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APOLLO  
GUIDANCE AND NAVIGATION SYSTEM  
CUSTOMER ACCEPTANCE READINESS REVIEW  
AND  
FLIGHT READINESS REVIEW REPORT  
G & N 217                      CM 112  
PHASE III CARR

23 November 1970

EP9360B

Delco Electronics Division  
General Motors Corporation  
Milwaukee, Wisconsin 53201

## 2.15 GUIDANCE AND NAVIGATION SUMMARY

This document is an update of the G & N CARR/FRR report since the CM 112 Phase I CARR Subsystem Data Review on 15 July 1969. G & N 217 has successfully completed the required field laboratory G & N testing, Spacecraft installation, and integrated testing. Recognizing the open items identified below, G & N 217 is ready for shipment to KSC.

Table 2.15-1 is a chronological event summary of G & N 217 related activities.

### 2.15.1 OPEN ITEM STATUS

#### a. Modifications Completed since the Phase I CARR.

|           |  |
|-----------|--|
| ECP 768R1 | DSKY EL Safety Cover Glass Installations, Completed 23 and 26 January 1970.  |
| ECP 786   | Inspection of OUA SCT Shaft and Trunnion Counters Was Accomplished on <del>5 May</del> 1969. Units Acceptable. 7/9 |
| ECP 790   | ESU Eyepiece Retainer Spring Tabs. Completed 24 October 1969.  |
| ECP 792   | GNIC Panel; Addition of Computer-Aided Optics Circuitry. Completed 6 October 1969.                                 |
| ECP 795   | Eyepiece Teflon Locking Rings. Completed 24 July 1969.   |
| ECP 815   | AGC Restart Monitor Module. Completed 24 March 1970.   |
| ECP 1007  | OUA SXT Halo Light Shield. Completed 5 May 1970.   |

#### b. Open Work Items at NR

"C" harness clamp screws replacement per TDRR-38189. Remove IMU-48/PEA-23 and ship to MKE prior to S/C shipment to KSC.

ESU spring replacement - reference FDR 3789

#### c. Modifications Pending

ECP-1017 IMU Blower Motor Retrofit - to be accomplished in MKE.

#### d. Open Work Items to KSC

Install IMU/PEA.

Colossus Flight Ropes including ECP 766 Thermal Vacuum Screen

Installation of ECP 754 GNIC Panel modification for interchangeable Verb/Noun Lists

GNIC Panel Verb/Noun List and Star Maps

GNIC Panel Star Chart Decal

ESU Checklist and Alarm Codes Decal per ECP 725.

e. Pertinent Items since the Phase I CARR.

1. IMU quick disconnects are to be replaced after 20 hours exposure to isopropyl alcohol. One quick disconnect coupling was replaced in IMU 48 at the factory 20 March 1970. The installed quick disconnects, P/N 1000135, S/N 328 and S/N 47, have had zero hours exposure to isopropyl alcohol since installation.
2. Flatpack contamination. CMC 36 has completed 32 minutes of computer-level  $Y_A$  and 43 minutes of computer-level  $Y_B$  vibration screen. However, no module-level flatpack vibration screening for contamination has been accomplished on this unit. ECDU 44 modules have experienced module-level  $Y_A$ - $Y_B$  vibration screening.
3. Relay vibration screen. DSKY's -94, -95 IDM modules have not been subjected to vibration screen at the module level. The DSKY relays have been vibrated at the system level for contamination detection, however. In addition, DSKY 95 contains Potter Brumfield (Rev. F) relays that underwent relay vibration prior to installation. DSKY 94 contains Filtor's (Rev. F) relays that underwent relay vibration prior to installation.

## 2.15.2 CHECKOUT ANOMALIES

Significant checkout anomalies during G & N 217 S/C acceptance testing are identified in Table 2.15-2.

Hardware changes made in G & N 217 since the Phase I CARR are identified in Table 2.15-3.

