TR-55-67-14(U)

THE PROBLEM OF OFF DUTY TIME IN LONG DURATION SPACE MISSIONS

Volume II
FINAL REPORT

October 1967

Prepared by
John W. Eberhard

Prepared under Contract No. NASw-1615

serendipity associates
9760 COZYCROFT, CHATSWORTH, CALIFORNIA
8027 LEESBURG PIKE, McLEAN, VIRGINIA

Prepared for
National Aeronautics and Space Administration

TR-55-67-14(U)

THE PROBLEM OF OFF DUTY TIME IN LONG DURATION SPACE MISSIONS

VOLUME II

FINAL REPORT

October 1967

Prepared by
John W. Eberhard

Prepared under Contract No. NASw-1615

SERENDIPITY ASSOCIATES
McLean, Virginia

Prepared for
National Aeronautics and Space Administration

FOREWORD

This final report is one of three volumes dealing with the off duty time problem in long duration space flight. The report is intended primarily for the mission analyst who is concerned about the time and activity requirements for space flight. Where trade studies concerning the utilization of time and design of activities should be performed, the report can be used in conjunction with the annotated bibliography presented in Volume III. Volume I presents a summary of the current study together with research requirements necessary before final answers concerning time utilization in long duration space missions are available. This work was performed by Serendipity Associates under Contract No. NASw-1615 for the National Aeronautics and Space Administration, Washington, D. C.

TABLE OF CONTENTS

LIST OF TABLES

SUMMARY, FINDINGS AND RECOMMENDED PRINCIPLES

This study analyzes the available off duty time in long duration space missions and suggests ways to use it. The time allocated for off duty, sleep, work and contingencies in representative mission studies was evaluated relative to the best current estimates of time required for these activities. The evaluation showed that there was too little scheduled off duty time, yet there was an excessive amount of off duty time available during the deep space phases of the mission.

Discretionary activity possibilities during off duty time for the mission were determined. A detailed analysis was performed of activity possibilities for long duration missions and of actual activities employed by both general and special populations. The special populations included space simulator studies, remote sites (Arctic, Antarctic, ships, submarines, missile bases), laboratory studies and air raid shelter studies. Twice as much free time will be available in the anticipated missions than in either special environments or in the general population. Additionally, anticipated activity patterns determined by this study differ both from those recommended in the mission studies and from those found in the general population. The best source of activity requirements was the activity regimes of isolated groups such as the scientist and Navy personnel during the wintering over period in the Antarctic.

Finally, suggestions are made for handling the excessive off duty time and guidelines were developed related to the off duty time period and to the design of discretionary activities. The guidelines were developed around the following findings.

TIME FINDINGS

1. There are two components of off duty time in the long duration studies: (1) scheduled off duty time and (2) unscheduled free time resulting from the excess time scheduled for other activities.

2. Men in general and men in special environments have approximately five hours a day for free time; the reviewed mission studies allocated 1.5 to 3.0 hours for scheduled off duty time.

3. Crew size is based upon heavy work phases of the mission, yet these phases frequently occupy less than one percent of total mission time.

4. The mission design goal of keeping men meaningfully occupied in work activities is difficult to sustain in deep space as there are inadequate opportunities for work.

5. Although contingency time is allocated in some mission studies, there is no indication given concerning what would be done with the time should contingencies not arise.

6. Men in confined space with little work to perform are unwilling to share their work load with others whose work opportunities may have been reduced.

7. Attempts should be made to reduce crew size in light of total mission work opportunities and excessive off duty time.

8. Reduced sleep time requirements may result from a weightless environment and from the problems of confinement and boredom in long duration missions.

9. The sleep time required during the weightless portions of interplanetary missions will be different from the time required in gravity situations, such as the Lunar (1/6 G) and Martian (.4 G) surfaces.

10. Off duty time may exceed 10 hours per day during deep space periods of the mission. This is because of unscheduled free time due to: (1) an excess of time (2.2 hours) allocated for sleep and (2) an inadequate opportunity for work (5.5 hours in excess).

ACTIVITY FINDINGS

1. Discretionary activities should depend upon the free choice of each crew member.

2. Men in confinement prefer work to free time.

3. There is a higher incidence of abnormal symptoms among men in confinement without adequate work opportunities than those who have such opportunities.

