BELLCOMM, INC.
955 L'ENFANT PLAZA NORTH, S.W. WASHINGTON, D.C. 20024

B70 02070

SUBJECT: Astronaut Sleep Patterns During AAP Missions - Case 610

DATE: February 26, 1970

FROM: D. J. Belz

MEMORANDUM FOR FILE

During the past half year studies have been carried out within Bellcomm and MSC to determine the relative merits of a crew day having an ∿23-1/2 hour duration as opposed to a "natural" 24-hour duration.

A comprehensive analysis of advantages and disadvantages arising from the use of either natural or shortened astronaut days in AAP was distributed in November 1969 (Reference 1). The results of additional analyses performed since then are summarized in the attachment to this memorandum. Major ground rules employed are currently valid with one exception: lift-off of AAP-1, assumed to occur at 4:00 P. M. EST on March 15, 1972, is currently planned for 3:00 P. M. EST on a day, yet to be specified, in July 1972. The principal conclusions of Reference 1 have not been altered as a result of the newer study, nor is it anticipated that the recent change in launch date and time of day will affect them. Those conclusions may be restated as follows:

1. If EVA's can be scheduled outside the South Atlantic Anomaly within periods of frequent MSFN contacts, and if maximum opportunities for spacecraft/ground communications are not required during crew-awake periods throughout the mission, it is desirable to establish the crew-day as 24 hours in duration.

2. If a shortened crew day is to be used in operational flight plans, it is desirable that flight-crew training include a reasonable period of time on the abnormal routine to determine individual adaptability and to provide an opportunity for gathering baseline data on the crew's response.

Action has recently been taken by MSC/AAPO to resolve the issue of crew-day duration; R. F. Thompson (MSC/KA) has reportedly established a 24-hour crew day as a programmatic requirement.

D. J. Belz

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1025-DJB-li

Attachments

(NASA-CR-112698) ASTRONAUT SLEEP PATTERNS DURING AAP MISSIONS (Bellcomm, Inc.) 14 p
N79-73082
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(NASA CR OR TMX OR AD NUMBER) (CATEGORY)
FF No. 602

