purge is required to maintain nose cone enclosure cleanliness and ambient temperature, and provide inerting. Loss of purge could result in excessive temperatures in PS volume, as well as hazardous gas buildup. At T-24 hours, purge temperature is increased from 63+5°F to 75+5°F to obtain acceptable launch temperatures for the ATM rack electrical/mechanical equipment. ATM telemetry data is not available to monitor temperatures; therefore, the proper purge temperatures must be assured. Loss of the purge after T-24 hours could result in cold rack equipment launch temperatures and corresponding cold problems in orbit prior to activation of the ATM systems, i.e., APGS, I&C, etc.

**REQUIRED BY:**  
ASTN  
ATM  

**CONTROL NUMBER:**  
513-EP-007-R 5  

**PAGE:** 1, 2  
**REVISION:** REV 4  
**DATE:** MAY 5 1973  
**PAGE:** I-23A
MSFC LAUNCH MISSION RULE BACKGROUND

SYSTEM BACKGROUND DATA:

1. **System Description**

   Volume enclosed by payload shroud is purged via a nose cone purge in two separate phases. First phase begins with the air purge at roll out from VAB. It is continuous, up to 30 minutes prior to cryogenic loading. At that time purge is switched over to N₂ at 50 lb/min with 1.54 psi umbilical pressure which is then continued till liftoff. Required compartment temperature range is 75°F ± 5°F.

2. **Probable Cause of (LMR) Violation**

   Facility GSE failure.

3. **Consequence of (LMR) Violation**

   Skylab launch with cold rack temperatures and corresponding cold equipment problems in orbit prior to ATM systems activation.

4. **Backup Measurements and Nominal Values**

   N/A

5. **Operational Tests**

   Facility air supply units (Nose Cone Purge GSE) are verified prior to hook-up.

6. **Reliability/Redundancy Considerations**

   There are no secondary purges available. Reliability of the system is dependent upon proven, well tested, and checked out facility GSE.

7. **Instrumentation Accuracy and Method of Redline Determination**

   Instrumentation Accuracy (Overall) is ± 1.3°F.

8. **Other Information**

   None
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(In addition, delete page 51A.2)
### MSFC Launch Mission Rule Input

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<td>3-219</td>
<td>M7002-440</td>
<td>VOLTAGE - PDCS, OWS BUS 1</td>
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<td>WHILE BUSES ARE ENERGIZED EITHER BY GROUND OR INTERNAL POWER UNTIL INITIATION OF AUTOMATIC SEQUENCE.</td>
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<td>M7400-440</td>
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<td>3-221</td>
<td>M7003-440</td>
<td>VOLTAGE - PDCS, OWS BUS 2</td>
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<td>* OWS BUS 1 AND 2 VOLTAGE SHALL BE WITHIN -1.8/+1.2 VDC OF THE RESPECTIVE AM REG. BUS.</td>
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<td>TRANSIENTS THAT OCCUR DURING LOAD SWITCHING AND POWER TRANSFER ARE NOT CONSIDERED REDLINE VIOLATIONS</td>
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### Remarks:

OWS Buses 1 and 2 are the main 28 VDC power buses for the OWS. They receive power from AM Reg. Bus 1 and 2 and distribute power to most OWS electrical loads. Monitoring the OWS Bus voltage levels with respect to the AM Reg. Bus levels will insure that the buses are supplied with power at the required voltage level from the AM and that no excessive voltage drop exists in the AM/OWS power feeder circuitry.
Form C

MSFC Launch Mission Rule Background

System Background Data:

1. System Description

OWS Buses 1 and 2 are the main 28 VDC power buses for the OWS. They receive power from Reg. Bus 1 and 2 in the AM and in turn distribute power to most other OWS electrical loads. Main power feeder from AM Reg. buses to OWS buses is divided into two groups, each containing nine parallel power paths. Each bus has twenty-seven conductors from the AM/OWS interface to the OWS Power Distribution Console, nine circuit breakers (one set of nine in OWS; other set of nine in AM), three relays with three power contacts each, and three interface connectors. (Ref. Figure 1)

2. Probable Cause of Redline Violations

a. Open circuit between REG & OWS buses
b. Excessive load on REG bus
c. Excessive load on OWS bus
d. Faulty power feeding REG bus

3. Consequences of Redline Violations

Consequence of violating either upper or lower redline limit for OWS bus voltages is possible loss of subsystem loads necessary for accomplishment of primary objectives. The consequence of violating redline limit for OWS Bus currents is excessive power consumption or possible opening of bus feeder circuit breakers if maximum current capability is exceeded.

4. Backup Measurements and Nominal Values

M0153-513 VOLT - REG BUS 1
M0154-513 VOLT - REG BUS 2
26.9 to 29.7 VDC (Refer to Airlock Module Rule 513-WP-018)

5. Operational Tests Not Applicable

6. Reliability/Redundancy Considerations

Both OWS buses must be operational at launch to insure refrigeration system redundancy and water tank heater operation. Remote switching capability does not exist to transfer loads from a failed to an operational bus. Liftoff with only one bus active and/or with unacceptable bus voltages or currents could compromise the achievement of mission objectives.
### The Critical Items Applicable:

<table>
<thead>
<tr>
<th>KSC LMN Item</th>
<th>CIL GP/CAT</th>
<th>CIL IDENT</th>
<th>FMEA IDENT</th>
<th>PART NUMBER/PART NAME</th>
<th>MEASUREMENT NUMBER</th>
<th>*</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>LCC-2</td>
<td>4-54</td>
<td>Elect 31-06</td>
<td></td>
<td>1B78543/Circuit Breaker Assy</td>
<td>M7400-M7403</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>LCC-2</td>
<td>4-57</td>
<td>Data 61.1-31</td>
<td></td>
<td>1B80813/Voltage Sensor</td>
<td></td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>LCC-2</td>
<td>4-51</td>
<td>Elect 31-03</td>
<td></td>
<td>1B83224/Wiring Harness 440A1W1</td>
<td>M7400,M7002, M7004</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>LCC-2</td>
<td>4-50</td>
<td>Elect 31-02</td>
<td></td>
<td>1B69384/Wiring Harness 436W1</td>
<td></td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>LCC-2</td>
<td>4-52</td>
<td>Elect 31-04</td>
<td></td>
<td>1B69383/Wiring Harness 436W2</td>
<td>M7401,M7003, M7005</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>LCC-2</td>
<td>4-53</td>
<td>Elect 31-05</td>
<td></td>
<td>1B83225/Wiring Harness 440A1W2</td>
<td></td>
<td>Yes</td>
<td></td>
</tr>
</tbody>
</table>

* WILL FAILURE OF THIS COMPONENT CAUSE MEASUREMENT TO EXCEED REDLINE LIMIT?
CONTINUATION SHEET (FORM C)

7. Instrumentation Accuracy and Method of Redline Value Determination

<table>
<thead>
<tr>
<th>Measurement</th>
<th>CRT</th>
<th>AR</th>
<th>Meter</th>
</tr>
</thead>
<tbody>
<tr>
<td>M7400-440</td>
<td>-</td>
<td>±1.19*</td>
<td>±1.82</td>
</tr>
<tr>
<td>M7002-440</td>
<td>±0.74</td>
<td>±1.26*</td>
<td>±1.89</td>
</tr>
<tr>
<td>M7004-440</td>
<td>±3.5</td>
<td>±5.32*</td>
<td>±7.7</td>
</tr>
<tr>
<td>M7401-440</td>
<td>-</td>
<td>±1.19*</td>
<td>±1.82</td>
</tr>
<tr>
<td>M7003-440</td>
<td>±0.74</td>
<td>±1.26*</td>
<td>±1.89</td>
</tr>
<tr>
<td>M7005-440</td>
<td>±3.5</td>
<td>±5.32*</td>
<td>±7.7</td>
</tr>
</tbody>
</table>

* PRIME MONITORING DEVICE

All OWS electrical modules have a design upper limit of 30 VDC. Since line drop to many of these modules is negligible, upper redline limit is 30 VDC. Lower limit was determined by operation of RS Pump Inverter which requires between 24 and 30 VDC for proper operation. Allowing for a one volt line drop between OWS bus and the inverter input brings the lower redline limit on the OWS bus to 25 VDC. The requirement that the voltage is within +1.2/-1.8 VDC of the respective AM Reg. Bus reflects a line drop of 0.6 VDC due to maximum loads of 30 AMPS (OWS Bus 1) and 22 AMPS (OWS Bus 2) and system accuracies of ±1.2 VDC. The bus current redline values reflect the predicted current loads and system accuracies.

8. Other Information

a. One volt peak-to-peak noise between 20 and 20K Hertz on steady-state voltage is allowed. Excursions less than 1 sec. duration to 22.0 V minimum and 34 V maximum are allowed.

b. One half of the water tank heaters are enabled prior to OWS closeout in the VAB and subsequently will operate as required as a function of the water temperature.

c. The Refrigeration System is turned on in the VAB before perishable food is installed in freezers and remains on through subsequent prelaunch operations until shortly before liftoff. Power will be supplied to the pump inverter from a separate ESE power supply via the RACS/RS bus for the majority of the countdown and the Refrigeration System will be transferred to OWS Bus 1 for a short period prior to the terminal count.

d. Monitoring the OWS Bus 1 & 2 voltage redlines will insure that both buses are being supplied with power at the required voltage level from the AM and insure that no excessive voltage drop exists in the AM/OWS power feeder circuitry.
The prime concern related to bus current-carrying capability is whether or not any of the main power feeder circuit breakers in the AM or in the OWS have been inadvertently tripped open. Each tripped feeder circuit breaker in the AM or in the OWS will cause a loss of 1/9 of the copper in the positive feeder line (the return line is assumed to remain intact since it does not involve any active components). Since there is no direct instrumentation of circuit breaker position, this information must be obtained by analyzing the voltage drop between the AM Regulated Buses and the corresponding OWS Bus as a function of load current. Detection of excessive voltage drop between these two points will serve to indicate an anomalous condition in the prime feeder circuitry, which could be caused by tripped circuit breakers or by other less probable circuit faults.

It will actually be difficult to detect an open circuit breaker(s) since (1) the voltage drops will be small at the levels of OWS bus current drawn during the launch countdown, and (2) the end-to-end measurement system inaccuracies are large enough to mask a change in voltage drop caused by open circuit breakers. Prelaunch checkout procedures will be utilized to reduce the theoretical measurement inaccuracy and by recording data from KSC integrated testing for various states of circuit breakers configuration at several incremental current levels. It will be possible to construct a profile for voltage drop vs load current (see Figure 2). 

e. The following is a summary of the predicted OWS bus loads during launch countdown:

<table>
<thead>
<tr>
<th>Function</th>
<th>Bus #1 (Amps)</th>
<th>Bus #2 (Amps)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Refrigeration Regenerator* Heater - 126 Watts</td>
<td>0 4.5</td>
<td>0 0</td>
</tr>
<tr>
<td>Refrigeration Logic Unit* - 33.6 Watts</td>
<td>1.2 1.2</td>
<td>1.2 1.2</td>
</tr>
<tr>
<td>Refrigeration Pump* Inverter</td>
<td>3.2 3.2</td>
<td>- -</td>
</tr>
<tr>
<td>Metabolic Analyzer Ion Pump - 4 Watts</td>
<td>0.1 0.1</td>
<td>- -</td>
</tr>
<tr>
<td>Water Container Heater 10 @ 95.5 Watts</td>
<td>0 17.1</td>
<td>0 17.1</td>
</tr>
<tr>
<td>(5 per Bus)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>4.5 26.1</strong></td>
<td><strong>1.2 18.3</strong></td>
</tr>
</tbody>
</table>

*These loads are on the RACS/RS bus until T-20 hours.

9. **System Schematic**

Ref. Figure 1
<table>
<thead>
<tr>
<th>REV</th>
<th>ITEM</th>
<th>MEAS/TM NO.</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>3-400</td>
<td>C7044-436</td>
<td>TEMP - TCS, FWD COMPT, NO. 6</td>
<td></td>
</tr>
<tr>
<td></td>
<td>C7042-436</td>
<td>TEMP - TCS, FWD COMPT, NO. 5 (ALTERNATE)</td>
<td></td>
</tr>
</tbody>
</table>

**REDLINE VALUES**

<table>
<thead>
<tr>
<th>TIME PERIOD/ACTION/NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>FROM START OF LMRD UNTIL T-12 HOURS</td>
</tr>
<tr>
<td>FROM T-12 HRS. UNTIL T-11 MIN.</td>
</tr>
<tr>
<td>FROM START OF LMRD UNTIL T-12 HOURS</td>
</tr>
<tr>
<td>FROM T-12 HRS. UNTIL T-11 MIN.</td>
</tr>
</tbody>
</table>

**REMARKS:**

Prelaunch temperature requirements for the OWS stored film in the film vault are to maintain temperature between 40°F and 50°F as much time as possible with allowable excursions to 65°F. 65°F is the maximum OWS internal environmental temperature which the refrigeration subsystem can tolerate during ground hold. A higher minimum temperature at T-12 hrs is required by the EREP tape requirement of 55°F minimum at launch (REF EDCR 2X0964).