4. Off duty time and activity patterns of isolated groups differ from those of the general population; furthermore, the activity patterns of individuals in confinement change over time.

5. Talking, reading fiction, watching movies and television are the most frequently performed activities by confined groups.

6. Men in confinement take almost twice as long to eat as men in the general population.

7. Exercise is an infrequently performed activity for all of the adults studied.

8. Interest in educational activities is highly individualistic; however, it is generally sought infrequently.

9. Individuals who regularly use religion, or those who do not, adjust best to confinement.

10. Confined individuals create some free time activities of their own.

11. Activities such as painting, playing cards, chess and checkers, are relatively infrequently mentioned by most of the individuals studied.

12. Recreational facilities have historically been the source of significant morale problems for confined groups.

PRINCIPLES IN DESIGNING DISCRETIONARY ACTIVITIES

Individual Considerations

1. Selection of discretionary activities must take into account personal preferences of crew members and the influence of long duration confinement on these preferences.

2. Use of discretionary activities should be the crew's free choice.

3. Crew member acceptance is critical in the selection and design of discretionary activities.

4. The discretionary activity patterns of crew members will differ as a function of their being in isolation and as a function of the time they are in isolation; therefore, the activity preferences of crew members must be adjusted for these factors.

5. The discretionary activity value of eating should not be overlooked since men in confinement take almost twice as long to eat.

6. In considering educational activities, previous habit patterns relative to education is a better predictor than lofty goals crew members might anticipate for their confinement period.

7. Activities that reduce or alleviate the abnormal symptoms frequently found in remote groups should be selected and developed; e.g., earth oriented activities such as participation in family affairs and organizations.

8. Activities which can produce interpersonal conflicts, for example, differences in musical preferences, should be handled either in the selection of individuals or in the manner of presenting the activities.

9. Discretionary activities should be selected that tend to reduce the anticipated monotony and increase sensory stimulation.

10. Discretionary activities should be custom designed both for the individual and the group.

11. Wherever possible and practical, existing onboard equipment should be employed as the means for discretionary activities.

12. Where onboard equipment is employed consideration of excesses such as additional logistic requirements, impact on reliability, storage and power as a function of use for discretionary activities must be taken into account.

13. Estimates of spares and expendables required for selected discretionary activities should be made based upon frequency of use of the total crew and length of mission.

14. The design must take into account the weightless environment and other characteristics of materials such as their flamability, toxicity and odiferousness.

Group Considerations

15. In considering group activities it is necessary to determine whether there is sufficient ability and interest among crew members to meet the group size requirement for the activity.

16. Since men in confinement withdraw from direct confrontation with incompatible crew members, there should be a provision for privacy in both crew quarters and discretionary activity possibilities.

17. Rules relative to activity performance should be considered in the design, integration, and use of activities in the space craft.

18. Discretionary activities should not accentuate pre-existing crew composition differences that are likely to lead to interpersonal conflicts.

19. Activities should not be selected that enhance concern about total committment, limited abort capabilities or the operations of the life support system.

CHAPTER 1

INTRODUCTION

PROBLEM STATEMENT

In light of the duration of the anticipated interplanetary missions (450 days), the relatively confined and small volume of space ships, and the criticality of crew size and composition characteristics, an analysis of off duty time and activities is required. This need is exemplified by the fact that recreational opportunities are almost always a serious problem in remote, isolated groups. Therefore, it is the intent of this study to determine if off duty time is a problem, and what can be done about it.

DEFINITIONS

Three essential definitions are required to place the current study in perspective. These definitions are:

Scheduled Off Duty Time - Time allocated on a mission time line that enables crew members to engage in activities of their own choosing.

Unscheduled Off Duty Time - Time available during the course of a mission due to unused time allocatcd to scheduled activities.

Discretionary Activities - Activities provided for or created by the crew members which are discretionary; i.e., the crew member has free choice concerning whether to use the activities or not.

APPROACH

Evidence of the current scheduled off duty time in mission studies was reviewed, and an evaluation of scheduled activity time was performed to determine the amount of unscheduled off duty time. The unscheduled off duty time was obtained primarily by evaluating the time allocated to sleep and work opportunities in contrast to that required during deep space portions of the missions. Results of this analysis are presented in Chapter II - the end product is the actual off duty time available in current mission studies.