ASTRONAUT SLEEP PATTERNS DURING THE FIRST AAP MISSION

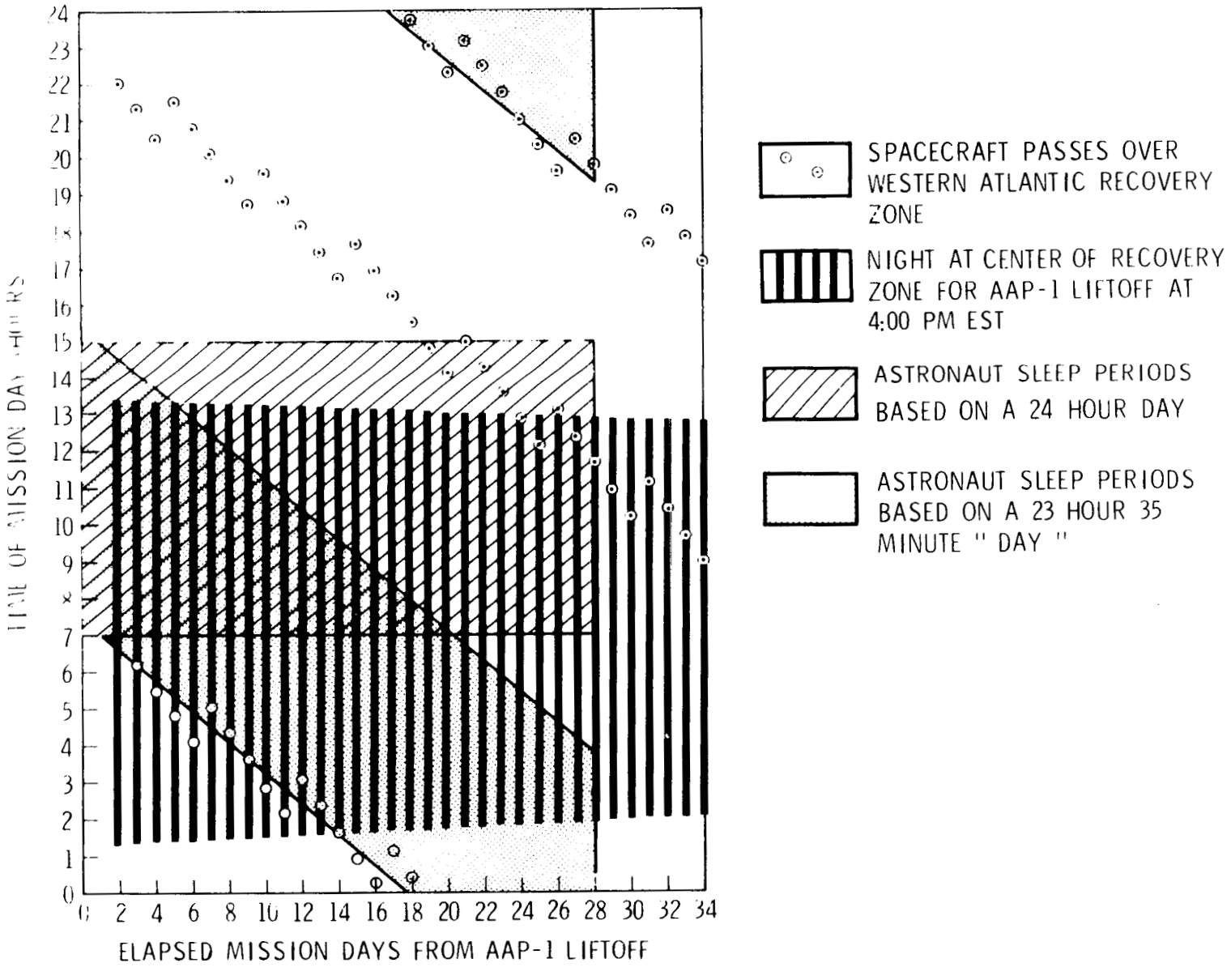
GROUNDRULES AND ASSUMPTIONS

- FLIGHT CREW WILL SLEEP NOCTURNALLY PRIOR TO MISSION (~ 11:00 PM EST TO ~ 7:00 AM EST).
- CREW WILL SLEEP CONCURRENTLY DURING FLIGHT.
- "PHASE SHIFTS" IN SLEEP PATTERN ARE UNDESIRABLE IF EASILY AVOIDABLE.
- NOMINAL MISSION PARAMETERS:

AAP - 1	LIFTOFF AT 4:00 PM EST, MARCH 15, 1972
	50^0 ORBITAL INCLINATION
	235 N. MILE INITIAL CIRCULAR ORBITAL ALTITUDE
AAP - 2	LAUNCHED ~ 23-1/2 HOURS AFTER AAP-1 LIFTOFF
	CM SPLASHDOWN DURING DAYLIGHT IN THE WESTERN ATLANTIC RECOVERY ZONE

- IT IS DESIRABLE TO CONDUCT EVA'S OUTSIDE THE SOUTH ATLANTIC ANOMALY WITHIN PERIODS OF RELATIVELY FREQUENT SPACECRAFT/MSFN CONTACT.