**REQUIRED BY:**
MDAC-WEST

**CONTROL NUMBER:**
513-OP-003-R5

**PAGE**
1

**REVISION**
REV. 4

**PAGE:**
I-57

**DATE:**
MAY C 1973

---

**MSFC - Form 3173-2 (Rev June 1970)**
MSFC LAUNCH MISSION RULE BACKGROUND

SYSTEM BACKGROUND DATA:

1. **System Description**

   The ground thermal conditioning system provides on-pad temperature control to a maximum of 65°F and minimum of 40°F from the time of system activation in the VAB through launch minus 12 hours (55-65°F T-12 hours to launch). Circulation of conditioned dry gaseous nitrogen within the habitation area is effected by operation of one of two fans which force the nitrogen across heat exchangers providing the temperature conditioning. The heat exchanger and the two fans are located in the vehicle wardroom in the entertainment center. At least one circulating fan will be in operation from "Button Up" in the VAB until launch.

2. **Probable Cause of Redline Violations**

   a. Ground heat exchanger coolant temperature high/low.
   
   b. Fan failure.

3. **Consequences of Redline Violations**

   Launch temperatures greater than 65°F could result in loss of temperature control in food freezers and shortened storage life of food. Temperatures less than 40°F violate the food and film ICD's. Temperature less than 55°F from T-12 hours until T-11 minutes violate the EREP tape to OWS ICD.

4. **Backup Measurements and Nominal Values**

   C7408-436 FILM VAULT INT.  
   C7411-436 FOOD CONTAINER EXT.  
   47±5°F(until T-12 hours): 59±4°F(after T-12 hours)

5. **Operational Tests**

   Not Applicable.

6. **Reliability/Redundancy Considerations**

   All critical active functions are redundant.

   a. Two Heat Exchanger Fans.
   
   b. Two TCUs.
   
   c. Two Sets of Control Valves.
The Critical Items applicable:

<table>
<thead>
<tr>
<th>KSC LMR ITEM</th>
<th>CIL GP/CAT</th>
<th>CIL IDENT</th>
<th>FMEA IDENT</th>
<th>PART NUMBER/PART NAME</th>
<th>MEASUREMENT NUMBER</th>
<th>*</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>LCC 2</td>
<td>4-62</td>
<td>Ref 72</td>
<td></td>
<td>1A49958/Disconnect</td>
<td>C7043-C7044</td>
<td>Yes</td>
<td></td>
</tr>
</tbody>
</table>

* WILL FAILURE OF THIS COMPONENT CAUSE MEASUREMENT TO EXCEED REDLINE LIMIT?

7. Instrumentation Accuracy and Method of Redline Value Determination

<table>
<thead>
<tr>
<th>MEASUREMENT</th>
<th>CRT</th>
<th>ACCURACY</th>
<th>METER</th>
</tr>
</thead>
<tbody>
<tr>
<td>C7044-436</td>
<td>+2.5°F*</td>
<td>+4.3°F</td>
<td>+6.5°F</td>
</tr>
<tr>
<td>C7042-436</td>
<td>+2.5°F*</td>
<td>+4.3°F</td>
<td>+6.5°F</td>
</tr>
</tbody>
</table>

*PRIME MONITORING DEVICE

Method of redline value determination - Red line is maximum value in ICD 651CD9541, also maximum refrigeration system can tolerate at lift off without depleting max heat sink capacity. 40°F is minimum value in food and film ICD. 55°F is minimum requirement from T-12 hours until T-11 minutes to pre-condition EREP tapes prior to liftoff.

8. Other Information

The Ground Support Equipment (GSE) can be adjusted to bring the OWS internal temperature within the prescribed tolerance.
8. **Other Information (Cont'd)**

**Effect of Ground Thermal Conditioning System (GTCS) Unrepaired Failure * on Launch Day**

<table>
<thead>
<tr>
<th>GTCS LOSS</th>
<th>RESULTING IMPACT</th>
<th>ASSUMPTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anytime from 6 a.m. (EDT) through the launch window</td>
<td>Film temperature reaches 70° F. Ambient food temperature specification of 85° F not exceeded. The frozen food will exceed its specification limit of 0° F by 2° F.</td>
<td>a. GTCS fan de-energized when failure occurred.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b. Controlled walls for 55 to 63° F prior to failure.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>c. For May launch.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>d. Refrigeration system (RS) ground cooling failure has not occurred.</td>
</tr>
</tbody>
</table>

* Since the resulting impacts represent some out of specification conditions, all effort should be made to maintain GTCS control. However, in the event that irreparable failures occur, the conditions given could be tolerated.

GTCS down time without recovery is indicated on Chart 1.

GTCS recovery time required is indicated on Chart 2.

GTCS "ON" requirements for various launch times as a function of GTCS failure times is indicated on Chart 3.

9. **System Schematic**

None
NOTES
1. Assumes C7044 at 58°F when coolant loss occurred
2. Applicable for Hot May Day
3. Assumes GTCS fan is turned off when coolant loss occurred
4. 15°F heat exchanger fluid supply temperature

TIME OF DAY WHEN GTCS COOLING IS LOST (EDT)

GTCS DOWN TIME, WITHOUT RECOVERY

CHART 1
MSFC LAUNCH MISSION RULE BACKGROUND

NOTES
1. ASSUMES C7044 AT 58°F WHEN COOLANT LOSS OCCURRED
2. APPLICABLE FOR HOT MAY DAY
3. ASSUMES GTCS FAN IS TURNED OFF WHEN COOLANT LOSS OCCURRED
4. 15°F HEAT EXCHANGER FLUID SUPPLY TEMPERATURE

CHART 2

GTCS FAILURE AT 3 P.M.

GTCS FAILURE AT 1 P.M.

GTCS FAILURE AT 10 A.M.

GTCS FAILURE AT 7 A.M.

TIME OF C7044 RECOVERY TO 63°F - HR (EDT)

TIME OF GTCS TURN ON - HR (EDT)

GTCS RECOVERY TIME

CHART 2
NOTES
1. ASSUMES C7044 AT 58°F WHEN COOLANT LOSS OCCURED
2. APPLICABLE FOR HOT MAY DAY
3. ASSUMES GTCS FAN IS TURNED OFF WHEN COOLANT LOSS OCCURED
4. 15°F HEAT EXCHANGER FLUID SUPPLY TEMPERATURE

CHART 3. GTCS 'ON' REQUIREMENTS FOR VARIOUS LAUNCH TIMES AS A FUNCTION OF GTCS FAILURE TIMES
### MSFC LAUNCH MISSION RULE INPUT

<table>
<thead>
<tr>
<th>REV</th>
<th>ITEM</th>
<th>MEAS/TM NO.</th>
<th>DESCRIPTION</th>
<th>CATEGORY</th>
<th>REDLINE VALUES</th>
<th>TIME PERIOD/ACTION/NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>3-401</td>
<td>C7115-403</td>
<td>TEMP-RS, PR CKT, T/C INL, COOL</td>
<td></td>
<td></td>
<td>-42°F -24°F</td>
<td>FROM START OF LMRD UNTIL PRIMARY AND SECONDARY LOOP DISABLE (APPROX. T-5 MIN)</td>
</tr>
<tr>
<td></td>
<td>K7326-403</td>
<td>EVENT-RS, PCR BYP VL, RDTR MOD</td>
<td></td>
<td></td>
<td>* *</td>
<td>* SYSTEM IN TOLERANCE WHEN COOLANT FLOW IS DIRECTED THROUGH THE GROUND HEAT EXCHANGERS.</td>
</tr>
<tr>
<td></td>
<td>UC8162</td>
<td>TEMP, CCU SUPPLY</td>
<td></td>
<td></td>
<td>-49°F -27°F</td>
<td>FROM START OF LMRD UNTIL PRIMARY AND SECONDARY LOOP DISABLE (APPROX. T-5 MIN)</td>
</tr>
<tr>
<td></td>
<td>UP8001</td>
<td>FLOW RATE, WATER/GLYCOL PLUS</td>
<td></td>
<td></td>
<td>1.0 GPM NONE</td>
<td>*(1) FOUR MEASUREMENTS REQUIRED.</td>
</tr>
<tr>
<td></td>
<td>UP8011 (ALT)</td>
<td>FLOW RATE, WATER/GLYCOL</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**MISSION:** SA-513/SL-1  
**SECTION:** WORKSHOP  
**STAGE/SUBSECTION:** OWA/REFRIGERATION SYSTEM  
**SYSTEM:** REDLINES AND CATEGORIES

**REMARKS:**
Verify proper prelaunch status and operation of the primary refrigeration loop and assure that thermal capacitor is completely frozen at launch. (Ref. 513-OP-002, page I-59)

**NOTE:** Measurement C7115-403 is the primary redline.

**CONTROL NUMBER:** 513-OP-021-R5  
**PAGE:** 5, 6  
**REV.** 2  
**REV. 5**
SYSTEM BACKGROUND DATA:

1. System Description

The refrigeration system contains a radiator bypass valve which directs coolant flow either through the radiator or the ground heat exchangers. During prelaunch operations, coolant flow is maintained continuously through the ground heat exchangers which provide proper coolant conditioning to maintain the thermal capacitor in a fully frozen state. The primary measurement indicates coolanol temperature in the primary loop between the ground heat exchangers and the thermal capacitors. Measurements within the redline values indicate the position of the radiator bypass valve in the bypass mode and sufficient cooling capacity from the ground heat exchangers.

2. Probable Cause of Redline Violation

a. Valve failure
b. Bypass valve controller malfunction
c. GSE input command failure
d. Insufficient cooling from the TCU

3. Consequences of Redline Violations

Consequence of a redline violation is that the thermal capacitor may not be in a fully frozen and chilled down condition at launch. This can result in insufficient cooling during the initial insertion/on-orbit operations and frozen food damage could result due to food temperatures exceeding 0°F. Loop switching could occur due to a freezer "HI" condition.

The long term impact is loss of the backup RS loop if the redline violation is due to a bypass valve or bypass valve controller failure.

4. Backup Measurements and Nominal Values

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Nominal Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>C7701-A04 RS, CCU COOLANT OUTLET TEMP</td>
<td>-21°F to -43°F</td>
</tr>
<tr>
<td>K7412-436 EVENT-RS, PRIMARY Ckt PUMP 1, ON</td>
<td>ON</td>
</tr>
<tr>
<td>D7002-436 PRESS-RS, PR LOOP, PUMP INLET</td>
<td>36 to 44 PSIA</td>
</tr>
<tr>
<td>D7001-436 PRESS-RS, PR LOOP, PUMP DELTA P</td>
<td>32 to 44 PSID</td>
</tr>
<tr>
<td>K7447-403 EVENT-RS, PLR BYP VLV, RDTR MODE</td>
<td>BYPASS MODE</td>
</tr>
</tbody>
</table>

5. Operation Tests

Not Applicable
6. Reliability/Redundancy Considerations

A redline violation may indicate an onboard system failure which could ultimately result in loss of one of the two available RS loops, thereby eliminating loop redundancy and reducing RS reliability.

The Critical Items applicable:

<table>
<thead>
<tr>
<th>KSC LMR ITEM</th>
<th>GP/CAT</th>
<th>CIL IDENT</th>
<th>CIL IDENT</th>
<th>FMEA IDENT</th>
<th>PART NUMBER/PART NAME</th>
<th>MEASUREMENT NUMBER</th>
<th>*</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>LCC-2</td>
<td>4-65</td>
<td>Ref 120.01.01</td>
<td>1B82697/Refrigeration Bypass Controller</td>
<td>C7115,K7326</td>
<td>Yes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LCC-2</td>
<td>4-67</td>
<td>Ref 120.01.01-10</td>
<td>1B79878-1/Solenoid Bypass Valve</td>
<td>Yes</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LCC-2</td>
<td>4-75</td>
<td>Ref 120.01.04-13</td>
<td>7541626/Quick Disconnect</td>
<td>Yes</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* WILL FAILURE OF THIS COMPONENT CAUSE MEASUREMENT TO EXCEED REDLINE LIMIT?

7. Instrumentation Accuracy and Method of Redline Value Determination

a. Measurement CRT AR Meter
   C7115-403 (P) ±4.4* ±7.6 ±11.3 °F

* Prime monitoring device

The method of redline value determination is to select temperatures which are sufficiently low to ensure a fully frozen and chilled thermal capacitor. Test data indicate that a coolanol temperature of -24°F, or colder, entering the thermal capacitor for a prolonged period of time will place the capacitor in the required "charged" condition. This upper value for measurement C7115-403 is a soft value and does not contain instrumentation error. The lower limit of -42°F is equal to the lower redline limit of -40°F for thermal capacitor outlet temperature (see reference 513-OP-002) less a 2°F temperature rise due to thermal control panel heat leak. (Page I-59)
b. Instrumentation accuracy for the alternate measurement is not applicable since it is a bilevel measurement. Absence of signal indicates flow through the ground heat exchangers.