Criteria were established to evaluate the available off duty time. The off duty time and activity requirements for both the general and special populations were reviewed. Problems and principles related to off duty time and discretionary activities were established. The criteria were used to evaluate the off duty time and discretionary activity possibilities suggested for mission studies. The results of the above analyses are presented in Chapter III.

The final chapter presents some suggestions for reducing off duty time as well as listing potential discretionary activities. Since excessive off duty time was uncovered during deep space flight considerations were given to reducing the off duty time as a function of crew size, length of day, length of work week, personnel selection, use of drugs and time depressants, and spacecraft energy and hardware capabilities. Potential discretionary activities of an intellectual, physical, social and religious nature with their probable utility is also presented.

The summary includes time and activity principles as well as the summary of time and activity findings. These principles were developed primarily as a function of the analysis of current mission requirements and off duty times and activities in analogous situations. The application of the time and activity principles should facilitate and improve the off duty time periods of long duration missions.

RELATED END PRODUCTS

Annotated Bibliography

In addition to the current report, an annotated bibliography related to the analysis and design of off duty time and discretionary activities was produced. This bibliography can serve the designer or researcher in obtaining additional information concerning the development of principles or obtaining further justification of the conclusions or research requirements. The annotated bibliography was designed to give the user easy access to the groups studied; namely, isolated sites, simulator studies, mission studies, laboratory studies and general literature reviews. Categorized information relevant to the off duty time; namely, the number of groups, group size, group composition, mission length, off duty time requirements, off duty time activities, special characteristics and performance measures are presented. Available abstracts and specially written abstracts for key articles were presented. Both the accession number (DDC No.) and report numbers are presented where available to facilitate acquisition of the documents by interested readers. The annotated bibliography contains 176 items.

Summary Report and Research Recommendations

An overview of this study effort together with required additional research is presented in the summary report. The research requirements include those that are specifically related to off duty time and activities as well as suggestions concerning the feasibility of reducing the off duty time period. Suggestions are given relative to the problem of weightlessness (development of space sports and other alternatives to handle the problem of physiological effects of weightlessness). Furthermore, research requirements related to the desirability of certain means for presenting reading material and eating possibilities as a function of mission length are included.

CHAPTER II

OFF DUTY TIME ON LONG DURATION SPACE MISSIONS

This chapter presents the results of an analysis of how much scheduled and unscheduled off duty time is available in current mission studies (8, 23, 26, 27, 33, 34, 35). Unscheduled off duty time was obtained by analyzing scheduled operations to determine how much of the time alloted was not required. Emphasis was placed upon the time allocated for sleep and work activities. The best estimates of time required for work and sleep, particularly during deep space, were applied to the mission studies in order to obtain unscheduled off duty time estimates.

SECTION I: TIME COMPONENTS OF REPRESENTATIVE LONG DURATION SPACE FLIGHTS

The best point of departure for determining scheduled and unscheduled off duty time for long duration space flights is a review of planned missions. All studies had some scheduled off duty time allocated in a given mission day. A detailed analysis of crew time allocations for some representative space missions is presented in Appendix A. A summary of the representative times of some relevant scheduled activities necessary for evaluating scheduled and unscheduled off duty time is presented in Table 1. This table represents a synthesis of the work, off duty time, contingency time and sleep periods presented by the mission time lines reviewed (8, 23, 26, 27, 33, 34, 35). Some points to note in the summary table are: (1) all groups employed a 7-day work week; (2) scheduled off duty time ranged from 1.5 to 3 hours per day; (3) both Douglas studies (8, 26) and the AFSC study (27) present a contingency time period; however, neither indicated what the time would be used for if the contingencies did not arise; (4) the range for scheduled work operations was from 5.6 (33) to 12.8 (23) hours per day; (5) the allotted sleep time ranged from 5.5 (23) to 8.0 (8, 27) hours per day. These times will be evaluated in light of the reduced times for work and sleep presented in the following sections.