G & N contract and engineering waivers were reviewed. The only Field Site non-conformance documentation items are:

- |            |  |
|------------|--|
| MRB-NR-320 | Insulation nicked on shield lead located 4 inches from potted end of connector 56P26 due to improper handling. Item repaired.  |
| MRB-NR-322 | Terminal 638 of connector 56P10 has one half of nylon insulator broken off on outside edge. Use as is. Since no electrical connection is made through this terminal, system performance will not be affected.                                  |
| MRB-NR-329 | Light from reticle illumination bulbs reflect from dirt particles entrapped on reticle assembly. Use as is. Particles will not affect mission performance since the light sphere reflections are visible only at abnormal illumination levels. |

E-Hanger  
A-HAWAII  
SPAN P/1

### 2.15.3 CRITICAL LIMITED LIFE ITEMS

The only G & N limited life item identified is the Motortach (P/N 1012156) in the OUA. Replacement criteria is 4 years since motortach bearing lubrication. The motortachs in OUA-29 are newly lubricated (approximately 8 months ago). In the case of gyros, the individual performance parameters are analyzed as end-of-life indicators. Test data on the instruments in G & N 217 has been reviewed and analysis indicates that the instruments are acceptable.

### 2.15.4 HARDWARE CERTIFICATION

The hardware in G & N 217 is identified in Table 2.15-4.

The Block II G & N system has completed qualification testing. Additional qualification and evaluation testing required due to modifications has been completed. Qualification and evaluation test reports have been approved. Corrective action has been incorporated in G & N 217 where required. ECP 815 Retrofit Qualification Test was successfully completed on 28 February 1970, and the test report was forwarded to NASA on 27 February 1970. CM-112, G & N 217 is qualified for flight by similarity to the qualification test hardware.

G & N 217 contains no irregular parts.

Items available or transferred to Crew Systems for installation are as follows:

|                                  |   |        |
|----------------------------------|---|--------|
| Eyepiece filters                 | SCT LER FILTER P/N 2012816 S/N 008      | 0.3 lb |
| (6/19/70)                        | SCT Eyepiece FILTER P/N 2012808 S/N 008 | 0.2 lb |
| GNIC Panel Handles (12 Mar 1970) |   |        |

### 2.15.5 FAILURE ANALYSIS AND CORRECTIVE ACTION

There are no significant G & N 217 checkout anomalies requiring problem summary documentation. Qualification test and generic problem summaries that have been closed as "Resolved" or "Explained" in previous G & N acceptance review meetings are not included.

### 2.15.6 SPARES STATUS

Adequate spares exist at Delco Electronics to support G & N System 217 through the next test phase.

### 2.15.7 WEIGHT SUMMARY

G & N 217 weight summary is contained in Table 2.15-4.

### 2.15.8 FLAMMABLE MATERIALS SUMMARY

This system contains the complete flammable materials retrofit.

### 2.15.9 TEMPORARILY INSTALLED ITEMS

Temporarily installed items are identified below.

|                        |    |                                   |
|------------------------|----|-----------------------------------|
| SXT Crown Dust Cover   |    | P/N 1902654-011, S/N 9            |
| SCT Crown Dust Cover   |    | P/N 1902651-021, S/N 9            |
| Air Focus Shim         |    | P/N 1022665, S/N 19               |
| Verb/Noun Blank Panel  |    | P/N 2901629                       |
| Star Chart Blank Panel |    | P/N 2901628                       |
|                        | B1 | P/N 2003972-041, S/N 133          |
|                        | B2 | P/N 2003972-071, S/N 134          |
| Test Ropes             | B3 | P/N 2003972-211, S/N 135          |
| (Sundial E)            | B4 | P/N 2003076-021, S/N 34           |
|                        | B5 | P/N 2003076-031, S/N 12           |
|                        | B6 | P/N 2003076-031, S/N 14           |
| PSAAM                  |    | P/N 2901143-021, S/N 8 - New 05/1 |

### 2.15.10 HARDWARE REUSE

The following components in G & N 217 have been processed and found acceptable for reuse per Hardware Reuse Evaluation (HRE) forms EG-AC-003 and EG-AC-004 respectively.

