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

B70 09079

SUBJECT: Integrated Flight-Crew Timelines for the "Pick a Day" Study - Case 610

DATE: September 30, 1970

FROM: D. J. Belz

ABSTRACT

The "Pick a Day" study is a coordinated analysis of time-varying behavior for Skylab systems during a representative mission day. Integrated timelines of on-board activities for that study are developed to serve as a common basis for subsystems analyses.

The selection of a mission day for study, the choice of in-flight crew activities, the definition of scheduling ground rules, and the synthesis of crew timelines are discussed in detail. The ninth day of the SL-1/SL-2 manned mission was selected for study. In-flight experiments were chosen to illustrate a wide variety of activities; selected experiments include those that require daily crew participation, have large programmatic importance, or illustrate significant types of experiment/spacecraft interactions. The pattern of daily personal-maintenance activities established for the crew by current NASA flight planning ground rules is followed. All experiments shown in the timelines for this study have been scheduled in accordance with requirements and constraints described in companion memoranda.

Detailed scheduling of early-morning crew activities in the Workshop's Waste Management Compartment indicates the crowded conditions that will occasionally prevail there: simultaneous two-man or three-man occupancy will be required at times during actual missions to maximize the time available for other assigned crew tasks during the remainder of each day.

(NASA-CR-113952) INTEGRATED FLIGHT-CREW TIMELINES FOR THE 'PICK A DAY' STUDY (Bellcomm, Inc.) 11 p

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MEMORANDUM FOR FILE

1.0 Introduction

Flight plans for Skylab missions implicitly define duty cycles for electrical, thermal, attitude control, and other spacecraft systems. To insure that planned operations do not exceed equipment performance limits, systems behavior must be accurately simulated prior to flight. A coordinated analysis of major spacecraft subsystems is being performed by MLS as part of an exercise informally known as the "Pick a Day" study. The purpose of that study is to apply to a single 24-hour period of spacecraft operations the analytical techniques and models that can later be applied to entire missions.

Since definitive Skylab flight plans do not yet exist, a hypothetical sequence of on-board activities was generated to provide a common timeline for use throughout the "Pick a Day" study. This memorandum describes that timeline and the rationale underlying its construction.

2.0 Selection of a Representative Mission Day

No two Skylab mission days will be identical in all details of crew and equipment timelines. For the purposes of this study, a "representative" day is considered to be a 24-hour period that illustrates a wide variety of on-board activities representing a substantial fraction of the types of operations that will occur during actual missions.

In selecting a day for study, attention was restricted to the SL-1/SL-2 mission since opportunities for solar, stellar, and terrestrial observations can be predicted with greater accuracy for that flight than for either of the revisit missions. In addition, present NASA flight assignments of experiments will result in a greater variety of experiment activities on SL-1/SL-2 than on either of the remaining missions (Reference 2.1).

For purposes of the "Pick a Day" study, it has been assumed that SL-1 will be launched at 3:00 P. M. EST on July 19, 1972 and that SL-2 will lift off on the following day at ∿2:35 P. M. EST.* The day selected for this study was July 29, 1972, which corresponds to the ninth day of the manned mission (July 20 ≡ Day zero); Day Nine was chosen arbitrarily from among the twenty mission days that will be devoted primarily to the performance of experiments. The remaining days of the flight will be occupied largely by activities associated with: Workshop activation (Days 0, 1); Workshop deactivation (Days 27, 28); EVA (Days 17, 26); and crew recreation (Days 7, 14, 21).

Although selected arbitrarily, Day Nine is sufficiently late in the mission to insure that ATM experiments will have been previously activated even if several days of observing the optical contamination environment surrounding the spacecraft are required prior to opening the ATM aperture doors.**

3.0 In-flight Experiment Activities

Experiments selected for inclusion in the "Pick a Day" study were chosen to illustrate tasks that require daily flight-crew participation, have large programmatic importance, or illustrate significant types of experiment/spacecraft interactions.