8. **Other Information**

The normal operating procedure for the Ground Temperature Control Unit as specified in TCRSC 1B83429 should preclude measurement C7115-403 from being out of redline limits.

Hold times vs. Recovery times are indicated on Charts 1, 2 and 3.

9. **System Schematic**

Ref. Figures 1 & 2, 513-OP-002, Pages I-59.6 & I-59.7
ALLOWABLE HOLD TIME (LOSS OF TCU) AS A FUNCTION OF MAX FREEZER TEMPERATURE TO PREVENT FOOD TEMPERATURE EXCEEDING 0°F. (ON BOARD PUMP OFF DURING HOLD) WITH RECOVERY REQUIRED.

NOTES
1. ALLOWS FOR FOOD TEMPERATURE OVERSHOOT AFTER TCU RESTART.
2. CURVE BASED ON TM SENSOR (C7281 OR C7282 OR C7283) REACHING -2°F. SUBSEQUENT ACTUAL FOOD TEMPERATURE OVERSHOOT WILL NOT EXCEED 0°F. IF TCU RESTART ON OR BEFORE TM SENSOR = -2°F.
3. THIS CURVE NOT VALID FOR HOLD PRIOR TO LIFT-OFF WITHOUT RECOVERY. SEE CHART 2 FOR REQUIRED RECOVERY TO ACHIEVE INITIAL CONDITIONS.
4. IF FREEZER TEMPERATURES REACH 0°F & TCU CANNOT RESTART, START ONBOARD PUMP TO UTILIZE CAPACITOR TO PROVIDE TEMPORARY THERMAL CONTROL FOOD MAY EXCEED 0°F IN THIS MODE.
5. TCU AND PUMPS MUST BE RESTARTED AT OR BEFORE HOLD TIME EXCEEDED.
MSFC LAUNCH MISSION RULE BACKGROUND

REQUIRED RECOVERY TIME VS HOLD TIME TO ACHIEVE FOOD TEMPERATURE RECOVERY TO INITIAL STEADY STATE CONDITIONS

NOTES
1. TCU PERFORMANCE (TEMP & FLOW RATE) EQUAL BEFORE AND AFTER HOLD.
2. FLIGHT SENSORS IN FREEZERS WILL RECOVER TWICE AS FAST AS THE ACTUAL FOOD.
3. SEE CHART 1 FOR ALLOWANCE HOLD TIMES.
MSFC LAUNCH MISSION RULE BACKGROUND

MAXIMUM RS/TCU HOLD TIMES FOR PRE-LAUNCH WITH NO RECOVERY REQUIRED PRIOR TO LIFT-OFF.

NOTE
1. INSTRUMENTATION TOLERANCE INCL.
2. PUMPS OFF (ON BOARD) DURING HOLD
3. ALL SYSTEM TEMPS @ STEADY STATE PRIOR TO HOLD.
4. ALLOWS FOR FOOD TEMPERATURE RISE DURING INSERTION.

CHART 3

CAPACITOR INLET TEMP, C7115, (°F)

HOLD TIME (MIN)
<table>
<thead>
<tr>
<th>REV</th>
<th>ITEM</th>
<th>MEAS/TM NO.</th>
<th>DESCRIPTION</th>
<th>CATEGORY</th>
<th>REDLINE VALUES</th>
<th>TIME PERIOD/ACTION/NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>3-402</td>
<td>C7279-403</td>
<td>TEMP - RS, PRI CKT, FREEZER THERMAL CONT VALVE COOLANT OUT</td>
<td>FLT CONT</td>
<td>1 OF 2 M</td>
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<td>C7296-436</td>
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**MISSION:** SA-513/SL-1  
**SECTION:** WORKSHOP  
**STAGE/SUBSECTION:** OWS/REFRIGERATION SYSTEM  
**SYSTEM:** REDLINES AND CATEGORIES

**REMARKS:**  
Verify proper prelaunch status and operation of primary refrigeration loop. Assure that thermal conditioning of OWS refrigeration system freezer, storage, and chiller compartments is maintained within acceptable limits during prelaunch operations. (Ref. 513-OP-008, Page 1-62

**REQUIRED BY:**  
MDAC-WEST  
ASTN

**CONTROL NUMBER:**  
513-OP-002-R5

**CONCURRENCES**

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SYSTEM BACKGROUND DATA:

1. System Description

The Refrigeration System (RS) is a low-temperature thermal control system that utilizes coolanol-15 in a closed loop to provide for freezing of food and urine and for chilling of food, urine, and potable water. Temperature control is provided in the range of +42°F to -20°F. Two coolant loops (primary and secondary) are provided in the RS, with the secondary loop being a backup in the event of primary loop failure. The two loops are essentially identical and independent of each other except for common utilization of the radiator, ground cooling heat exchanger, and thermal capacitor in the heat rejection portion of the loop. These components have separate primary and secondary coolant paths as do the freezers, chillers, regenerator HX, and regenerative heater located in the inner portion of the loop. Each loop of the RS contains automatic failure logic that will switch pumps on receipt of a low pump differential pressure signal, or switch loops due to low pump accumulator level or logic unit power supply voltage out of band. The primary loop also contains logic to switch to the secondary loop for high wardroom freezer inlet temperature, or low chiller inlet temperature.

For on-orbit operation, heat gained in the freezers, chillers and associated plumbing is rejected to space by the radiator with supplemental heat rejection capability provided by the thermal capacitor (charged with undecane wax) located downstream of the radiator. During the LMRD effectivity period, normal operation of the RS will be on the primary loop with the radiator bypass valve in the bypass position. Heat gained will be rejected to a GSE ground cooling cart via the ground cooling heat exchangers.

2. Probable Cause of Redline Violations

a. Causes of high side violations of measurements C7279-403 and C7402-403:
   1. Pump failure.
   2. Radiator bypass valve failed in radiator mode.
   4. Insufficient chilldown time.
   5. Excessive heat leak.

b. Causes of low side violations of measurements C7279-403 and C7402-403:
   1. Ground cooling heat exchanger TCU coolant temperature low.

c. Causes of high side violations of measurements C7296-436 and C7404-436:
   1. Chiller control valve malfunction.
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<tr>
<th>REV ITEM</th>
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<td>K374-512</td>
<td>POSITION - COAX SWITCH 2W OR 10W</td>
<td>M</td>
<td>*</td>
<td>COMMIT AT END OF FINAL TRANSMITTER TEST (APPROX. T-19 HRS.)</td>
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- **SYSTEM IN TOLERANCE IF 2 WATT XMTR SELECTED. DISREGARD WHEN 10 WATT XMTR IS BEING TESTED**

**MISSION:** AS-513/SL-1  
**SECTION:** WORKSHOP  
**STAGE/SUBSECTION:** AM/I&C SYSTEM  
**SYSTEM:**

**REQUESTS:**

Should the 10-watt transmitter be selected for launch, telemetry transmission may be impaired at certain altitudes.

**MDAC-EAST**  
**ASTN**

**CONTROL NUMBER:** 513-WP-014-R1

**PAGE:** PRELIM.

**REVISION:** REV. 5

**DATE:** MAY 6 1973

**PAGE:** I-78
SYSTEM BACKGROUND DATA:

1. System Description

AM Data Transmission and Antenna Subsystem provides RF transmission capability to STDN during prelaunch, launch and orbit for real time and delayed time data and delayed time voice, in both stabilized and unstabilized vehicle attitudes. Airlock telemetry data is transmitted to STDN by means of four telemetry transmitters consisting of three 10-watt units and one 2-watt unit. 2-watt transmitter is used during launch phase of SL-1. 10-watt transmitters are used during orbit phases of mission. See Figure 1 for system diagram.

2. Probable Cause of Redline Violations
   a. Relay malfunction
   b. Human error

3. Consequence of a Redline Violation

When used with the 10-watt transmitter the quadriplexer is subject to a corona discharge at certain ambient pressures down to .07 MMHg, which will reflect the transmitter output power. Although no permanent damage would be sustained by either the transmitter or quadriplexer, telemetry transmission would be impaired until the corona was extinguished.

4. Backup Measurements and Nominal Valves - See Paragraph 5

5. Operational Tests - During the final transmitter test the DCS command S195 will be sent for the last time selecting the 2-watt transmitter for operation for the remainder of the countdown and for launch. When the command is sent, observe that received signal strength decreases to insure 2-watt transmitter was actually selected. The above assumes sufficient attenuation is inserted in RF link to take receiver out of saturation.

6. Reliability/Redundancy Considerations - None.

7. Instrumentation Accuracy and Method of Redline Value Determination - The discrete measurement verifying coax switch position in combination with change in signal strength is used rather than a continuous signal strength indication. Atmospheric conditions, antenna orientation/location, etc., make continuous signal strength monitoring an unreliable method for determining whether the 2-watt or 10-watt is transmitting at a given time. With the above method, there is no accuracy problem.

8. Other Information - None
### MSFC Launch Mission Rule Input

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**MISSION:** SA-513/SL-1  **SECTION:** WORKSHOP  **STAGE/SUBSECTION:** AM/ELECTRICAL POWER SYSTEM

**REMARKS:**

AM battery temperatures are controlled by active TCS during prelaunch operations to assure battery electrical performance within acceptable limits. Battery degradation and/or loss occurs at high operating temperatures. (Ref. 513-WP-016, Page I-86)

**CONCURRENCES**

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**CONTROL NUMBER:** 513-WP-003 - R 2

**PAGE** | **REVISION**
---|---
0.1, 0.2 | REV. 5
0.3 | REV. 3

**DATE:** MAY 9 1973

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MSFC - Form 3173-2 (Rev June 1970)
SYSTEM BACKGROUND DATA:

1. System Description

   b. OWS solar array is divided into eight electrically identical parts called solar array groups, each of which feeds a power conditioning group (PCG) composed of battery charger, battery, and voltage regulator. The function of each PCG is to provide conditioned power to using equipment and to recharge nickel-cadmium batteries during orbital daylight period. Battery charger output voltage is limited as a function of battery temperature and available power. Temperature compensation of charger voltage is provided to prevent hydrogen generation within battery and to restrict oxygen generation rate to that level which can be recombined within battery without venting. Two thermistors installed within each battery provide temperature sensing to the battery charger for this function. An additional thermistor within each battery provides battery temperature for telemetry purposes. Each battery is mounted with base of the case in contact with a cold-plate, through which coolant is circulated to remove battery generated heat. For diagram ref. Fig. 1, 513-WP-016 and Fig. 1, 513-WP-023 on Pages I-86 and I-97 respectively.

   During the LMRD effectivity period, each battery will be charged and discharged, with resulting heat removed by active coolant system to maintain control of battery temperature.

2. Probable Cause of Redline Violations
   a. Excessive battery charge/overcharge due to battery charger malfunction (maximum limit violation).
   b. Malfunction of ground cooling system (maximum limit violation - all batteries). Refer to 513-WP-022, Page I-96.
   c. Malfunction of active coolant system (maximum or minimum limit violation - all batteries). Refer to 513-WP-022, Page I-96.

3. Consequences of Redline Violations

   An overtemperature condition will reduce battery cycle life; therefore, depending on the extent of degradation, energy storage capability of the affected battery or batteries in the latter portions of the mission may be reduced. If the violation is the result of a charger malfunction, the charger and affected battery may be unusable, reducing system energy storage capability as long as the malfunction persists. An undertemperature condition will result in lower than normal battery charge rates, however, no adverse effect on the batteries will result.

4. Backup Measurements and Nominal Values

   Primary Coolant Loop:
   C233-505 TEMP, PRI LOOP - BAT MOD 1 OUTLET  Nominal Values:
   C235-505 TEMP, PRI LOOP - BAT MOD 2 OUTLET  37 to 90°F.

   Comparative temperatures of coolant in the active loop entering and leaving battery module coldplates provide battery coolant status.
4. Backup Measurements and Nominal Values (Contd)

- C273-534 TEMP, PRI CLNT CTL VLV - CVPC OUT 1
  Nominal Values: 34 to 70°F
  Ref: 513-WP-022

- C275-534 TEMP, PRI CLNT CTL VLV - CVPC OUT 2

- M133-524 thru M136-524 VOLT, BATTERY 1 THRU 8
  Nominal Values: 37.3 to 46.9 VDC
  Battery voltage level is an indication of the battery temperature when the battery is maintained in the voltage limited charge mode. If the voltage is fairly steady and is between the stated limits, then the battery temperature is in the acceptable range.