|                     |                 |              |
|---------------------|-----------------|--------------|
| SXT Long Eye Relief | P/N 2012748-011 | S/N 2017 HRE |
| SCT Long Eye Relief | P/N 2012790-011 | S/N 2018 HRE |

| DATE              | EVENT   |
|-------------------|---|
| 10 July 1969      | IMU-44/PEA-19 Installed in S/C 112  |
| 24 July 1969      | ECP 795 Eyepiece Teflon Locking Rings Retrofit Completed  |
| 30 September 1969 | GNIC 25 Assigned to G & N 217   |
| 6 October 1969    | Completed Installation of G & N 217 into CM 112   |
| 7 October 1969    | Started S/C 112 Testing. DCS 6504. (Completed 10/10/69).  |
| 15 October 1969   | Started DCS 0126. (Completed 10/16/69).   |
| 24 October 1969   | ECP 790, ESU Eyepiece Retainer Spring Tabs Retrofit Completed.  |
| 4 November 1969   | IMU S/N 44/PEA S/N 19 Removed from CM 112 and Returned to Factory. IMU-48, PEA 23 installed 13 July 1970. |
| 26 January 1970   | ECP 768R1, Safety Glass Cover Retrofits on DSKY 94 and 95 Completed.                                      |
| 24 March 1970     | ECP 815, AGC Restart Monitor Retrofit on CMC 36 Completed.  |
| 25 March 1970     | "A" Harness Roll Pins Checked, OK.  |
| 5 May 1970        | ECP 1007, OUA SXT Halo Light Shield Retrofit on LER S/N 2017 Completed.                                   |
| 13 May 1970       | OUA and Bellows Assembly — 4 Removed from S/C. Bellows seal distorted and was replaced.                   |
| 14 May 1970       | OUA and Bellows Assembly — (Including OUA-29), ESU-15, APTPS-7 and Optics Shroud — 17 Installed.          |
| 22 May 1970       | GNIC-25 Transferred to NR for Installation.   |
| 10 July 1970      | IMU Coolant Hoses Replaced with S/N -122, -137 Due to Possible Contamination During DCS-5051.             |
| 5 August 1970     | GNIC-25 Installed, PSAAM-6 Installed.   |
| 6 August 1970     | Eyepieces and Filters Installed.  |
| 10 August 1970    | Start DCS-6504 G & N Functional Test. Completed 13 August.  |
| 13 August 1970    | PSAAM-6 Replaced with S/N 8. Lost S/C Power During Test/Troubleshooting.                                  |
| 14 August 1970    | Verified Proper System Operation After Power Loss.  |
| 17 August 1970    | Start DCS-0126 Interface Test. Completed 18 August.   |
| 19 October 1970   | Performed TPS-027 Cryo Mod. Retest.   |
| 20 October 1970   | ESU Eyepiece Retainer Spring Stretched.   |
| 22 October 1970   | S/C Support of MSFN Data Test per TPS-043.  |
| 28 October 1970   | DSKY Retest After Panel 2 Removal per TPS-044.  |
| 29 October 1970   | Troubleshooting Support per TPS-046.  |
| 17 November 1970  | DCS-0131 Integrated Test Started. Completed 24 Nov.   |

Table 2.15-1. Chronological History

| TEST SEQUENCE          | HARDWARE AFFECTED | DATE     | ANOMALY DESCRIPTION   | CORRECTIVE ACTION  | DOCUMENTATION                    |
|------------------------|-------------------|----------|---|--|----------------------------------|
| DCS-6504<br>Seq. 2-024 | SCA-13            | 10/7/69  | CG 1331, 3.2 kHz 28 V<br>Reading 27.3 V S/B 27.7<br>Volts                         | Corrected GSE Setup for<br>SCA Calibration   | AFR 17307<br>TDCR-NR-744<br>DR-1 |
| DCS-6504<br>Seq. 17    | G & N 217         | 10/10/69 | Fine Align Test Y at X<br>Reading was -152 arc-sec.<br>S/B $\leq \pm 150$ arc-sec | FNN No. NR-262 pre-<br>pared to accept G&N 217<br>as is. IMU 44 subse-<br>quently replaced for<br>CAT IV update. | AFR 17308<br>DR-6                |
|                        | OUA-15            | 10/10/69 | Optics covers not placed<br>over optics following<br>DCS-6504.                    | Optics were cleaned<br>and covered.  | Stack -133                       |
| DCS-0126               | CMC-36            | 10/15/69 | Noise on UDL lines and<br>CMC INLINK REGISTER<br>WHEN UDL relays close.           | Replaced defective G & N<br>buffer (NR-GSE)  | DR-6                             |
| DCS-6504               | OUA-29            | 8/10/70  | Light spots in SXT field of<br>view at maximum reticle<br>illumination.           | Use as is per MRBR-NR-<br>329. Caused by dirt not<br>close to the focal plane.                                   | AFR 17317<br>DR-PILOT-1          |
| DCS-6504<br>11-009     | G & N 217         | 8/11/70  | SXT Trunnion Servo Error<br>Out of Specification                                  | Signal for engineering<br>reference — tolerance<br>has been changed to<br>LLL.                                   | AFR 17318<br>DR-4<br>TDCR-AE-199 |
| DCS-6504<br>21-032     | CMC-36            | 8/13/70  | UPLOCK received during<br>K-start transmission.                                   | "O" line UDL relay<br>found open in NR-GSE.  | DR-12                            |
| TPS-027<br>Seq. 13     | IMU-48            | 10/19/70 | IMU HTR MNA circuit<br>breaker intermittent.                                      | Replaced circuit breaker.  | DR-33                            |