Experiments in the first category - those that require flight-crew participation at least once a day - must necessarily be included in any typical mission work day selected for study. Based on flight assignments at this writing, those experiments are:

M071 - Mineral Balance
M073 - Bioassay of Body Fluids
M074 - Specimen Mass Measurement
M151 - Time and Motion Study
M172 - Body Mass Measurement
S015 - Zero-G Single Human Cells
T003 - In-flight Aerosol Analysis

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*As a result of recent changes in Apollo and Skylab flight schedules, SL-1 is currently baselined to be launched on a date in November 1972.

**Experiments T025 - Coronagraph Contamination Measurement" and T027 - ATM Contamination Measurement.

The major goals of the Skylab experiment program are to investigate the crew's physiological response to long-term space flight, to perform solar astronomical observations with the ATM, and to perform terrestrial observations with the Earth Resources Experiment Package (EREP). While the relative emphasis among these goals will vary from mission to mission, activities associated with each will be carried out on all missions.

ATM experiments are to a significant degree operated concurrently; the selection of operating modes for the "Pick a Day" study is discussed in Reference 3.1. Portions of all ATM experiments have been included:

S052 - White Light Coronagraph
S054 - X-ray Spectrographic Telescope
S055 - UV Scanning Polychromator/ Spectroheliometer
S056 - X-ray Telescope
S082 - UV Spectrograph/Heliograph.

EREP experiments will also be largely operated concurrently with one another. For the purposes of this study, it is assumed that all such experiments may be in operation during EREP passes over the USA.

Unlike ATM and EREP, medical experiments cannot all be represented or scheduled on a single day. The most frequently performed medical experiment, after those already listed above, is M093 - Vectorcardiogram, one performance of which is included in the representative mission day.

In addition to the experiments listed above, portions of three others have been included to illustrate other experiment/ spacecraft interactions:

M509 - Astronaut Maneuvering Equipment
T025 - Coronagraph Contamination Measurement (Sunside Scientific Airlock Operations)
S019 - UV Stellar Astronomy (Stellar Targeting)

Scheduling requirements and constraints for each of the above experiments are described in companion memoranda (References 3.1 - 3.12).

4.0 Scheduling Ground Rules and Assumptions

The basic pattern of flight-crew personal maintenance activities such as eating, sleeping, and personal hygiene are presently defined by NASA scheduling ground rules published in Reference 4.1.

This section summarizes the ground rules pertinent to the present study:

1. The period of the crew's scheduled cycle of waking and sleeping shall be 24 hours.

2. Breakfast, dinner, and sleep periods for each crewman shall be scheduled concurrently with those of the other crew members.

3. Personal hygiene periods shall be scheduled immediately before and after sleep periods.

4. On workdays, off-duty periods and mission planning sessions shall be scheduled after dinner.

Off-duty periods constitute free time for crew rest and recreation. Mission planning periods are provided to review the following day's scheduled activities and to prepare equipment for use the next day. In addition to the above activities, systems housekeeping periods will be scheduled daily to permit monitoring and maintenance of operational and experiment systems.

Nominal durations assigned to the preceding activities are as follows (Reference 4.1):

Activity	Duration (Hours/man/day)
Sleep	8
Meals	3
Personal Hygiene	1.5
Systems Housekeeping	1.5 (Average)
Mission Planning	1.0
Off-duty	1.0

Baseline Skylab operations presently include a requirement to man the ATM Control and Display console 10 hours per day, six days per week. That requirement will be satisfied in operational plans by assigning a man to the console throughout the working day, by assigning each crewman to the console for up to two hours after dinner every third working day, and by staggering lunch periods or scheduling one man to eat lunch at the console. The 10 hours/day ATM requirement is, however, ignored in the "Pick a Day" study in order to include a larger variety of experiment activities within the period under study.

5.0 Ephemeris Data

Scheduling opportunities for several Skylab experiments are dependent on time and the location of the spacecraft in orbit. ATM and T025 solar observations obviously require a clear line-of-sight between the Orbital Assembly and the sun. EREP observations can be scheduled only when the spacecraft is over designated target regions under appropriate natural lighting conditions. Experiment S019 - "UV Stellar Astronomy" must be scheduled when the vehicle lies within the earth's shadow.