- M137-525 thru M140-525 and VOLTAGE

Secondary Coolant Loop:

- C234-505 TEMP, SEC LOOP - BAT MOD 1 OUTLET
  Nominal Values: 37 to 90°F
  Comparative temperatures of coolant in the active loop entering and leaving battery module coldplates provide battery coolant status.
  Ref: 513-WP-022

- C236-505 TEMP, SEC LOOP - BAT MOD 2 OUTLET

- C274-534 TEMP, SEC CLNT CTL VLV - CVSC OUT 1
  Nominal Values: 34 to 70°F

- C276-534 TEMP, SEC CLNT CTL VLV - CVSC OUT 2

5. Operational Tests

None

6. Reliability/Redundancy Considerations

Eight (8) nickel-cadmium batteries are provided in the AM EPS. Battery overtemperature conditions could result in a reduction of cycle life capability of the affected batteries which could ultimately result in loss of the affected batteries and a reduction of available power.

The Critical Items applicable:

<table>
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<tr>
<th>KSC LMR ITEM</th>
<th>CIL GP/CAT</th>
<th>CIL IDENT</th>
<th>FMEA IDENT</th>
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*Will failure of this component cause measurement to exceed redline limit?
7. Instrumentation Accuracy and Method of Redline Value Determination

Instrumentation Accuracy: +2.9, -5.3 (Range 26 to 100°F) (CRT)

Method of Redline Value Determination: Analysis of previous AM battery subcontractor testing has indicated desirability of maintaining nickel-cadmium battery temperature and at absolute levels of approximately room temperature (75°F). Maximum limit is beyond normal operating range using ground coolant system, but below automatic cut-off point setting of battery chargers. Minimum limit is well below normal operating range and was widened by the amount of instrumentation accuracy.

8. Other Information

Each battery charger contains control circuitry to limit battery charge current to 0.5 AMP max. in the event battery temperature reaches 120 + 0, - 12°F.

9. System Schematic

Ref. Fig. 1, 513-WP-023 & Fig. 1, 513-WP-016 on Pages I-97 and I-71 respectively.
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**REMARKS**

AM batteries (8) are required to power AM/MDA/OWS loads from transfer to internal power (prelaunch) through launch. Each AM battery must be at nearly full SOC during final prelaunch periods to provide maximum total battery energy for initial OWS SAS activation, plus contingency backup activation command time, and during orbital night periods. (Ref. 513-WP-003 and -017 on Pages 1-82 and 1-85 respectively.)

**REQUIRED BY:**

MDAC-EAST

**CONTROL NUMBER:**

513-WP-016- R5

**PAGE** | **REVISION**
---|---
.4, .5 | REV.3
.1, .2, .3 | REV.5

**DATE:** MAY 9 1973

**AGE:** I-86
SYSTEM BACKGROUND DATA:

1. System Description

   a. AM EPS is designed to accept power from a solar array mounted on OWS (during flight) or from external power (during prelaunch operations) and to condition this power for application to AM EPS buses and nickel-cadmium batteries. Nickel-cadmium batteries are utilized to provide power to Loads during the orbital night period, launch period, and during prelaunch periods when external power is not applied.

   b. OWS solar array is divided into eight electrically identical parts called solar array groups, each of which feeds a power conditioning group (PCG), composed of battery charger, battery, and voltage regulator. Function of each PCG is to provide conditioned power to loads and to recharge the nickel-cadmium batteries during orbital daylight periods. Each battery charger contains two ampere-hour integrator circuits, (primary and second), each of which computes an approximate value for battery state of charge, with the selected circuit providing a control signal to reduce charging to low levels upon reaching full charge conditions. The state of charge measurement of each ampere-hour integrator circuit is continuously provided to the AM telemetry subsystem. Temperature compensation is provided for each ampere-hour integrator circuit to account for variation in battery charging efficiency as temperature of the battery changes. Each battery contains 30 series connected cells. During LMRD effectivity period, each battery will be charged and discharged, with apparent SOC monitored and charging controlled (in part) by ampere-hour integrator circuits. Battery voltage will also be monitored to provide an indication of battery performance under both charge and discharge conditions. For diagram, refer to Figure 1.

2. Probable Cause of Redline Violations

   Minimum SOC Limit Violations (SOC, CN 513-WP-017 on Page I-85) (Note: Maximum SOC Limit Violations - N/A)
   a. Excessive battery discharge due to loss of external power (all eight batteries).
   b. Excessive battery discharge due to battery discharge due to battery charger malfunction (one battery).
   c. Malfunction of ampere-hour integrator circuit selected to control battery charging (one battery).

   Maximum Voltage Limit Violations (Charge Cycle, AM Fig. 3) (Note: Minimum Limit Violations during charge cycle - N/A)
   a. Excessive charging voltage resulting from a charger malfunction.

   Minimum Voltage Limit Violations (Discharge Cycle, AM Fig. 4) (Note: Maximum Limit Violations during discharge cycles N/A)
   a. Excessive load impressed on the battery.
   b. Loss of individual cell outputs.
   c. Low battery state of charge.
Unexpected Increase in Battery Current (Discharge Cycle, AM Fig. 4)

a. Although there is no redline value for maximum battery current, an unexpected increase may be caused by a malfunction in the EPS or load equipment and therefore should be investigated.

3. Consequences of Redline Violations

Violation of the minimum limit for state-of-charge would reduce the stored energy available for initial OWS SAS activation, plus contingency backup activation command time, and during orbital night periods. Violations of the maximum voltage limit of AM Figure 3 would require bypass of the affected battery and charger combination, which would reduce energy storage capacity by one-eighth. Violation of the minimum voltage limit of AM Figure 4 may also result in loss of one-eighth of AM energy storage capacity.

4. Backup Measurements and Nominal Values

For primary and secondary state-of-change:

A gross indication of battery SOC during discharge can be obtained by integration of the current time plot:

\[ \text{Iah} = \text{Integrated current in amp-hrs} \]
\[ \text{SOC} = \left(1 - \frac{\text{Iah}}{33}\right) \times 100\% \]

To substantiate reason for low voltage indication.

For battery voltage:

M117-524 thru M124-525
M120-524 thru M129-525
M121-525 thru M132-525
M125-524 thru M128-524
M118-524 thru M119-524
M141-524 thru M148-524
M144-524 thru M145-525

Nominal Values:

- Current: 0 to 15A
- Voltage: 95 to 100%
- Pri SOC
- Sec SOC

Nominal Values:

- VOLT, BATTERY
- 1 thru 8

MSFC - Form 3173-6 (August 1968)
### Operational Tests

None

### Reliability/Redundancy Considerations

The AM EPS is designed to operate as essentially eight paralleled subsystems, each of which uses one battery for energy storage. Loss of battery or battery charger before launch would reduce system capability to sustain launch electrical loads as well as orbital loads thereafter.

#### The Critical Items applicable:

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* WILL FAILURE OF THIS COMPONENT CAUSE MEASUREMENT TO EXCEED REDLINE LIMIT?
<table>
<thead>
<tr>
<th>REV</th>
<th>ITEM</th>
<th>MEAS/TM NO.</th>
<th>DESCRIPTION</th>
<th>CATEGORY</th>
<th>REDLINE VALUES</th>
<th>TIME PERIOD/ACTION NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>3-2706</td>
<td>C217-541</td>
<td>TEMP, MOLE SIEVE B - CHX PRI INLET</td>
<td></td>
<td></td>
<td>43°F</td>
<td>51°F</td>
</tr>
<tr>
<td></td>
<td>C209-542 (ALT)</td>
<td>TEMP, MOLE SIEVE A - CHX PRI INLET</td>
<td></td>
<td></td>
<td>43°F</td>
<td>51°F</td>
</tr>
<tr>
<td>3-2706A</td>
<td>C218-541</td>
<td>TEMP, MOLE SIEVE B - CHX SEC INLET</td>
<td></td>
<td></td>
<td>43°F</td>
<td>51°F</td>
</tr>
<tr>
<td></td>
<td>C210-542 (ALT)</td>
<td>TEMP, MOLE SIEVE A - CHX SEC INLET</td>
<td></td>
<td></td>
<td>43°F</td>
<td>51°F</td>
</tr>
</tbody>
</table>

**REMARKS:**
Temperatures are monitored to assure that coolant is supplied to the condensing heat exchanger at the desired temperature. (Ref. 513-WP-008, -009, -022, and -023, pages I-98, I-99, I-96 and I-97 respectively.)

**REQUIRED BY:**
MDAC-EAST

**CONTROL NUMBER:**
513-WP-004-R5

**PAGE:** 1, 2, 3
**REVISION:** REV. 5

**DATE:** MAY 9 1973
**PAGE:** I-94
SYSTEM BACKGROUND DATA:

1. System Description
   Ref. 513-WP-023, page I-97.

2. Probable Causes of Redline Violations

   Maximum limit violations:
   a. Coolant temperature control valve malfunction.
   b. Premature switching of radiator bypass selector valve - should be detectable by discrete measurement K209-515 for the primary coolant loop and K210-515 for the secondary coolant loop. (Ref. 513-WP-028, page I-100).
   c. Malfunction of ground cooling system.
   d. Motor/pump unit malfunction - Should be detected by the observer monitoring pump ΔP and coolant flow (Ref. 513-WP-009, page I-99.)

   Minimum limit violations:
   a. Coolant temperature control valve CVPB or CVSB malfunction.
   b. Failure of control valve CVPA or CVSA to hold minimum temperature limit. (Ref. 513-WP-023, I-97)

3. Consequences of Redline Violations

   A violation of minimum limit could result in excessive cooling or equipment in modules downstream of coolant control valve. Violation of maximum limit would lead to possible overheating of equipment downstream of coolant control valve CVPB or CVSB. Violation of either limit would alter moisture removal capability of CHX and thus, prevent maintenance of desired dew point with present operational plans. Extreme violations could cause equipment damage. CHX does not remove moisture until system activation in orbit, however.

4. Backup Measurements and Nominal Values

   Primary Coolant Loop:
   C244-515 TEMP - THERMAL CAPACITOR - PRIMARY OUTLET
   C265-517 TEMP - THERMAL CAPACITOR 2 PRIMARY INLET
   A temperature higher than +40°F prior to T-30 minutes or +18°F after T-30 minutes would indicate a failure of the ground cooling system or premature switching of the radiator bypass selector valve.
   C283-534 TEMP - PRIMARY COOLANT CONTROL VALVE CVPA OUTLET 1 (Ref. 513-WP-023, page I-97)
4. Backup Measurements and Nominal Values (Contd)

Primary Coolant Loop:
K209-515 EVENT, PRI RAD BYPASS MONITOR - ONE = BYPASS

Value of ONE until Bypass Mode is switched at T-9:25 min.

Secondary Coolant Loop:
C245-515 TEMP - THERMAL CAPACITOR - SECONDARY OUTLET

A temperature higher than +40°F prior to T-5 hours would indicate a failure of the ground cooling system or premature switching of the radiator bypass selector valve.

C284-534 TEMP - SECONDARY COOLANT CONTROL VALVE CVSA OUTLET 1 (Ref. 513-WP-023, page I-97)

K210-515 EVENT, SEC RAD BYPASS MONITOR - ONE = BYPASS

Value of ONE until valve switching during sec. loop deactivation at approximately T-5 hrs.

LMRs 513-WP-008 and 513-WP-009 covering pump inlet pressure, pump differential pressure and coolant flow may provide additional information. (See pages I-98 and I-99 respectively)

5. Operational Tests

Not Applicable

6. Reliability/Redundancy Considerations

Exceeding redline limits can be an indication that any one of several failures may have occurred which could ultimately result in complete operational loss of one of the two coolant loops thereby eliminating loop redundancy. Such an event would decrease the coolant system reliability.

The Critical Items applicable:

<table>
<thead>
<tr>
<th>KSC LMR ITEM</th>
<th>CIL GP/CAT</th>
<th>CIL IDENT</th>
<th>FMEA IDENT</th>
<th>PART NUMBER/PART NAME</th>
<th>MEASUREMENT NUMBER</th>
<th>*</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>LCC-II</td>
<td>pg 21</td>
<td>ECS 4.1.37</td>
<td></td>
<td>61C830096-9/Temperature Control Valve -47°F</td>
<td>*(1) C217, C218, C210, C209</td>
<td>Yes</td>
<td>*(1) Item to be included in Rev C of CIL (ECP 971)</td>
</tr>
</tbody>
</table>

* WILL FAILURE OF THIS COMPONENT CAUSE MEASUREMENT TO EXCEED REDLINE LIMIT?

MSFC - Form 3173-8 (August 1968)
7. **Instrumentation Accuracy and Method of Redline Value Determination**

   **Instrumentation accuracy:** +1.0, -1.9 (Range 42 to 52)°F (CRT)

   Method of redline value determination: The coolant temperature control valves CVPB and CVSB are adjusted prior to installation to maintain valve outlet coolant temperature between 45°F and 49°F. The correct outlet temperature is obtained by proportional mixing of hot and cold incoming coolant. In a normally operating valve, the flow of hot coolant into the valve will be completely blocked (except for allowable internal leakage) if the outlet temperature rises to 49°F and the flow of cold coolant completely blocked if the outlet temperature drops to 45°F. The given redline limits were based on these valve characteristics for the expected coolant temperature distribution, instrumentation accuracy noted above and an allowance for heat leak into coolant lines between the valve and the sensors.