Table 2.15-2 (Sheet 1 of 2). G &amp; N Checkout Anomalies

| TEST SEQUENCE | HARDWARE AFFECTED | DATE     | ANOMALY DESCRIPTION   | CORRECTIVE ACTION   | DOCUMENTATION  |
|---------------|-------------------|----------|---|---|--|
| DCS-0131      | CMC-36            | 11/17/70 | 'Program Alarm' caused by UPLINK-TOO-FAST received during K-start tape transmission.  | Caused by noise on zero "0" line which could not be correlated to any S/C GSE event. CMC-36 tested for noise sensitivity and found acceptable. Item closed for G & N. | DR-13<br><i>CLOSED FOR G &amp; N<br/>OPEN ON S/C</i>               |
| DCS-0131      | G & N             | 11/17/70 | Optics Signals (CG 3117, 3118, 3145, & 3155 Shaft and Trunnion Servo Errors and MDA Outputs) varying at an abnormally high magnitude. | Caused by 60 Hz on the GSE Spacecraft DC bus. No corrective action, since the anomaly is the normal system reaction to 60 Hz on the bus.                              | DR-47<br><i>RAW UP TO<br/>10 VOLTS ON MLKF<br/>LEARNER SYSTEM.</i> |

Table 2.15-2 (Sheet 2 of 2). G &amp; N Checkout Anomalies



| HARDWARE DESCRIPTION  | REMOVED            | INSTALLED          | REASON FOR CHANGE  | VERIFI-<br>CATION<br>STATUS | REMOVED<br>HARDWARE<br>DISPOSITION                  |
|---|--------------------|--------------------|--|-----------------------------|---|
| GNIC<br>P/N 2021290-041 S/N 22<br>P/N 2021290-051 S/N 25                      | 9/30/69            | 9/30/69            | GNIC S/N 25 contains<br>ECP 792 (Computer Aided<br>Optics Tracking Mod).   | DCS-6504                    | Returned to<br>factory for<br>retrofit              |
| IMU<br>P/N 2018601-231 S/N 44<br>S/N 48                                       | 11/4/69            | 7/13/70            | IMU S/N 48 contains<br>Category IV IRIGS                                   | DCS-6504                    | Returned to<br>factory for <del>4</del><br>retrofit |
| PEA<br>P/N 2007201-031 S/N 19<br>S/N 23                                       | 11/4/69            | 7/13/69            | Matched assembly to above<br>IMU   | DCS-6504                    | Returned to<br>factory                              |
| OUA<br>P/N 2011000-081 S/N 15<br>S/N 29                                       | 5/13/70            | 5/14/70            | Beryllium corrosion control<br>and servo motor tach-<br>ometer replacement | DCS-6504                    | Returned to<br>factory for<br>retrofit              |
| OUA and Bellows Assembly<br>P/N 2010790-181 S/N 4<br>S/N 9                    | 5/13/70            | 5/14/70            |  |                             | Returned to<br>factory for<br>retrofit.             |
| IMU Coolant Hoses<br>P/N 2018821-021 S/N 153<br>S/N 122<br>S/N 154<br>S/N 137 | 7/10/70<br>7/10/70 | 7/10/70<br>7/10/70 | Suspected contamination  | DCS-6504                    | Return to<br>factory for<br>cleaning                |
| Internal Dust Covers<br>P/N 2012796/97 S/N 33, 24<br>S/N 14, 14               | 5/13/70            | 5/14/70            | OUA Replacement  | DCS 6504                    | Returned to<br>Factory                              |