COMPARISON OF ALTERNATE INFLIGHT SLEEP PATTERNS
WITH WESTERN ATLANTIC RECOVERY OPPORTUNITIES
DURING THE AAP-1/AAP-2 MISSION

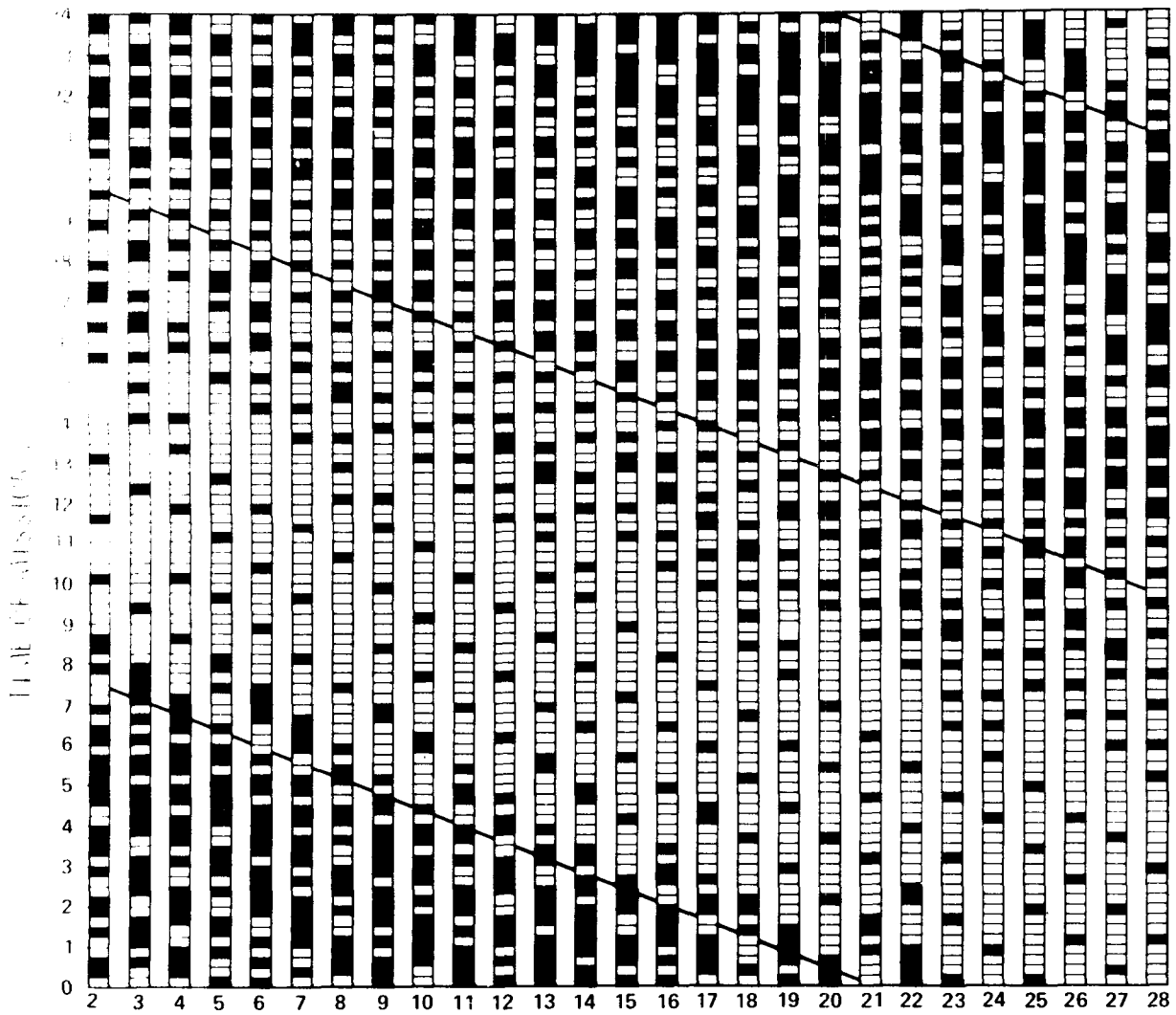


RECOVERY OPPORTUNITIES

FOR EITHER A 23:35* OR A 24-HOUR ASTRONAUT "DAY", OPPORTUNITIES FOR DAYLIGHT SPLASHDOWN IN THE WESTERN ATLANTIC ARE AVAILABLE DAILY THROUGHOUT A 28-DAY MISSION WITHOUT DISTURBING NOMINAL SLEEP PATTERNS.