8. **Other Information** None

9. **System Schematic** Ref. Fig. 1, 513-WP-023, page I-97.4.
<table>
<thead>
<tr>
<th>REV</th>
<th>ITEM</th>
<th>MEAS/THM NO.</th>
<th>DESCRIPTION</th>
<th>CATEGORY</th>
<th>REDLINE VALUES</th>
<th>TIME PERIOD</th>
<th>ACTION NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>FLT CON</td>
<td>ENG DATA</td>
<td>PRE-LAUNCH</td>
<td>MINIMUM</td>
</tr>
<tr>
<td>3-2709</td>
<td>C262-517</td>
<td>TEMP, THERMAL CAP. SKIN 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>C263-517</td>
<td>TEMP, THERMAL CAP. SKIN 2 *</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>40°F</td>
</tr>
<tr>
<td></td>
<td>C264-517</td>
<td>TEMP, THERMAL CAP. SKIN 3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>C265-517</td>
<td>TEMP, THERMAL CAP. 2 PRI INLET</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>C244-515 (ALT)</td>
<td>TEMP, THERMAL CAP. PRI OUTLET</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3-2709A</td>
<td>C245-515</td>
<td>TEMP, THERMAL CAP. SEC OUTLET</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**MISSION:** SA-513/SL-1  
**SECTION:** WORKSHOP  
**STAGE/SUBSECTION:** AM/ THERMAL CONTROL  
**SYSTEM:** REDLINES AND CATEGORIES

**REMARKS:**
From start of LMRID until T-30 minutes this rule provides assurance that coldplated AM equipment will be maintained at acceptable temperatures. From T-30 minutes until launch, this rule provides assurance that the AM thermal capacitors are charged prior to launch.

**REQUIRED BY:** MDAC-EAST  
**CONTROL NUMBER:** 513-WP-024-R5

**PAGE:** .1, .2  
**REVISION:** REV. 5

**DATE:** MAY 9 1973  
**PAGE:** 1-95

(Rev June 1970)
SYSTEM BACKGROUND DATA:

1. **System Description**
   
   Ref. 513-WP-023, page I-97.

2. **Probable Causes of Redline Violations**

   **Maximum limit violations:**
   
   a. Malfunction of ground cooling system.
   b. Motor/pump unit malfunction in primary loop or secondary loop.
   c. Premature switching of primary or secondary radiator bypass selector valve.
   d. Excessive heat leak into capacitor module or coolant primary or secondary inlet/outlet line due to damaged insulation.

   **Minimum limit violations:**
   
   a. Ground coolant supply temperature too low.

3. **Consequences of Redline Violations**

   A violation of the maximum limit of 40°F (prior to T-30 minutes) may result in overheating of AM coldplated equipment.

   Violation of maximum limit of +18°F after T-30 minutes would decrease the coldplated equipment cooling available prior to radiator activation/cool-down due to a less than fully charged capacitor module.

4. **Backup Measurements and Nominal Values**

   None

5. **Operational Tests**

   Not applicable
6. **Reliability/Redundancy Considerations**

Exceeding redline limits may indicate that any one of several failures has occurred. The failure could result in ineffective operation of the coolant system and overheating of equipment and could ultimately result in complete operations loss of one of the two coolant loops thereby eliminating loop redundancy.

7. **Instrumentation Accuracy and Method of Redline Determination**

Instrumentation accuracy: C244-515, +1, -2.2 (Range -20 to +20)°F (CFT), -2.53°F; C262-517 thru C265-517, +.9, -1.3 (Range -20 to +20)°F; C245-515, +1, -2.2 (Range -20 to +20)°F

The maximum redline limit of +40°F (Prior to T-30 minutes) was based on assuring adequate cooling of the AM battery modules while allowing some margin should the ambient FTC temperature be abnormally high. The maximum limit of +18°F for the primary loop after T-30 minutes is based on a requirement to freeze the capacitors for launch. Should the ambient KSC temperature be abnormally high, supplemental cooling will be introduced at a point in the count such that at T-30 minutes the capacitors will be frozen. Although the capacitors freeze at approximately +22°F, the redline limit was set at +18°F to allow for instrumentation inaccuracy and the location of temperature sensors attached to the capacitor skin.

8. **Other Information**

No problem with violations of the minimum temperature limit (-120°F) is anticipated based on the present ground cooling system capabilities.

9. **System Schematic**

Ref. Figure 1, 513-WP-023, page I-97.4.
<table>
<thead>
<tr>
<th>REV</th>
<th>ITEM</th>
<th>MEAS/TM NO.</th>
<th>DESCRIPTION</th>
<th>CATEGORY</th>
<th>REDLINE VALUES</th>
<th>TIME PERIOD/ACTION/NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>3-2711</td>
<td>C273-534</td>
<td>TEMP - PRIMARY COOLANT CONTROL VALVE CVPC OUTLET 1</td>
<td></td>
<td></td>
<td></td>
<td>FROM SYSTEM ACTIVATION AND TEMPERATURE STABILIZATION UNTIL T -30 MIN.</td>
</tr>
<tr>
<td></td>
<td>C275-534 (ALT)</td>
<td>TEMP - PRIMARY COOLANT CONTROL VALVE CVPC OUTLET 2</td>
<td></td>
<td></td>
<td></td>
<td>FROM T -30 MIN UNTIL INITIATION OF AUTO SEQUENCE.</td>
</tr>
<tr>
<td>3-2711A</td>
<td>C274-534</td>
<td>TEMP - SECONDARY COOLANT CONTROL VALVE CVSC OUTLET 1</td>
<td></td>
<td></td>
<td></td>
<td>FROM SYSTEM ACTIVATION AND TEMPERATURE STABILIZATION UNTIL TERMINATION OF SECONDARY COOLANT LOOP FLOW. (APPROX. T-5 HOURS)</td>
</tr>
<tr>
<td></td>
<td>C276-534 (ALT)</td>
<td>TEMP - SECONDARY COOLANT CONTROL VALVE CVSC OUTLET 2</td>
<td></td>
<td></td>
<td></td>
<td>*MOMENTARY DEVIATIONS WHEN HEAT LOAD OR TEMPERATURE OF COOLING SOURCE VARIES RAPIDLY ARE NOT CONSIDERED VIOLATIONS.</td>
</tr>
</tbody>
</table>

**REMARKS:**
The CVPC and CVSC outlet temperatures are monitored to assure that the coolant temperature is adequate for cooling of battery and electronics modules. Only the Primary loop will be active for launch. The Secondary loop will be deactivated at approximately T-5 hours.

MSFC LAUNCH MISSION RULE BACKGROUND

SYSTEM BACKGROUND DATA:

1. System Description and Diagram

Ref. 513-WP-023, page I-97.

2. Probable Causes of Redline Violations

Maximum limit violations:

a. Coolant temperature control valve malfunction.

b. Premature switching of radiator bypass selector valve - should be detectable by discrete measurement K209-515, for the primary coolant loop and K210-515 for the secondary coolant loop.

(Ref. 513-WP-028, page I-100).

c. Malfunction of ground cooling system.

d. Motor/pump unit malfunction - Should be detected by the observer monitoring pump ΔP and coolant flow

(Ref. 513-WP-009, page I-99).

Minimum limit violations:

a. Coolant temperature control valve malfunction.

b. Failure of control valve CVPB (CVSB) and CVPA (CVSA) or CVPB (CVSB) alone to hold minimum primary (secondary) temperature limits. Failure of control valve CVPB (CVSB) and CVPA (CVSA) should be detected by the observer monitoring redlines in 513-WP-004 and 513-WP-023, respectively.

3. Consequences of Redline Violations

A violation of maximum limit could have a detrimental effect upon electrical equipment downstream by not providing adequate cooling. (Ref: 513-WP-003, page I-82)

A violation of the minimum limit could result in excessive cooling of equipment in modules downstream of coolant control valve. (Ref: 513-WP-003, page I-82)

4. Backup Measurements and Nominal Values

Primary Coolant Loop:

C244-515 TEMP, THERMAL CAPACITOR PRIMARY OUTLET

Nominal Values: A temperature higher than +40°F prior to T-30 minutes or +18°F after T-30 minutes would indicate a failure of the ground cooling system, or premature switching of the radiator bypass selector valve.
4. Backup Measurements and Nominal Values (contd)

<table>
<thead>
<tr>
<th>Sensor Code</th>
<th>Description</th>
<th>Nominal Value</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>C279-534</td>
<td>TEMP, PRI ATM COOLANT MODULE OUTLET</td>
<td>&gt;45°F</td>
<td>Indication that coolant temperatures entering the control valve are in the correct range following completion of thermal capacitor charging (no later than T-30 minutes).</td>
</tr>
<tr>
<td>C277-534</td>
<td>TEMP, PRI COOLANT CONTROL VALVE CVPC INLET</td>
<td>&lt;42°F</td>
<td>Value of ONE until Bypass Mode is switched at T-9:25 minutes.</td>
</tr>
<tr>
<td>K209-515</td>
<td>EVENT, PRI RAD BYPASS MONITOR, ONE = BYPASS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C245-515</td>
<td>TEMP, THERMAL CAPACITOR SECONDARY OUTLET</td>
<td></td>
<td>A temperature higher than +40 °F prior to T-5 hours would indicate a failure of the ground cooling system, or premature switching of the secondary radiator bypass valve.</td>
</tr>
<tr>
<td>K210-515</td>
<td>EVENT, SEC RAD BYPASS MONITOR, ONE = BYPASS</td>
<td></td>
<td>Value of ONE until secondary loop is turned off (approx. T-5 hours).</td>
</tr>
</tbody>
</table>

5. Operational Tests

Not Applicable.

6. Reliability/Redundancy Considerations

Exceeding redline limits can be an indication that any one of several failures may have occurred which could ultimately result in complete operational loss of one of the two coolant loops thereby eliminating loop redundancy. Such an event would decrease the coolant system reliability.
The Critical Items applicable:

<table>
<thead>
<tr>
<th>KSC LMR ITEM</th>
<th>CIL GP/CAT</th>
<th>CIL IDENT</th>
<th>FMEA IDENT</th>
<th>PART NUMBER/PART NAME</th>
<th>MEASUREMENT NUMBER</th>
<th>*</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>LCC-II</td>
<td>pg 32</td>
<td>ECS 4.1.06</td>
<td>52-83700-491/40°F Temp Control Valve</td>
<td>C273, C275</td>
<td>C274, C276</td>
<td>Yes</td>
<td></td>
</tr>
</tbody>
</table>

* WILL FAILURE OF THIS COMPONENT CAUSE MEASUREMENT TO EXCEED REDLINE LIMIT?

7. Instrumentation Accuracy and Method of Redline Value Determination

Instrumentation accuracy: +1.3, -1.7 (Range 33°F to 45°F)(CRT)

Method of redline value determination: The coolant temperature control valves CVPC and CVSC are adjusted prior to installation to maintain valve outlet coolant temperature between 36°F and 42°F. The correct outlet temperature is obtained by proportional mixing of hot and cold incoming coolant. In a normal operating valve, the flow of hot coolant into the valve will be completely blocked (except for allowable internal leakage) if the outlet temperature rises to 42°F and the flow of cold coolant completely blocked if the outlet temperature drops to 36°F. The given redline limits for the period from T-30 minutes until launch were based on these valve characteristics together with noted instrumentation accuracy and an allowance for heat leak into coolant lines between the valve and the sensors. During the period prior to T-30 minutes, the valve cold inlet ports may be supplied with coolant higher than 42°F and thus be unable to maintain the 36°F to 42°F range. The higher temperature is acceptable as long as it remains below 70°F, a limit based on maintaining the downstream battery modules at acceptable temperatures.

8. Other Information

None.