TABLE I

SUMMARY OF OFF DUTY TIME, CONTINGENCY TIME, SLEEP TIME, WORK TIME AND DAYS FOR EACH CREW MEMBER PER 24-HOUR DAY FOR LONG TERM SPACE FLIGHT

Source	Off Duty	Time Allocation Contingency	Sleep	Work	Work Days 1 Week
Douglas MORL (8)	1.5	2.4	8	9.3	7
Douglas Mars Contingency (26)	1.5-3	1.5-2	7	10.3-10.8	7
Serendipity Long Term Mission(33, 44)	2.75	-----	7.6	5.6- 7.7	7
Lockheed Early Manned Interplanetary (35)	1.9	-----	7.2	8	7
NAA Mars Landing and Return (23)	Indeterminate		5.5	12.8	7
AFSC 30-Day Low Orbited (27)	3	2	8	11	7
Average of Mission Studies	2.1-2.4	1.96-2.1	7.2	9.5-9.9	7

on the other hand, perform their primary objective, viz., collect scientific data, during the wintering over period, although they do help in the pre-winter preparation, as do all personnel in the Antarctic studies. Therefore, the civilian personnel have meaningful tasks throughout their stay, whereas the tasks of the military personnel during the wintering over period tend to be less fulfilling and usually less time consuming.

A summary of symptoms for the two groups for the two time periods is presented in Table 2.

TABLE II

INCIDENCE OF SYMPTOMS IN RECENT ANTARCTIC GROUPS AT TWO TIME PERIODS (Percentages)

	Military		Civilian	
	Early Winter	Late Winter	Early Winter	Late Winter
Feeling blue	68	82	64	48
Difficulty sleeping	58	83	52	48
Easily annoyed	68	87	69	76
Feeling lonely	64	70	52	48
Nervous and tense	46	71	45	52
Waking up at night	44	67	31	24
Inability to concentrate	36	49	33	58
Uneasy or worried	46	53	33	36
Feeling tired during the day	74	78	52	61
Critical of others	54	77	64	88
N	80	78	42	33

From Gunderson (16)

A review of this table makes it clear that even among reasonably well selected individuals, as the later Antarctic groups have been, there is an extremely high incidence of symptoms normally related to abnormal behavior. Also, these symptoms are much more prevelant among the military personnel, who, as indicated earlier, have a lower work activity schedule than the civilian personnel. The relevance of the above findings for long duration space flight is that groups in confinement, even reasonably high level groups as represented by some of the Antarctic civilian personnel, tend toward abnormal symptoms. There is marked evidence of sleeping difficulties and depression -- symptoms which can frequently influence crew performance reliability. As demonstrated by the civilian group, there is also evidence to indicate that meaningful work tasks tend to reduce the incidence of abnormal symptoms. In view of the above findings, sleeping difficulties may arise in long term space flights due to the availability of meaningful work activities and confinement as well as the anticipated reduced physiological requirements for sleep related to weightlessness.

Simulator Studies

A number of simulator studies offer another source of data relative to the reduced sleep requirements of confinement. For example, the Lockheed-Georgia studies indicate a reduction in the number of hours of sleep as a function of the work/rest schedules employed (12). The average amount of sleep obtained by subjects on a 4 hours on, 2 hours off schedule was less than 5-1/2 hours per day. A similar amount is reported by Rathert, et. al. (36), employing a 4 on, 4 off work/rest cycle during a 7-day simulated space mission. His two subjects averaged 4.5 and 5.75 sleep hours per day. The Boeing 30-day simulated space mission (24) also shows that 5 subjects operating on a split 3-1/2 hour sleep schedule for two sleep periods obtained sufficient sleep over the length of the study period. The primary point in the above simulator studies is that either as a function of confinement or work/rest cycle or participation in a study the subjects were able to perform adequately over an extended period of time, that is, up to 30 days, with a much reduced sleep schedule. In fact, a schedule in most instances similar to the total amount of sleep experienced by the crew of Gemini VII. It is also interesting to note that the subjects suggest that some variety in the schedule is advisable such as simulating Sunday in order to break the monotony and relieve boredom.