Present  
Plan is  
to keep  
this IMU  
for this  
system  
IMU  
out of  
PEC

Table 2.15-3. G &amp; N System 217 — Major Hardware Change Summary

| EQUIPMENT   | PART<br>NUMBER | S/N      | OPERATING<br>HOURS<br>AS OF<br>10-31-70 | WEIGHT            |
|---|----------------|----------|---|-------------------|
| Inertial Measurement Unit (IMU)                                       | 2018601-231    | 48       | 895                                     | 41.1              |
| IRIG X  |                | 8A119    | 1,008                                   |                   |
| Y   |                | 8A117    | 995                                     |                   |
| Z   |                | 8A125    | 1,178                                   |                   |
| PIPA X  |                | 2AP232   |   |                   |
| Y   |                | 2AP265R  |   |                   |
| Z   |                | 2AP179   |   |                   |
| Blower Motors   | 2018644        | 155      | 822                                     |                   |
|   |                | 212      | 124                                     |                   |
| PIPA Electronics Assembly (PEA)                                       | 2007201-031    | 23       | 708                                     | 8.5               |
| CM Guidance Computer(CMC)   | 2003993-111    | 36(C-20) | 1,055                                   | 58.9              |
| Flight Ropes Colossus   | TBA            |          |   | 12.6 <sup>1</sup> |
| DSKY Main   | 2003994-121    | 94(D-61) | 600                                     | 18.3              |
| DSKY Navigation   | 2003994-121    | 95(D-62) | 529                                     | 18.3              |
| Power and Servo Assembly (PSA)  | 2007200-151    | 21       | 526                                     | 49.7              |
| Signal Conditioner Assembly (SCA)                                     | 2007234-021    | 13       | 280                                     | 5.9               |
| G & N Indicator Control Panel (GNIC)                                  | 2021290-051    | 25       | 234                                     | 14.7              |
| Interconnect Harness Group  | 2014567-071    | 33       |   | 26.0              |
| Navigation Base   | 2899982-031    | 18       |   | 11.3              |
| Optical Unit and Bellows Assembly                                     | 2010790-181    | 4        |   | 60.6              |
| Optical Unit Assembly (OUA)   | 2011000-081    | 29       | 597                                     | -                 |
| Electronic Data Coupling Unit (ECDU)                                  | 2007222-231    | 44       | 476                                     | 36.9              |
| Optics Shroud   | 2021394-011    | 17       |   | 3.4               |
| Eyeiece Storage Unit (ESU)  | 2021382-031    | 15       |   | 6.8               |
| Astro sextant Passive Thermal Pro-<br>tective System Assembly (APTPS) | 1021373-051    | 7        |   | 4.8               |
| Dust Covers (External)  | 1021352/62     | 15, 15   |   | 0.7 <sup>1</sup>  |
| (Internal)  | 20: 12796/97   | 14, 14   |   | 0.5               |
| Verb Noun   | 2021472        | -        |   |                   |
| Star Chart  | 2021473        | -        |   |                   |
| Check List and Alarm Codes  | 2021474        | -        |   |                   |
| Eyeieces  |                |          |   |                   |
| SCT Eyeiece   | 2012793-011    | 2004     |   | 2.1               |
| SCT Prism Assembly  | 2012775        | 2007     |   | 1.1               |
| SXT Eyeiece   | 2012700-021    | 2009     |   | 0.7               |
| SXT Mirror Assembly   | 2012791-021    | 2015     |   | 1.3               |
| SCT Long Eye Relief   | 2012790-011    | 2018-HRE |   | 1.8               |
| SXT Long Eye Relief   | 2012748-011    | 2017-HRE |   | 0.5               |
| Installation Kits (CMC)   | 2004199-011    | 19       |   | 0.6               |
| (OUA)   | 2899950-021    | 17       |   | 4.5               |
| IMU Coolant Hoses (2)   | 2018821-021    | 122, 137 |   | 1.0               |
| TOTAL   |                |          |   | 392.5             |
| 1. Representative Weight  |                |          |   |                   |

Table 2.15-4. G & N 217 System Summary