9. System Schematic Ref. Fig. 1, 513-WP-023, Page I-97.4
<table>
<thead>
<tr>
<th>REV</th>
<th>ITEM</th>
<th>MEAS/TM NO.</th>
<th>DESCRIPTION</th>
<th>CATEGORY</th>
<th>REDLINE VALUES</th>
<th>TIME PERIOD/ACTION/NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>3-2712</td>
<td>C283-534</td>
<td>TEMP - PRIMARY COOLANT CONTROL VALVE CVPA OUTLET 1</td>
<td></td>
<td>-1 of 2</td>
<td>43°F</td>
<td>51°F M *</td>
</tr>
<tr>
<td></td>
<td>C285-534 (ALTERNATE)</td>
<td>TEMP - PRI RGN HX IN-S/B CLNT MOD</td>
<td></td>
<td></td>
<td></td>
<td>FROM SYSTEM ACTIVATION AND TEMPERATURE STABILIZATION UNTIL INITIATION OF AUTO SEQUENCE (T-3 MIN 7 SEC). IN THE CASE OF A VIOLATION OF THE MINIMUM REDLINE LIMIT, CARE SHOULD BE EXERCISED TO PREVENT FREEZING OF THE EVA/IVA SUIT COOLANT. THE PRIMARY LOOP SHOULD BE DEACTIVATED, AND THE SECONDARY LOOP ACTIVATED, IF NECESSARY. *(1)MOMENTARY DEVIATIONS WHEN HEAT LOAD OR TEMPERATURE OF COOLING SOURCE VARIES RAPIDLY ARE NOT CONSIDERED VIOLATIONS. *(2)MAXIMUM REDLINE APPLICABLE ONLY AFTER T-30 MIN.</td>
</tr>
</tbody>
</table>

**REMARKS:**

The CVPA and CVSA outlet temperatures are monitored to assure adequate cooling of battery modules and satisfactory temperature control for moisture removal in the condensing heat exchanger. For related data see CN 513-WP-004, 008, -009, and -022, Pages I-94, I-98, I-99, I-96).
<table>
<thead>
<tr>
<th>REV</th>
<th>ITEM</th>
<th>MEAS/TM NO.</th>
<th>DESCRIPTION</th>
<th>CATEGORY</th>
<th>REDLINE VALUES</th>
<th>TIME PERIOD/ACTION/NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3-2712A</td>
<td>C284-534</td>
<td>TEMP - SECONDARY COOLANT CONTROL VALVE CVSA OUTLET 1</td>
<td>FLT CONT</td>
<td>M</td>
<td>NONE</td>
</tr>
<tr>
<td></td>
<td></td>
<td>C286-534 (ALT)</td>
<td>TEMP - SEC RGN HX IN-S/B CLNT MOD</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1 of 2</td>
<td>43°F</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>MINIMUM</td>
<td>NONE</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>MAXIMUM</td>
<td>*(1)</td>
</tr>
</tbody>
</table>

*IN THE CASE OF A VIOLATION OF THE MINIMUM REDLINE LIMIT, CARE SHOULD BE EXERCISED TO PREVENT FREEZING OF THE EVA/IVA SUIT COOLANT. THE PRIMARY LOOP SHOULD BE DEACTIVATED, AND THE SECONDARY LOOP ACTIVATED, IF NECESSARY.

*(1) MOMENTARY DEVIATIONS WHEN HEAT LOAD OR TEMPERATURE OF COOLING SOURCE VARIES RAPIDLY ARE NOT CONSIDERED VIOLATIONS.
SYSTEM BACKGROUND DATA:

1. System Description

Two independent, redundant coolant loops (primary and secondary) are provided. There are two pump packages, one for each loop containing three coolant pump/motor units. Three power supplies are provided for the three pump/motor units of each loop to convert spacecraft supplied DC power to the AC power required by the pump motors. During normal operation, one pump is operated in each loop, with each pump powered by a separate inverter. For a contingency mode after loss of one coolant loop, two pumps are operated in the remaining loop, with both pumps powered by a single inverter. Pump and inverter selection is provided by onboard switches and also DCS command. Inverter No. 1 powers pumps A and/or B, inverter No. 2 powers pumps B and/or C, and inverter No. 3 powers pumps C and/or A. Reservoirs are provided to maintain pump inlet pressure.

The coolant loops provide temperature control for ECS equipment, coldplated electrical/electronic equipment, and the ATM C&D panel/EREP heat exchanger. ECS equipment consists of suit cooling heat exchangers, condensing heat exchangers, cabin heat exchangers for OWS and AM/MDA, and an oxygen heat exchanger. The coldplated equipment includes three tape recorders, two battery modules, six electronic modules and two coolant pump inverter coldplates. All coldplated equipment except the pump inverters contain parallel coolant passages to permit passage of both primary and secondary coolant. Figure 1 is a system diagram illustrating measurement sensor locations.

During the LMRD effectivity period one or both loops may be activated and heat is dissipated to a ground coolant cart through a ground cooling heat exchanger installed in a bypass line around the radiator. Flow through the ground cooling heat exchanger is controlled by the radiator bypass selector valves which are in the bypass position until approximately T -5 hours, at which time the secondary loop is switched to the normal position and deactivated via DCS command. At T -9:25 minutes, the primary loop is switched to the normal position via DCS command. In orbit, heat is rejected to space by a radiator. Radiator performance is supplemented by a thermal capacitor (charged with tridecane wax) located downstream of the radiator. The capacitor stores heat while the vehicle is on the hot side of the orbit and rejects the heat on the cold side.
2. Probable Causes of Redline Violations

Maximum limit violations:

a. Coolant temperature control valve malfunction.

b. Premature activation of radiator bypass selector valve - Should be detected by discrete measurement K209-515 for the primary coolant loop and K210-515 for the secondary coolant loop.
   (Ref 513-WP-028, Page I-100)

c. Malfunction of ground cooling system.

d. Motor/pump unit malfunction - Should be detected by the observer monitoring pump ΔP and coolant flow.
   (Ref. 513-WP-009, Page I-99)

Minimum limit violations:

Coolant temperature control valve malfunction.

3. Consequences of Redline Violations

A violation of the minimum limit in the primary (secondary) loop may prevent coolant temperature control valve CVPB (CVSB) from maintaining satisfactory temperature control for moisture removal in the condensing heat exchanger and thus prevent maintenance of the desired dew point with present operational plans. A gross violation of minimum limit could result in freezing of the EVA/IVA suit coolant. A violation of the maximum limit could reduce cooling of battery modules to an unacceptably low level.

4. Backup Measurements and Nominal Values

Primary Coolant Loop:

- C244-515
  - TEMP, THERMAL CAPACITOR, PRI OUTLET
- C265-517
  - TEMP-THERMAL CAP 2 PRI INLET
- K209-515
  - EVENT, PRI RAD BYPASS MONITOR. ONE = BYPASS

Nominal Values: \( \leq +18^\circ F \)

A value higher than 40°F prior to T-30 minutes or a value higher than 18°F after T-30 minutes would indicate a failure of the ground cooling system or premature switching of the radiator bypass selector valve.

Value of ONE until Bypass Mode is switched at T -5 minutes.
Secondary Coolant Loop:

C245-515  TEMP, THERMAL CAPACITOR, SEC OUTLET

K210-515  EVENT, SEC RAD BYPASS
MONITOR. ONE = BYPASS

Nominal Values: \( \leq +40^\circ F \)

A value higher than \( +40^\circ F \) prior to secondary loop deactivation would indicate a failure of the ground cooling system or premature switching of the radiator bypass selector valve.

Value of ONE until secondary loop turned off at approximately T -5 hours.

4. Backup Measurements and Nominal Values (Continued)

LMRs 513-WP-008 and 513-WP-009 covering pump inlet pressure, pump differential pressure and coolant flow provide additional information.

5. Not Applicable

6. Reliability/Redundancy Consideration

Exceeding redline limits can be an indication that any one of several failures may have occurred which could ultimately result in complete operational loss of one of the two coolant loops thereby eliminating loop redundancy. Such an event would decrease the coolant system reliability.
The Critical Items applicable:

<table>
<thead>
<tr>
<th>KSC LMR ITEM</th>
<th>CIL IDENT</th>
<th>FMEA IDENT</th>
<th>PART NUMBER/PART NAME</th>
<th>MEASUREMENT NUMBER</th>
<th>*</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>LCC-II pg 24</td>
<td>ECS 4.1.37</td>
<td>61C830096-11/Temp Control Valve</td>
<td>-47°F</td>
<td>C283, C285</td>
<td>C284, C286</td>
<td>Yes</td>
</tr>
</tbody>
</table>

* WILL FAILURE OF THIS COMPONENT CAUSE MEASUREMENT TO EXCEED REDLINE LIMIT?

7. Instrumentation Accuracy and Method of Redline Value Determination

   a. Instrumentation accuracy: +0.3, -1.0 (Range 42 to 52)° F (CRT)

   b. Method of redline value determination: The coolant temperature control valves CVPA and CVSA adjusted prior to installation to maintain valve outlet coolant temperature between 45°F and 49°F. The correct outlet temperature is obtained by proportional mixing of hot and cold incoming coolant. In a normally operating valve, the flow of hot coolant into the valve will be completely blocked (except for allowable internal leakage) if the outlet temperature rises to 49°F and the flow of cold coolant completely blocked if the outlet temperature drops to 45°F. The given redline limits were based on these valve characteristics together with noted instrumentation accuracy and an allowance for heat leak into coolant lines between the valve and the sensors.

8. Other Information

   None.

9. System Schematic

   See Fig. 1.
<table>
<thead>
<tr>
<th>REV</th>
<th>ITEM</th>
<th>MEAS/TM NO.</th>
<th>DESCRIPTION</th>
<th>CATEGORY</th>
<th>REDLINE VALUES</th>
<th>TIME PERIOD ACTION NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>3-2715</td>
<td>D222-515</td>
<td>PRESSURE - PRI COOLANT PUMP INLET</td>
<td>M</td>
<td>25 PSIA</td>
<td>NONE</td>
<td>FROM START OF LMRD UNTIL INITIATION OF AUTOMATIC SEQUENCE.</td>
</tr>
<tr>
<td>3-2716</td>
<td>D223-515</td>
<td>PRESSURE - SEC COOLANT PUMP INLET</td>
<td>M</td>
<td>25 PSIA</td>
<td>NONE</td>
<td></td>
</tr>
</tbody>
</table>

**MISSION:** SA-513/SL-1  
**SECTION:** WORKSHOP  
**STAGE/SUBSECTION:** AM/Thermal Control System  
**SYSTEM:** REDLINES AND CATEGORIES  
**REMARKS:**  
Required to verify that adequate coolant is available in the reservoir.  
(Ref. 513-WP-004, -009, -022, and -023)  

**CONTROL NUMBER:** 513-WP-008-R3  
**PAGE:** REV. 3  
**REVISION:** REV. 5  
**DATE:** MAY 9 1973  
**PAGE:** T-98
SYSTEM BACKGROUND DATA:

1. System Description

Ref. 513-WP-023.

2. Probable Causes of Redline Violations

Maximum limit violations

a. Excessive coolant in system.

b. Excessive coolant temperature resulting in excessive coolant expansion (See 513-WP-022).

Minimum limit violations

a. Coolant leakage.

b. Leak of Freon pressurant in reservoir.

c. Malfunction of coolant control valve CVPC or CVSC causing coolant temperature to be lower than specified resulting in excessive coolant contraction (See 513-WP-022).

3. Consequences of Redline Violations

Minimum redline limit violation would render the affected loop unusable and, if undetected, operating electronic equipment could be overheated and damaged. An upper limit violation caused by a coolant overfill could result in sufficiently high pressures to rupture a cooling system component.

4. Backup Measurements and Nominal Values

K222-515 EVENT, PRI COOLANT RESERVOIR LOW

K223-515 EVENT, SEC COOLANT RESERVOIR LOW

Nominal Value: OFF

ON indicates almost total loss of reserve coolant. Pump ΔP will not be affected until coolant loss is greater than that indicated by these measurements.

5. Operational Tests

Not Applicable.
<table>
<thead>
<tr>
<th>REV</th>
<th>ITEM</th>
<th>MEAS/TM NO.</th>
<th>DESCRIPTION</th>
<th>CATEGORY</th>
<th>REDLINE VALUES</th>
<th>TIME PERIOD/ACTION/NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>3-2717</td>
<td>D224-515</td>
<td>PRESS, PRI COOLANT PUMP DIFF</td>
<td></td>
<td></td>
<td>20 PSID</td>
<td>FROM SYSTEM ACTIVATION UNTIL INITIATION OF AUTOMATIC SEQUENCE.</td>
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<tr>
<td></td>
<td>F214-534 (ALT)</td>
<td>FLOW, PRI COOLANT CONTROL VALVE CVPB OUT</td>
<td></td>
<td></td>
<td>70 PSID</td>
<td></td>
</tr>
</tbody>
</table>

**REMARKS:**

Provides indication of primary and secondary coolant loop flow and verification of primary and secondary pump performance.

(Ref. 513-WP-004, -008, -022, and -023 on Pages I-94, I-98, I-96, and I-97.)
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<tr>
<th>REV</th>
<th>ITEM</th>
<th>MEAS/TM NO.</th>
<th>DESCRIPTION</th>
<th>CATEGORY</th>
<th>REDLINE VALUES</th>
<th>TIME PERIOD/ACTION/NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>3-2717A</td>
<td>D225-515</td>
<td></td>
<td>PRESS, SEC COOLANT PUMP DIFF</td>
<td></td>
<td></td>
<td>FROM SYSTEM ACTIVATION UNTIL TERMINATION OF SECONDARY COOLANT LOOP FLOW (APPROX. T-5 HOURS)</td>
</tr>
<tr>
<td></td>
<td>F215-534</td>
<td>(ALT)</td>
<td>FLOW, SEC COOLANT CONTROL VALVE CVSB OUT</td>
<td></td>
<td></td>
<td>ONE PUMP OPERATION. TRANSIENTS WILL OCCUR DURING VALVE SWITCHING</td>
</tr>
</tbody>
</table>
MSFC LAUNCH MISSION RULE BACKGROUND

SYSTEM BACKGROUND DATA:

1. System Description and Diagram
   Ref. 513-WP-023, Page I-97.

2. Probable Cause of Redline Violations
   Maximum limit violations
   a. Pump inverter malfunction
   b. Operation of more than one pump in a coolant loop.