* HOURS: MINUTES

DENSITY OF SPACECRAFT/MSFN COMMUNICATIONS CONTACTS
DURING THE AAP-1/AAP-2 MISSION



NOTE:

- INITIAL WORKSHOP ORBITAL ALTITUDE = 235. N. MILES
- ORBITAL INCLINATION = 50.^{0}
- MSFN STATIONS CONSIDERED ACTIVE ARE HAWAII, TEXAS, MERRITT ISLAND, BERMUDA, CANARY, ASCENSION, CARNARVON, GUAM, GOLDSTONE, MADRID, AND CANBERRA

NO COMMUNICATION BETWEEN SPACECRAFT AND MSFN

ONE OR MORE CONTACTS BETWEEN SPACECRAFT AND MSFN

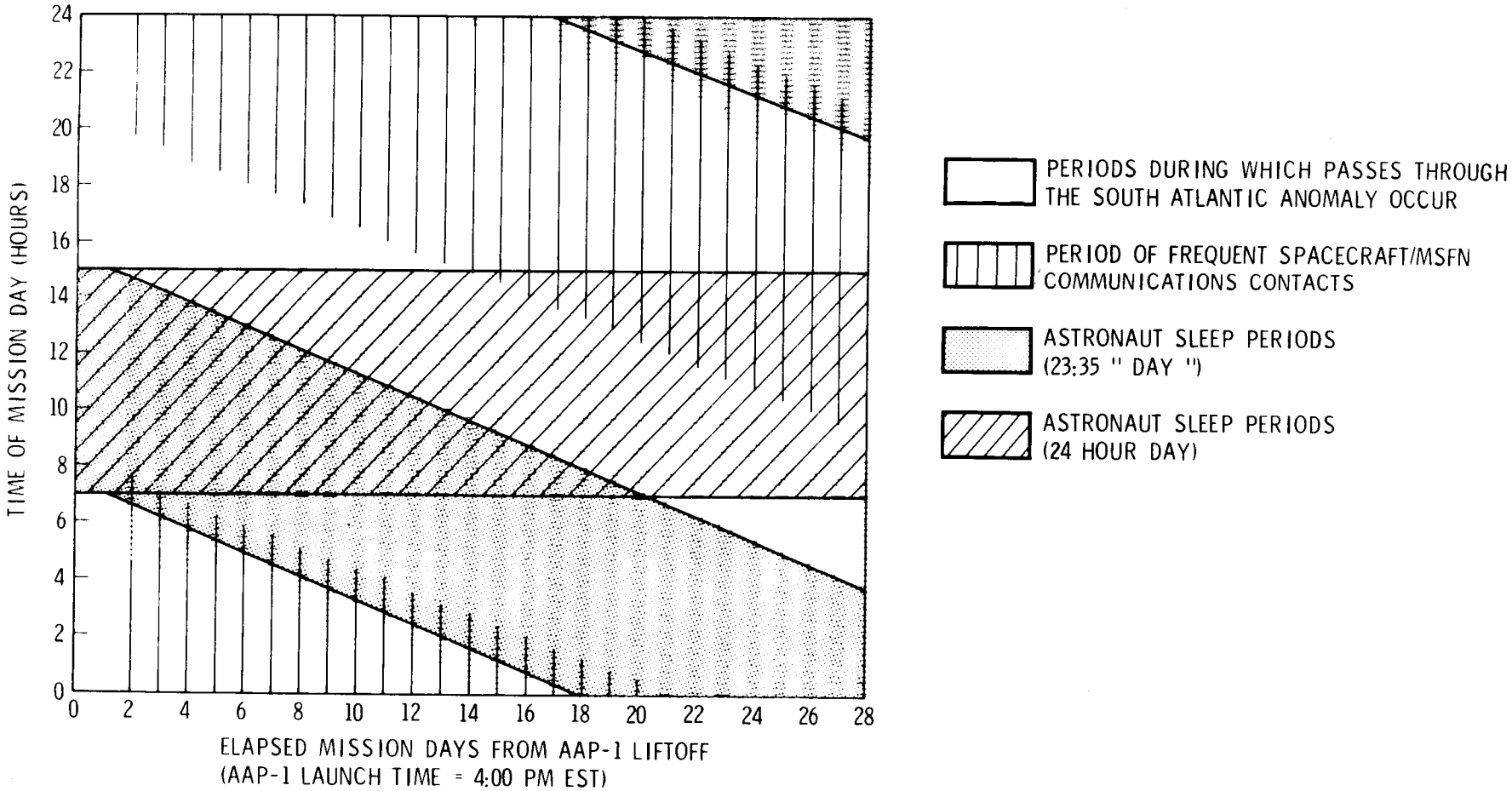
ARBITRARILY DEFINED BOUNDARY SEPARATING REGION OF RELATIVELY FREQUENT SPACECRAFT CONTACTS FROM REGION OF RELATIVELY INFREQUENT CONTACTS