A variety of ephemeris data for the "Pick a Day" study is reported in Reference 5.1; values of time-varying parameters used in scheduling experiments are displayed graphically in Figure 2.

6.0 Integrated Crew Timeline for the "Pick a Day" Study

In this section experiment requirements, scheduling ground rules and ephemeris-related experiment opportunities are combined into a set of integrated crew timelines for the "Pick a Day" study. The timelines shown below represent the latest in a series of iteratively developed crew and activity schedules for Day 9.

6.1 Subscheduling of Experiments M071/M073/M074/M172

Schedulable portions of Experiments M071/M073/M074/M172 are related to meals and personal hygiene periods but, from a timeline viewpoint, are otherwise relatively independent of other experiments. It is therefore possible to develop a subschedule relating performances of the "meal time" medical experiments to one another before considering an entire day's activities. Scheduling requirements to be met are as follows:

Experiments	Scheduling Requirements
M071/M073*	A. Measure mass of unconsumed food and record food/water consumption in log book at the end of each meal (5 minutes/man/meal)
	B. Change fecal bags, measure mass of feces, dry feces; log mass, time, and identification on each bag (20 minutes/man/day plus duration of defecation periods charged to personal hygiene time)

*Reference 3.2.

Experiments	Scheduling Requirements
	C. Measure urine volume, extract samples, replace collection bag, place samples under refrigeration (20 minutes/man/day scheduled immediately after first urine void following scheduled sleep period).
M074*	Included above under parts A and B of M071/M073 scheduling requirements.
M172**	Determine body mass of each crewman following the first urine void after each scheduled sleep period. Preparation of the body mass measurement device requires two minutes of one man's time; stowage of the device requires one minute of one man's time. Measurement periods are five minutes in duration for each man.

The preceding requirements are satisfied by the subschedule timelines shown in Figure 1.

Detailed scheduling of early-morning crew activities in the Workshop's Waste Management Compartment indicates the crowded conditions that will occasionally prevail there: simultaneous two-man or three-man occupancy will be required at times during actual missions to maximize the time available for other assigned crew tasks during the remainder of each day.

6.2 Overall Timelines for Day 9

Integrated Crew Timelines for the "Pick a Day" study are shown in Figure 2.† For each activity, the following information is given: (a) crewman or crewmen involved, (b) crew location, and (c) task start/stop times.

Scheduled sleep periods for all crewmen are initiated at midnight Eastern Standard Time. Early morning activities, lunch, and evening activities have been timelined in accordance with the scheduling ground rules and subschedules described above. However, mission planning periods, as shown, depart somewhat from the nominal duration of one hour/man/day, the scheduled values being 55 minutes for Crewman A, 56 minutes for Crewman B, and 45 minutes for Crewman C. These reduced mission planning periods were used in order to accommodate more experiments in the overall timeline than would otherwise have been possible.

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*Reference 3.3.

**Reference 3.6.

†Additional details are shown in Figure 1.

All experiments have been scheduled without violating any of the requirements or constraints described in References 3.1 - 3.12.

7.0 Summary

Integrated crew timelines for the "Pick a Day" study have been developed to serve as a common basis for analyses of the time-varying behavior of Skylab spacecraft and ground systems. The ninth day of the SL-1/SL-2 manned mission was selected for study. In-flight experiments represented during that day include those that require daily crew participation, have large programmatic importance, or illustrate significant types of experiment/spacecraft interactions.

Detailed scheduling of early-morning crew activities in the Workshop's Waste Management Compartment indicates the crowded conditions that will occasionally prevail there: simultaneous two-man or three-man occupancy will be required at times during actual missions to maximize the time available for other assigned crew tasks during the remainder of each day.