   Minimum limit violations
   a. Pump malfunction.
   b. Pump inverter malfunction.
   c. Excessive coolant leak (should be detected first by observing redline measurements in 513-WP-008, Page I-98).
   d. Pump off.

3. Consequences of Redline Violations
   Over-stress conditions that could follow a maximum limit violation may weaken or damage system. Reduced heat removal capability that would follow a minimum limit violation of either the primary or alternate redlines would eventually result in damage to dependent equipment. The given probable causes can result in partial or total loss of affected loop capability or reduction in loop reliability.

4. Backup Measurements
   None.

5. Operational Tests
   Not Applicable.

6. Reliability/Redundancy Considerations
   A redline violation introduces the possibility of subsequent total loss of the affected primary coolant loop thereby eliminating loop redundancy. Loss of one pump will reduce the affected coolant loop reliability.
### MSFC LAUNCH MISSION RULE BACKGROUND

The Critical Items applicable:

<table>
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<tr>
<th>KSC LMR ITEM</th>
<th>CIL IDENT</th>
<th>FMEA IDENT</th>
<th>PART NUMBER/PART NAME</th>
<th>MEASUREMENT NUMBER</th>
<th>*</th>
<th>COMMENTS</th>
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</thead>
<tbody>
<tr>
<td>LCC-II</td>
<td>pg 32</td>
<td>ECS 4.1.03</td>
<td>61B85009/Pwr Inv, Cool Pump</td>
<td>D224, D225</td>
<td>Yes</td>
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<tr>
<td>LCC-II</td>
<td>pg 32</td>
<td>ECS 4.1.01</td>
<td>52-83700-833/Cool Pump, Dual</td>
<td>D224, D225</td>
<td>Yes</td>
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* WILL FAILURE OF THIS COMPONENT CAUSE MEASUREMENT TO EXCEED REDLINE LIMIT?

7. Instrumentation Accuracy and Method of Redline Value Determination

Instrumentation accuracy: D224-515, (D225-515), ±7 PSI F214-534, (F215-534) ±7.2 lb/hr. (Based on 20-100% F.S. Range)

Method of redline value determination: The given redline limits were estimated from pump performance curves and were verified during spacecraft systems tests. The maximum redline of 70 PSID considers a maximum pump differential pressure of 63 PSID for stabilized one-pump operation with the radiator bypass valve in the NORMAL position and allows for ±7 PSI instrumentation inaccuracy. The minimum redline of 20 PSID is based on a minimum differential pressure of 27 PSID for stabilized one-pump operation with the radiator bypass valve in the BYPASS position and allows for -7 PSI instrumentation inaccuracy. For the alternate measurement, the minimum redline of 238 lb/hr considers a minimum design flow rate of 230 lb/hr for one-pump operation and allows for +7.2 lb/hr instrumentation inaccuracy.

8. Other Information

None.

9. System Schematic

Ref. Fig. 1, 513–WP–023, Page I-97.4
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<th>REV</th>
<th>ITEM</th>
<th>MEAS/TM NO.</th>
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<th>CATEGORY</th>
<th>REDLINE VALUES</th>
<th>TIME PERIOD/ACTION/NOTES</th>
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</thead>
<tbody>
<tr>
<td>3-2720</td>
<td>K209-515</td>
<td>PRIMARY RADIATOR BYPASS MONITOR.</td>
<td>FLT CONT</td>
<td>ENG DATA</td>
<td>PRE-LAUNCH</td>
<td>MINIMUM</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>M</td>
<td></td>
<td>*(1)</td>
<td>*(1)</td>
</tr>
<tr>
<td></td>
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</tr>
</tbody>
</table>

**REMARKS:**

Provide verification that coolant system radiator bypass valves are in the proper position.

**REQUIRED BY:**

MDAC-East

**CONTROL NUMBER:**

513-WP-028-R5

**PAGE:**

.1, .2, .3

**REVISION:**

REV. 5

**DATE:**

MAY 9 1973

**PAGE:**

I-100
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<th>REV</th>
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<th>MEAS/TM NO.</th>
<th>DESCRIPTION</th>
<th>CATEGORY</th>
<th>REDLINE VALUES</th>
<th>TIME PERIOD/ACTION/NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>3-2721</td>
<td>K210-515</td>
<td>3-2721</td>
<td>SECONDARY RADIATOR BYPASS MONITOR</td>
<td>M</td>
<td>*(1)</td>
<td>FROM START OF LMRD UNTIL SECONDARY LOOP TURN-OFF (APPROX. T-5 HRS)</td>
</tr>
</tbody>
</table>

**SYSTEM IN TOLERANCE:**
- WHEN BYPASS MONITOR IS DIRECTED TO BYPASS
- *(1)* FROM SECONDARY LOOP TURN-OFF (APPROX. T-5 HRS) UNTIL INITIATION OF AUTO SEQUENCE (T-3 MIN 7 SEC)
- SYSTEM IN TOLERANCE WHEN BYPASS MONITOR IS DIRECTED TO RADIATOR. AT LEAST A 4 PSID INCREASE IN D225 IS REQUIRED COINCIDENT WITH THE BYPASS VALVE CYCLING TO INSURE THE BYPASS VALVE HAS MOVED TO RADIATOR POSITION.
1. **SYSTEM DESCRIPTION**

   Ref. 513-WP-023, Page I-97.

2. **PROBABLE CAUSES OF REDLINE VIOLATIONS**

   a. Premature switching of radiator bypass valve.
   b. Failure of command system to properly position the valve.
   c. Valve malfunction.

3. **CONSEQUENCES OF REDLINE VIOLATIONS**

   Violation of the redline limit for K210-515 prior to primary loop turn on will prematurely terminate ground cooling of the AM coolant system. Violation of the redline limit for K209-515 after secondary loop turn off and prior to T-10 minutes will prematurely terminate ground cooling of the AM coolant system. If ground cooling is prematurely terminated, excessive coolant temperatures could be obtained with possible overheating of coldplate mounted equipment or lift-off could occur with thermal capacitors which are partially or completely discharged (Ref. 513-WP-024). A violation after T-10 minutes will result in loss of heat rejection capability of the primary coolant loop via the radiator during orbital operation unless the valve can be manually positioned by the crew during cluster activation. (See Page I-95.)

   Violation of the redline limit for K210-515 will result in loss of heat rejection capability of the secondary coolant loop via the radiator during orbital operation.

   Failure of pump differential pressure to increase at least 4 PSID in either loop after switching command is sent is a positive indication that the related valve did not operate to the radiator position even though the appropriate discrete (K209 or K210) may be indicating that it has. (Note: In the case of one of the discretes indicating a valve has assumed the radiator position without the occurrence of a corresponding increase of differential pressure, crew operation of the onboard switch is not likely to cause valve operation.)

4. **BACKUP MEASUREMENTS AND NOMINAL VALUES**

   Primary and Secondary Loop: C262-517 TEMP, THERMAL CAP. 1 SKIN 1
   C263-517 TEMP, THERMAL CAP. 1 SKIN 2

   A temperature increase will occur following premature switching of primary radiator bypass valve.

5. **OPERATIONAL TESTS**

   None
6. RELIABILITY/REDUNDANCY CONSIDERATIONS

Exceeding redline limits may indicate that any one of several failures has occurred. The failure could result in ineffective operation of the coolant system and overheating of equipment and could ultimately result in complete operational loss of one of the two coolant loops thereby eliminating loop redundancy.

7. INSTRUMENTATION ACCURACY AND METHOD OF REDLINE DETERMINATION

Not applicable to the discrete measurements.

The requirement given for the increase in pump differential pressure when the bypass valve is switched is based on CDDT and spacecraft tests and analyses. The D224 and D225 instrumentation inaccuracy of ± 7 PSID is not considered applicable since the requirement is expressed in terms of a delta rather than an absolute measurement. Test experience indicates that an increase in stabilized differential pressure greater than 4 PSI will be obtained as a result of switching the radiator bypass valve to the normal (radiator) position.

8. OTHER INFORMATION

None

9. SYSTEM SCHEMATIC

Ref. Figure 1, 513-WP-023, Page I-97.4
INTERNAL POWER ENVELOPE
AM BATTERIES 1 THRU 8

TIME PERIOD:
ANY TIME AN AM BATTERY IS DISCHARGING WITH AVERAGE PRELAUNCH LOADS UNTIL INITIATION OF AUTO SEQUENCE

NOTE:
CURRENT GREATER THAN 25 AMPS IS NOT CONSIDERED A REDLINE VIOLATION BUT WILL SOON CAUSE AN SOC REDLINE VIOLATION & MAY INDICATE A MALFUNCTION IN EITHER THE EPS OR USING EQUIPMENT
<table>
<thead>
<tr>
<th>REV</th>
<th>ITEM</th>
<th>MEAS/TM NO.</th>
<th>DESCRIPTION</th>
<th>CATEGORY</th>
<th>REDLINE VALUES</th>
<th>TIME PERIOD/ACTION/NOTES</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>3-6101A</td>
<td>DP7033 (ACE)</td>
<td>POSITION, EVACUATION VALVE OPEN CMG 1</td>
<td>M</td>
<td>*</td>
<td>FROM START OF LMRD UNTIL INITIATION OF AUTO SEQUENCE</td>
</tr>
<tr>
<td></td>
<td>3-6101B</td>
<td>DP7034 (ACE)</td>
<td>POSITION, EVACUATION VALVE OPEN CMG 2</td>
<td>M</td>
<td>*</td>
<td>*SYSTEM IN TOLERANCE IF INDICATION IS OFF</td>
</tr>
<tr>
<td></td>
<td>3-6101C</td>
<td>DP7035 (ACE)</td>
<td>POSITION, EVACUATION VALVE OPEN CMG 3</td>
<td>M</td>
<td>*</td>
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</table>

**MISSION:** SA-513/SI-1  
**SECTION:** WORKSHOP  
**STAGE/SUBSECTION:** ATM/APCS  
**SYSTEM:**

**REMARKS:**

Insure energy is not applied to ATM APCS Buses +7D12 & +7D22. The evacuation valve positions will indicate OPEN if either of the subject busses have been inadvertently powered. Assessment of the cause will have to be performed and corrective action taken.

**CONTROL NUMBER:** 513-RP-011-R 5

**REDLINES AND CATEGORY**

**REQUIRED BY:**
- QUAL-PF
- ASTR-S
- ATM (APCS) Mr. Igou

**CONCURRENCES**

- AERO: E. E. Mads  
  - ASTR: 4/3/73  
  - ASTN:  
  - QUAL: 3-4-73

- ATM:  
  - 4/4/73

**PAGE:** .1, .2, .3,  
**REVISION:** REV 5

**DATE:** MAY 9 1973  
**PAGE:** I-108A

* **PROG. ENG. OFFICE:**  
  - PROG. OFFICE: (ET)  
  - MO-MGR:  
  - DATE: 4/5/73  
  - PAGE: I-108A
SYSTEM BACKGROUND DATA:

1. **System Description**

   The ATM/APCS sub-buses +7D12 and +7D22 are the sources of input DC power to the Attitude and Pointing Control System components. The on/off status of these sub-buses can be controlled from the IU through the SWS switch selector, from the AMDCS, and from ATM switch selector number one. The APCS sub-buses can be energized from these control sources anytime the ATM +7D11 and +7D21 main buses are energized; these buses are energized for approximately 70 hours during the countdown and are still on at liftoff. Electrical closeout of the APCS in the VAB latches (sets) the power input relays for the primary ATMDC, the Acq. S.S., and the 3 CMG's so that these components are powered up in flight by the "APCS on" commands from the IU. The 9 rack rate gyros are configured in a similar manner during countdown. Any command to the APCS sub-buses during countdown will prematurely power up the APCS components that are latched to +7D12 and +7D22. The status of these buses can be monitored by observing the status of the three CMG evacuation valve open indications since electrical closeout provides a path from the sub-buses through the CMGIA and CMG to the umbilical measuring system. An additional monitor point is available until T-9 minutes when the deadface relays open; this monitor point is a direct readout of the sub-buses.