SPACECRAFT/MSFN CONTACTS AND EVA SCHEDULING OPPORTUNITIES

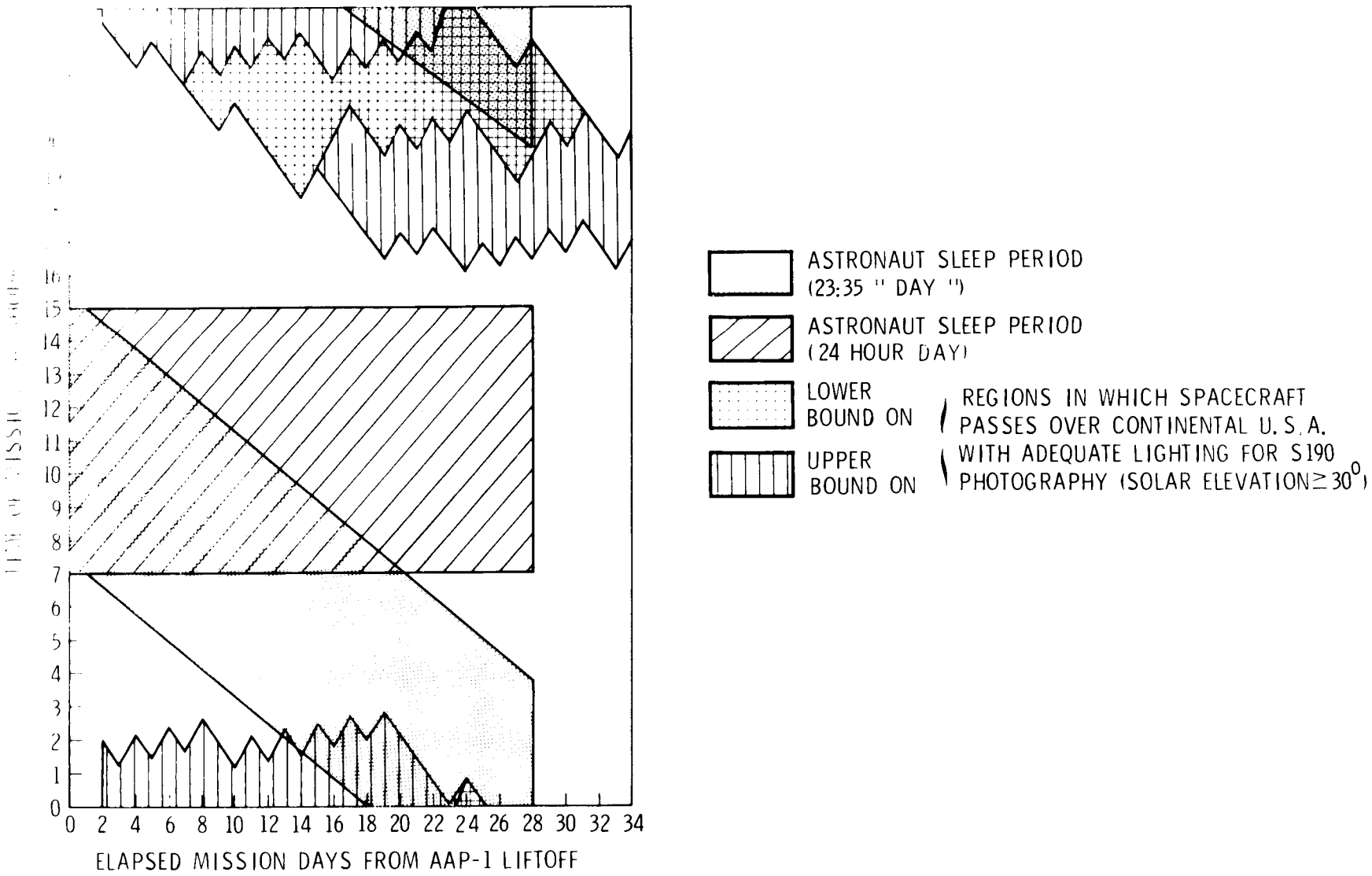
	23:35 CREW "DAY"	24-HOUR CREW "DAY"
MSFN CONTACTS	CREW WILL BE AWAKE DURING ALL BUT ONE HOUR OF EACH DAY'S "BEST" MSFN COVERAGE THROUGHOUT THE MISSION.	CREW WILL BE AWAKE DURING DAILY PERIODS OF "BEST" MSFN COVERAGE FOR FIRST HALF OF MISSION ONLY.
SOUTH ATLANTIC ANOMALY (SAA)	PASSES THROUGH THE SAA OCCUR ALMOST ENTIRELY DURING SLEEP AND BREAKFAST PERIODS THROUGHOUT THE MISSION. (EXPERIMENT D008 - "RADIATION IN SPACECRAFT" INTERFERES WITH EITHER SLEEP OR BREAKFAST ON ONE MISSION DAY.)	SAA PASSES OCCUR LARGELY DURING SLEEP AND MEAL PERIODS AT START OF MISSION AND, RELATIVE TO SLEEP PERIODS, BEGIN ~ 25 MINUTES EARLIER EACH DAY THEREAFTER.
EVA	DAILY EVA OPPORTUNITIES OCCUR THROUGHOUT THE MISSION; MAXIMUM SCHEDULING FLEXIBILITY FOR EVA'S IS PROVIDED BY A 23:35 CREW "DAY".	OPPORTUNITIES FOR EVA OCCUR DAILY FROM DOCKING THROUGH DAY 21 OF THE MANNED MISSION.*

*BASED ON A 3 HOUR EVA REQUIRING 2 HOURS OF PREPARATION, AND AN ASSUMED BREAKFAST PERIOD OF AT LEAST 1.25 HOURS DURATION.

RELATION OF ALTERNATIVE SLEEP PATTERNS TO PERIODS OF FREQUENT SPACECRAFT/MSFN CONTACTS AND PASSES THROUGH THE SOUTH ATLANTIC ANOMALY.



RELATION OF ALTERNATE INFLIGHT SLEEP PATTERNS TO OPPORTUNITIES FOR S190 PHOTOGRAPHY



COULD THE FLIGHT CREW ADAPT TO A 23:35 "DAY"?