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D. J. Belz

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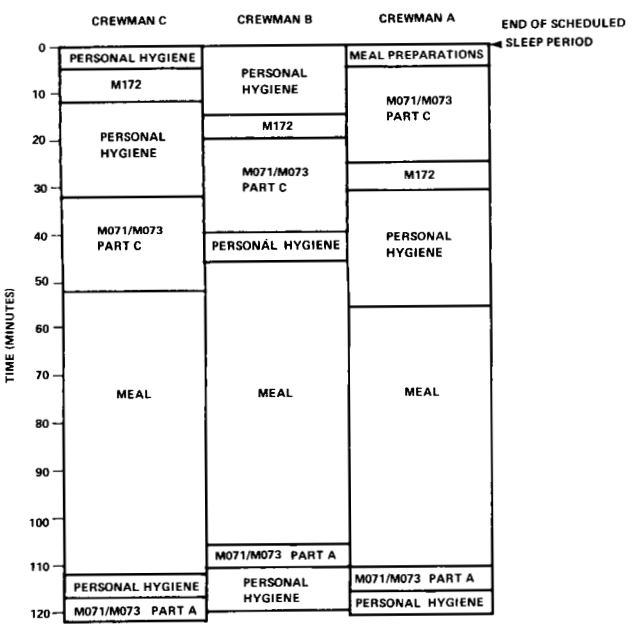
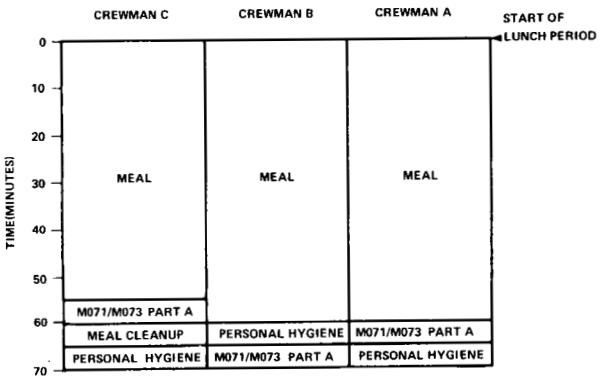
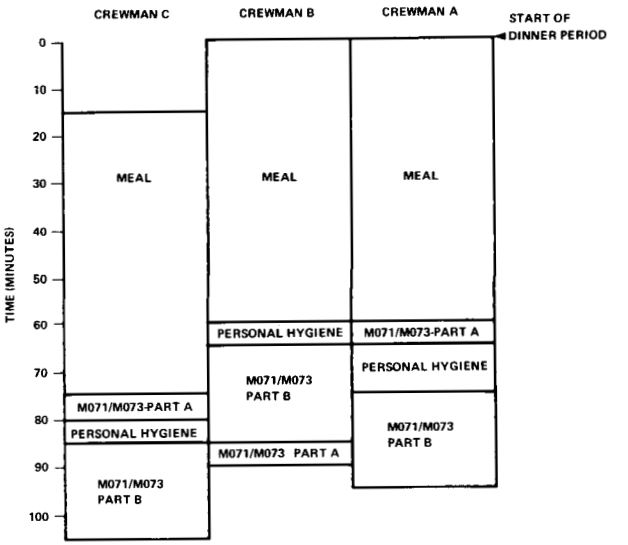