2. **Probable Cause of Redline Violations**

   **a. Inadvertent ATM switch selector number one command.**

   **b. Inadvertent IU command.**

   **c. Inadvertent AMDCS command, local or from MCC Houston.**

   **d. Failure in control networks.**

3. **Consequences of Redline Violations**

   **a.** If the APCS sub-buses are powered up during the countdown, this would indicate that an erroneous command has been issued by one of the control sources or that a failure has occurred in the control networks. The results of such a premature command would be:

   1) The ATM Batteries would be loaded with approximately 40 amperes from T-71 Hours until T-7 Minutes. After T-7 Minutes the ATM Batteries would be loaded with approximately 50 amperes. On orbit battery reserve could be reduced below an acceptable level, depending upon the time of malfunction.

   2) The ATM DC, WCIU, CMG, CMG Inverter Assemblies, Acquisition Sun Sensors, and Rack Rate Gyros would be operated with no method of monitoring their performance or temperature. These components and the ATM batteries could operate above their specified ranges and be damaged.
4. Backup Measurements and Nominal Values

<table>
<thead>
<tr>
<th>Measurements</th>
<th>Nominal Value</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>*BP7033, Voltage, Bus +7D12</td>
<td>0.0 to 2.0 VDC</td>
<td>*Inactive after deadface relays</td>
</tr>
<tr>
<td>*BP7034, Voltage, Bus +7D22</td>
<td>0.0 to 2.0 VDC</td>
<td>open at T-9 minutes.</td>
</tr>
</tbody>
</table>

5. Operational Test (Other Method of System Validation)

None

6. Reliability/Redundancy Considerations

The APCS sub-buses can be turned on from three sources. Any of the commands will power up both +7D12 and +7D22; separate command is available from ATM switch selector number one and to turn the buses off one at a time.

The Critical Items applicable: TBD

<table>
<thead>
<tr>
<th>KSC LMR ITEM</th>
<th>CIL GP/CAT</th>
<th>CIL IDENT</th>
<th>FMEA IDENT</th>
<th>PART NUMBER/PART NAME</th>
<th>MEASUREMENT NUMBER</th>
<th>*</th>
<th>COMMENTS</th>
</tr>
</thead>
</table>

* WILL FAILURE OF THIS COMPONENT CAUSE MEASUREMENT TO EXCEED REDLINE LIMIT?

7. Instrumentation Accuracy and Method of Redline Value Determination

These measurements are discrete indications.

The position of latching relays and CMG valve switches after electrical closeout in the VAB is such that the +7D12 and +7D22 bus voltages are available on the above measurements until plug eject. These three measurements are on red event lights in the ATM control room.

8. Other Information

None.
9. System Schematic

FIGURE 1.

APCS SUB-BUS MONITOR VIA CMG EVACUATION VALVE OPEN INDICATION
# MSFC LAUNCH MISSION RULES

## INDEX

### SECTION III DISAPPROVED LAUNCH MISSION RULES

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<tr>
<td>RP-010 *(4)</td>
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<td>VOLTAGE, BUS 7D11</td>
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<tr>
<td>*</td>
<td></td>
<td>ATM FIGURE 1</td>
<td></td>
</tr>
<tr>
<td>*(1)</td>
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<td>ATM FIGURE 2</td>
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<td>OP-011</td>
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<td>TEMP - GTCS, FOOD CONTAINER EXT.</td>
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<tr>
<td>BP-004</td>
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<td>S-II LOX DEPLETION SENSORS 1-5 OPEN</td>
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<td>OP-012</td>
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<td>EVENT, RS, PRI LOOP RAD BYPASS VLV, BYPASS MODE</td>
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<td>OP-018</td>
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<td>EVENT, MS, TENS STRAPS SECURED</td>
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<td>3-2106 thru 3-2109</td>
<td>WP-007</td>
<td>VOLT, INSTR BUSES A</td>
<td>III-18</td>
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<td>3-611 thru 3-616</td>
<td>OP-015</td>
<td>EVENT, TACS THRUSTERS</td>
<td>III-19</td>
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<td>3-218A</td>
<td>OP-024</td>
<td>EVENT - AM GND PWR ENABLE ON</td>
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<td>OP-025</td>
<td>EVENT - RS, RADIATOR PROTECTIVE SHIELD JETTISON AND RTN SW RLYS IF MODE ON</td>
<td>III-21</td>
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<td></td>
<td>OP-026</td>
<td>EVENT - OWS, ATM SAW PRI AND SEC AND A &amp; B</td>
<td>III-22</td>
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<tr>
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<td>OP-027</td>
<td>EVENT - OWS SAW SECTION AND FAIRING DEPL RLY RST</td>
<td>III-23</td>
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<tr>
<td></td>
<td>OP-028</td>
<td>EVENT - OWS MS RLY RST ON &amp; H/A SOL VNT VLV CLOSE OFF</td>
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**DISAPPROVED LAUNCH MISSION RULES**

These rules are retained in the MO-E files.
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<tr>
<td>OP-030</td>
<td></td>
<td>EVENT - PAYLOAD SHROUD RELAYS RST ON</td>
<td>III-26</td>
</tr>
</tbody>
</table>
### MSFC LAUNCH MISSION RULE INPUT

<table>
<thead>
<tr>
<th>REV</th>
<th>ITEM</th>
<th>MEAS/TM NO.</th>
<th>DESCRIPTION</th>
<th>CATEGORY</th>
<th>REDLINE VALUES</th>
<th>TIME PERIOD/ACTION/NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>3-218A</td>
<td>K7428-411 (UMB)</td>
<td>EVENT-AM GND PWR ENABLE ON</td>
<td></td>
<td></td>
<td>M</td>
<td>FROM TRANSFER TO INTERNAL POWER (APPROX. T-15 MIN.) UNTIL INITIATION OF AUTOMATIC SEQUENCE.</td>
</tr>
</tbody>
</table>

**REMARKS:**

This measurement verifies that the OWS SAS power buses are electrically isolated from the OWS umbilical. A change in output of K7428 from +28 VDC to 0 VDC at execution of Airlock Module Ground Power Enable Off command (launch minus 15 minutes) indicates that the OWS umbilical deadfacing circuitry is in launch configuration.

**DISAPPROVED RULE**

This rule has been disapproved by SL-E1. The rule is not considered to be a mandatory requirement.

**REQUIRED BY:**

MDAC-West

**CONTROL NUMBER:**

513-OP-024-R4

**CONCURRENCES**

- ASTR: 3-13-73
- ASMT: 3-13-73
- SW: 3/31/73
- PROG. ENG. OFFICE: 3-28-73
- PROG. OFFICE: 3-28-73
- MC-MGR: 3/28/73

**PAGE REVISION**

- 1.1, 2.2.3

**PAGE:** III-20

**DATE:** MAY 9, 1973

**PAGE:** III-20

**MSFC - Form 3173-2 (Rev June 1970)**
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<thead>
<tr>
<th>REV</th>
<th>ITEM MEAS/TM NO.</th>
<th>DESCRIPTION</th>
<th>CATEGORY</th>
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<th>TIME PERIOD/ACTION/NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>K7444-404 (UMB)</td>
<td>EVENT - RS, RADIATOR PROTECTIVE SHEILD JETTISON AND RTN SW RLYS IF MODE ON</td>
<td>M</td>
<td>*</td>
<td>FROM RS TRANSFER TO INTERNAL (T-20 HOURS) UNTIL RS DISABLE (APPROX. T-5 MINUTES)</td>
</tr>
</tbody>
</table>

**DISAPPROVED RULE**

This rule has been disapproved by SL-EI. The rule is not considered to be a mandatory requirement.

Monitor this indication for proper liftoff configuration to preclude launching with either certain premature jettison of RS Shield, possible loss of RS secondary loop, or reduction in RS secondary loop power and/or return wiring.

REMARKS:

Monitor this indication for proper liftoff configuration to preclude launching with either certain premature jettison of RS Shield, possible loss of RS secondary loop, or reduction in RS secondary loop power and/or return wiring.

REQUIRED BY:

MDAC-WEST

CONTROL NUMBER:

513-OP-025-R5

PAGE: REVISION

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<table>
<thead>
<tr>
<th>REV</th>
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<th>REDLINE VALUES</th>
<th>TIME PERIOD/ACTION/NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>28</td>
<td>7651-411</td>
<td>EVENT - OWS, ATM SAW PRI AND SEC AND A &amp; B</td>
<td>M</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

**DISAPPROVED RULE**

This rule has been disapproved by SL-EI. The rule is not considered to be a mandatory requirement.

**REV 5**

**Date**: MAY 9 1973

**MISSION**: SA-513/SL-1

**SECTION**: WORKSHOP

**STAGE/SUBSECTION**: OWS/ATM DEPLOYMENT

**SYSTEM**:

**REMARKS**:

This measurement verifies proper liftoff configuration of OWS relays controlled by the OWS switch selector for ATM EBW System A & B Arm and ATM Solar Wings Deploy to preclude launching with one or more "reset" commands continuously applied to ATM circuitry.

**REQUIRED BY**: MDAC-West

**CONTROL NUMBER**: 513-OP-026-R5

**PAGE**: 1

**REVISION**: III-22
### MSFC Launch Mission Rule Input

**Revision Item Measurement Number:** K7653-411 (UMB)

**Mission:**

**Section:** SA-513/SL-1 WORKSHOP

**Stage/Subsection:** OWS/POWER DISTRIBUTION AND CONTROL SYSTEM

**System:**

**Redlines and Categories**

<table>
<thead>
<tr>
<th>REDLINE VALUES</th>
<th>TIME PERIOD/ACTION/NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>MINIMUM</td>
<td>MAXIMUM</td>
</tr>
</tbody>
</table>

**Description:** EVENT - OWS SAW SECTION AND FAIRING DEPL RLY RST

**Remarks:**

Monitor this indication for proper liftoff configuration to preclude launching with one of the two SAS Wing 'Section or Beam Fairing deployment systems failed or inoperative due to relay configuration.

**Concurrences**

**Aero:**

**Astro:** 3/18/73

**Sw:** 1970-011

**Prog. Eng. Office:**

**Prog. Office:** EI

**Reversed:**

**Date:** MAY 9 1973

**Page:** III-23

---

**DISAPPROVED RULE**

This rule has been disapproved by SL-EI. The rule is not considered to be a mandatory requirement.

**Verification:**

Verify prior to pad clear and at initiation of auto seq.

*System in tolerance if relays reset indication on.*
**MSFC LAUNCH MISSION RULE INPUT**

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</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>EVENT-OWS MS RLY RST ON &amp; H/A SOL VNT VLV CLOSE OFF</td>
<td></td>
<td>M</td>
<td>*</td>
</tr>
</tbody>
</table>

**REMARKS:**

Monitor this indication for proper liftoff configuration to preclude launching with one of the two Meteoroid Shield deployment EBW systems failed or inoperative due to relay configuration.

**DISAPPROVED RULE**

This rule has been disapproved by SL-EI. The rule is not considered to be a mandatory requirement.

**Control Number:** 513-OP-028-R5

**Page:** I-24

**Date:** May 9, 1973

**Required by:** MDAC-West

**PROG. ENG. OFFICE:**

**PROG. OFFICE:** EI

**MO-MGR:**

**DATE:** May 9, 1973

**PAGE:** I-24

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</tr>
</thead>
<tbody>
<tr>
<td>K7657-411 (UMB)</td>
<td>EVENT, ATM DEPLOYMENT ASSEMBLY RELAYS RST ON</td>
<td>M</td>
<td>*</td>
<td>*</td>
<td>VERIFY PRIOR TO PAD CLEAR AND AT INITIATION OF AUTO SEQ.</td>
</tr>
</tbody>
</table>

This rule has been disapproved by SL-EI. The rule is not considered to be a mandatory requirement.

Monitor this indication for proper liftoff configuration to preclude launching with one or both of the ATM DA primary deployment systems failed or inoperative due to relay configuration.

MDAC-West

CONTROL NUMBER:
513-OP-029-R5

REQUIRED BY:

PAGE: III-25
REVISION:
### EVENT - PAYLOAD SHROUD RELAYS RST ON

**Description:**
- **MEAS/TM NO.:** K7658-411
- **CATEGORY:** M
- **REDLINE VALUES:** *
- **TIME PERIOD/ACTIONNOTES:**
  - **VERIFY PRIOR TO PAD CLEAR AND AT INITIATION OF AUTO SEQ.**
  - **REMARKS:**
    - Monitor this indication for proper liftoff configuration to preclude launching with one or both of the primary PS jettison EBW systems failed or inoperative due to relay configuration.

---

**DISAPPROVED RULE**

This rule has been disapproved by SL-EL. The rule is not considered to be a mandatory requirement.

---

**REMARKS:**
- Monitor this indication for proper liftoff configuration to preclude launching with one or both of the primary PS jettison EBW systems failed or inoperative due to relay configuration.

---

**CONCURRENCES**

- **AERO:**
  - **ASTR:** 3/13/73
  - **SW:** 3/13/73
- **PROG. ENG. OFFICE:**
  - **PROG. OFFICE:** EI
  - **MO-MGR:**
- **DATE:** MAY 9 1973
- **PAGE:** III-26

**CONTROL NUMBER:** 513-OP-030-R5