- VARIABILITY AMONG INDIVIDUALS IS TO BE EXPECTED.
- GEMINI VII EXPERIENCE:
  - SCHEDULED SLEEP PATTERN WAS ROUGHLY ANALOGOUS TO A 23:35 " DAY ".
  - SPACECRAFT, MISSION AND WORKLOAD WERE NOT COMPARABLE TO AAP.
  - ONSET OF ACTUAL SLEEP EXHIBITED AN IRREGULARLY WIDENING GAP RELATIVE TO START OF SCHEDULED SLEEP-PERIOD AS MISSION PROGRESSED. THIS MIGHT HAVE BEEN CAUSED BY THE CREW'S ENDOGENOUS CIRCADIAN RHYTHMS; OTHER INTERPRETATIONS ARE ALSO POSSIBLE.
  - OVERALL, THE GEMINI VII EXPERIENCE IS NOT CONCLUSIVE.
- TERRESTRIAL EXPERIENCE WITH ABNORMAL TIME ROUTINES:
  - HUMANS LIVING FOR WEEKS UNDER EXPERIMENTAL CONDITIONS WHERE THE LENGTH OF THE DAY WAS CONSTANT BUT OTHER THAN 24 HOURS USUALLY, BUT NOT ALWAYS, ADAPTED THEIR SLEEP PATTERN TO THE UNUSUAL ROUTINE.* DURATION OF THE EXPERIMENTAL "DAY" RANGED FROM 21 TO 28 HOURS.
- CONCLUSION: IT IS MORE LIKELY THAN NOT THAT THE FLIGHT CREW WOULD BE ABLE TO ADAPT TO A 23:35 "DAY."

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* P.R. LEWIS AND M.C. LOBBAN, QUARTERLY J. OF EXPERIMENTAL PHYSIOLOGY, VOL. 42, pp 371-386(1957).

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SUMMARY OF ADVANTAGES AND DISADVANTAGES OF A 23:35 CREW "DAY" RELATIVE TO A 24-HOUR CREW DAY DURING THE AAP-1/AAP-2 MISSION

ADVANTAGES	DISADVANTAGES
• CREW WILL BE AWAKE DURING VIRTUALLY ALL OF EACH PERIOD OF RELATIVELY FREQUENT SPACECRAFT/MSFN CONTACT THROUGHOUT THE MISSION.	
FACILITATES REAL-TIME COMMUNICATION BETWEEN FLIGHT AND GROUND PERSONNEL.	CREW SLEEPS DURING PERIOD OF RELATIVELY INFREQUENT MSFN CONTACTS, RESULTING IN LEAST GROUND MONITORING OF ONBOARD SYSTEMS-STATUS DURING PERIOD OF LEAST FLIGHT-CREW VIGILANCE.
PROVIDES MAXIMUM SCHEDULING FLEXIBILITY FOR EVA'S.	
• SOUTH ATLANTIC ANOMALY (SAA) PASSES OCCUR ALMOST ENTIRELY DURING SLEEP AND BREAKFAST PERIODS THROUGHOUT THE MISSION.	
PERMITS EVA TO BE PERFORMED OUTSIDE THE SAA ON ANY MISSION DAY.	CAUSES SCHEDULING CONFLICT BETWEEN EXPERIMENT D008 - "RADIATION IN SPACECRAFT" AND SLEEP OR BREAKFAST PERIOD ON ONE MISSION DAY.
	• SOME OPPORTUNITIES FOR EXPERIMENT S190-"EARTH RESOURCES PHOTOGRAPHY" MAY CONFLICT WITH SCHEDULED SLEEP DURING THE LAST 1/3 TO 1/2 OF THE MISSION.
	• FAILURE OF ONE OR MORE CREWMEN TO READILY ADAPT TO A SHORTENED "DAY" MAY COMPLICATE THE INTERPRETATION OF DATA COLLECTED FOR EXPERIMENT M073- "BIOASSAY OF BODY FLUIDS".

REFERENCES

1. D. J. Belz, "Crew Sleep Cycles During the First AAP Mission", Bellcomm Memorandum for File B69 11034, November 17, 1969.

BELLCOMM, INC.

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From: D. J. Belz

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