BELLCOMM, INC.
1100 Seventeenth Street, N.W. Washington, D.C. 20036

SUBJECT: Subsystem Modification to Develop Quiescent Operation for Gemini B
Case 620

DATE: February 28, 1968

FROM: R. K. McFarland

ABSTRACT

The Gemini B was reviewed with representatives of the McDonnell-Douglas Corporation, to determine subsystem modification made to this spacecraft primarily for the 30 day quiescent storage mode. The Gemini B will be operated in orbit in a mode requiring minimum electrical power, maintenance and monitoring, a mode of operation that is similar to projected use of the Apollo CSM for future AAP missions.

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MEMORANDUM FOR FILE

INTRODUCTION

In an effort to better understand the requirements for operating the Apollo CSM in a minimum power (i.e. quiescent) mode, the Gemini B configuration was reviewed with representatives of the McDonnell-Douglas Corporation. The Gemini B will be used in the MOL program, and during this 30 day mission will be operated in orbit in a mode requiring minimum electrical power, maintenance and monitoring; a mode of operation that is similar to projected use of the Apollo CSM for future AAP missions. The text of this memorandum was presented to C. W. Mathews at NASA Headquarters on February 13, 1968.

GEMINI B OPERATIONAL REQUIREMENTS

The Gemini Spacecraft (S/C) will be required to provide G&N, environmental control, communications, and electrical power for it operation during the launch and ascent phase of the mission. For the descent and re-entry phase, in addition to the above functions, the S/C will provide retro propulsion and reaction control.

During the quiescent portion of the mission the S/C is depressurized to 0.1 psia, with the crew not re-entering the S/C until the end of the mission. Electrical and thermal power are provided to the S/C by the laboratory, as well as telemetry for ground monitoring of the S/C status.

SUBSYSTEM DESCRIPTION

RCS

Positive isolation valves placed in line below N_2 pressurization tank, between fuel tank and motor, and between oxidizer tank and motor. Redundant heaters and thermostats on reactant tanks; heaters on valves, lines and regulators. Temperature and pressure transducers on N_2 tank and reactant tanks. Two independent RCS systems.

Isolation valves are not opened until re-entry phase.

RETRO

Six Gemini solid motors provided for re-entry. Five motors will provide safe re-entry.

EPS

Power during quiescent period provided by laboratory; present allocation is approximately 160 W average. Eight 45 AH Ag-Zn batteries provided for ascent and re-entry, no recharge capability provided.

ECS

Gaseous O_2 carried to provide for ascent and re-entry. Two separate GOX systems utilized, one system on the S/C, other in transition section.

Thermal control provided by S/C redundant coolant loops. Radiator removed from system, and "cold plate" provided at the S/C-laboratory interface to provide a thermal input from the laboratory electrical power system coolant loop. All S/C equipment held between +40° and +80°F, by using one active coolant loop with second loop on standby. Each coolant loop has one pump, one inverter, with a heavy duty backup inverter provided for redundancy. External painting on S/C provides $\alpha/\varepsilon = 1$.

G & N

All systems off, or on standby during quiescent period of mission. Appropriate thermal control provided to maintain temperatures on critical components. Update to IMU provided from laboratory prior to re-entry.

COMMUNICATIONS

All systems off during quiescent period of mission.

STAGE SEPARATION

All stage separations utilize springs in lieu of separation rockets. Initial separation between S/C adapter and laboratory for re-entry uses springs to attain approximately a 3 ft/sec rate.

PYROTECHNICS

All pyrotechnics will be hermetically sealed units, where applicable. Linear charge devices will be qualified for the full mission.

INSTRUMENTATION

During quiescent period of the mission, crew in the laboratory will monitor 10 parameters from S/C using meters, annunciators, and aural warning. Parameters monitored by crew are:

O_2 pressure, secondary, L/H

O_2 pressure, secondary, R/H

Coolant pump failure, primary

Coolant pump failure, secondary

N_2 pressure, system A

N_2 pressure, system B

Fuel tank pressure, system A

Fuel tank pressure, system B

Oxidizer tank pressure, system A

Oxidizer tank pressure, system B

Approximately 73 S/C parameters monitored by ground during quiescent period, through laboratory communication system. S/C instrumentation system interrogated only during station pass, system left off when not being interrogated by ground.

CONCLUSIONS

In postulating the development of a quiescent CSM, the initial modification would be to eliminate the need for the fuel cell power plants carried with SM. The removal of this system, either by using it for the ascent phase only or replacing it with batteries, would reduce CSM housekeeping power requirements during quiescent operation by 450 to 500 watts. Apart from heater requirements, this system accounts for a major portion of the CSM housekeeping power requirements.

The availability of a retro system capable of reliable operation subsequent to an extended earth orbit mission would considerably reduce reliance on the SM RCS system, a handicap that is very apparent in the present AAP missions. Following the Gemini B concept, the availability of such a system could feasibly remove all requirements for an SM RCS system subsequent to the ascent phase of the mission. RCS requirements for deorbit could be provided by a "dry" system in the CM, thus obviating the need for an RCS system that would be used during ascent, maintained during the mission, and reused during deorbit.

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