BREAKFAST, MORNING PERSONAL HYGIENE, AND PORTIONS OF M071/M073/M074/M172



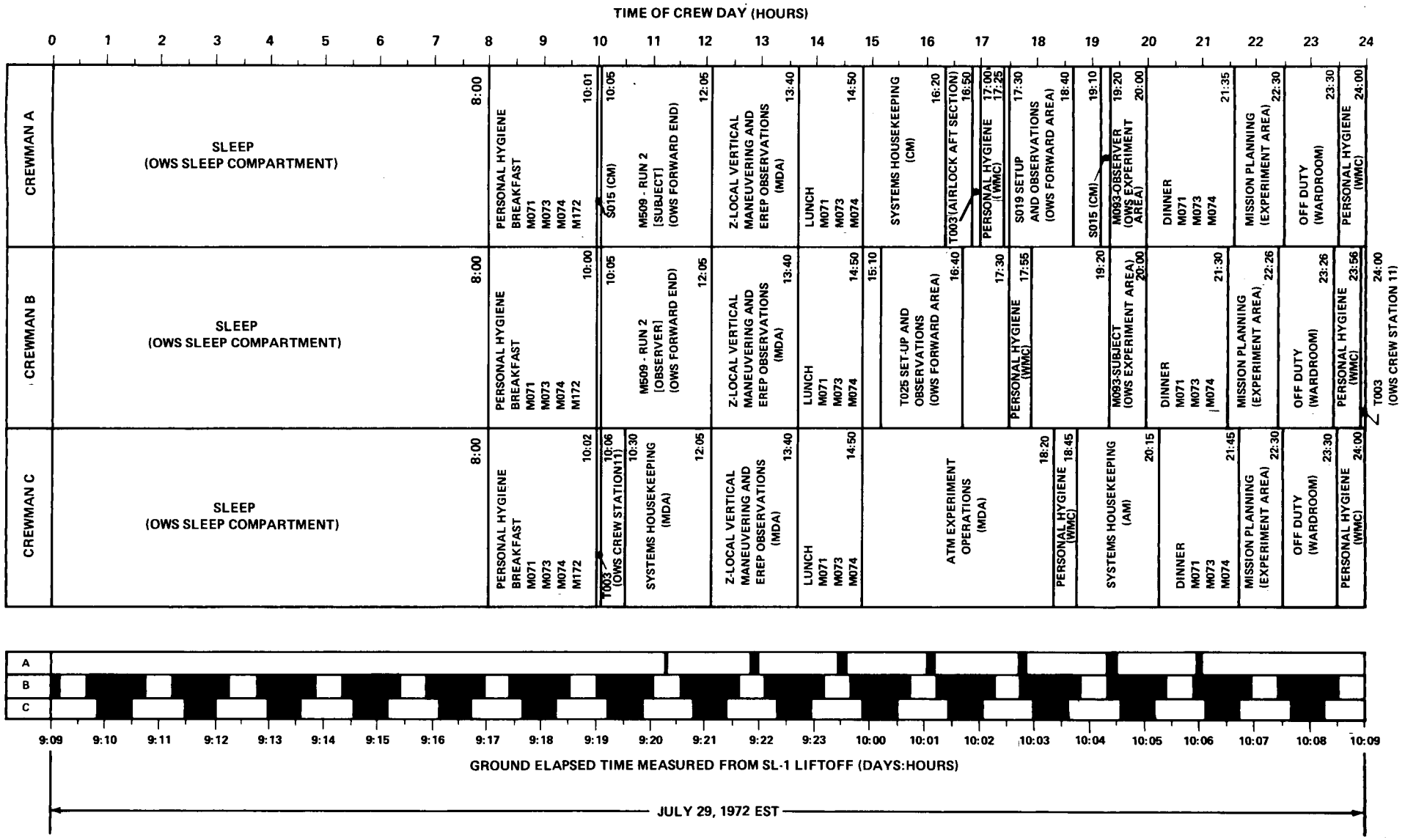
LUNCH AND PART A OF M071/M073



DINNER AND PARTS A, B OF M071/M073

FIGURE 1 - SUBSCHEDULES OF EXPERIMENTS M071/M073/(M074)/M172

CREW LOCATIONS:	M071/M073 PART A	WARDROOM
	M071/M073 PARTS B,C	WASTE MANAGEMENT COMPARTMENT
	M172	EXPERIMENT AREA
	PERSONAL HYGIENE	WASTE MANAGEMENT COMPARTMENT
	MEALS	WARDROOM



A ≡ SPACECRAFT PASSES OVER CONTINENTAL U.S.A. (BLACK REGION OF TIMELINE)

B ≡ SOLAR ELEVATION AT SPACECRAFT SUBPOINT ≥ 30° (WHITE REGION OF TIMELINE)

C ≡ SUN DIRECTLY VISIBLE FROM SPACECRAFT (WHITE REGION OF TIMELINE)

	LAUNCH DATE	LAUNCH TIME
SL-1	JULY 19, 1972	3:00 P.M. EST
SL-2	JULY 20, 1972	2:35 P.M. EST

FIGURE 2 - INTEGRATED SKYLAB FLIGHT–CREW TIMELINES FOR THE PICK A DAY STUDY

BELLCOMM, INC.

Subject: Integrated Flight-Crew Timelines for the "Pick a Day" Study - Case 610

From: D. J. Belz

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