Two findings which can be stated about sleep are: 1) there appears to be a tendency toward reduced sleep requirements in actual space missions, and 2) there is a tendency toward reduced sleep requirements in confinement and isolation. Referring to Table 1, the Summary Table for the currently planned missions, there would appear to be too much sleep time scheduled for these missions. The exception is the $5\frac{1}{2}$ hours of sleep scheduled by North American Aviation (23) which appears to be a more realistic allotment than shown by the other missions reviewed. NAA also suggests $7\frac{1}{2}$ hours of sleep for the Mars excursion crew. This Earth-like sleep requirement appears advisable for this phase of the mission since work and sleep conditions on Mars may be similar to those required on Earth due to high work demands and higher gravity conditions (.4G). However, for deep space flight, reduced sleep requirements result in unscheduled off duty time if the current 24-hour mission day is retained.

SECTION III: WORK OPPORTUNITIES AND OFF DUTY TIME

An analysis of the work requirements and opportunities in long term space flights indicates that there is a difference between design goals of mission studies and the actual situation with respect to work opportunities. The underlying philosophy in all of the mission studies reviewed is that the men should be kept as busy as possible in meaningful work activities. The problem which develops is that staffing criteria center around crucial phases of the mission, for example, the Mars exploration phase; staffing also takes into account mission length and contingencies such as incapacitation or death of one or more crew members. As a consequence, insufficient emphasis has been placed upon work opportunities for the deep space portions of the mission. Careful inspection of work opportunities during deep space shows that the design goals of keeping men meaningfully occupied as a control of monotony and boredom (23) probably cannot be attained. The problem with development of long duration manned space flight is that when you need men you need a fairly representative number of highly skilled personnel; however, the need is principally for a very short time. The crucial phases of fly by missions normally take only a day and for most of the Mars exploration studies, the time spent on the Martian surface is normally less than 45 days. For the one extended Mars exploration study, in which there is a 500 day stay, it is anticipated that problems of inadequate work opportunities might arise similar to those found in deep space. Thus, for very short periods of time highly skilled individuals will be required to work long hours with little, if any, time available for discretionary activities. Fortunately, there have been a sufficient number of work/rest and sleep studies performed to show that men normally can extend themselves to the required level of performance for the short time periods anticipated (1, 2, 7, 19). This is not to say that the work schedules employed in these studies would be optimum for the highly crucial phases of the long term space flight. In fact, further research on optimum work/rest cycles for these various phases is desirable particularly with respect to sleep requirements. The principle point is that staffing for long term space flights is currently based upon a time period which is sometimes less than 1% of the total mission time.

Deep Space Work Opportunities

The most definitive inquiry into work opportunities for the deep space portion of the mission has been performed by Serendipity in their

Analysis of Crew Functions and Habitability Requirements for Long Duration Space Flights (33, 34). The Serendipity analysis of a Mars landing with a Venus fly-by (33) indicates that in order to have sufficient crew to adequately handle the two heavy phases, approximately 10 crew members are necessary. Figure 2 shows the man hours for the different phases. During the longer periods, approximately 10% - 15% of the total man hours are employed in operational and scientific requirements. This only represents somewhere between 2-1/2 and 4+ man hours a day on the average. During the deep space phases (Table III) one of the crew members, the biologist, has 23 required work hours out of 844 for the Earth-Venus phase, 89 out of 1,457 hours for the Venus-Mars phase, and somewhat more than 32 hours out of 1,150 hours for the Mars-Earth phase. Note that most of these hours, 88, are spent as a physiology subject. Whether a crew member could maintain his personal well-being for such extended periods without adequate activity in a confined, small group environment is questionable. The directive to have as many waking hours as possible occupied with productive and meaningful activities is obviously sound, whether this can be accomplished on an actual mission is doubtful in view of this Serendipity task analysis. Table III (33) shows that, except for the physical scientist technician and the navigator, all the other participants tend to have too much free time during deep space. In fact only 35%-40% of the available work time is scheduled work time for the other participants. Note that the time available for activities represents only 30% of the mission day during these phases of the mission. In addition, 2-1/2 hours a day is allocated for exercise and human support time already includes 2-3/4 hours a day for off duty time. Thus, actual free time, excluding exercise time, during the deep space phases may exceed 10 hours a day in current mission studies. When one takes an empirical approach to detailing tasks, activities and time, it is readily apparent that the initial goal of providing a full and meaningful work day is quite difficult to accomplish. There are limited mission operations, limited opportunities for deep space experiments, and an extensive

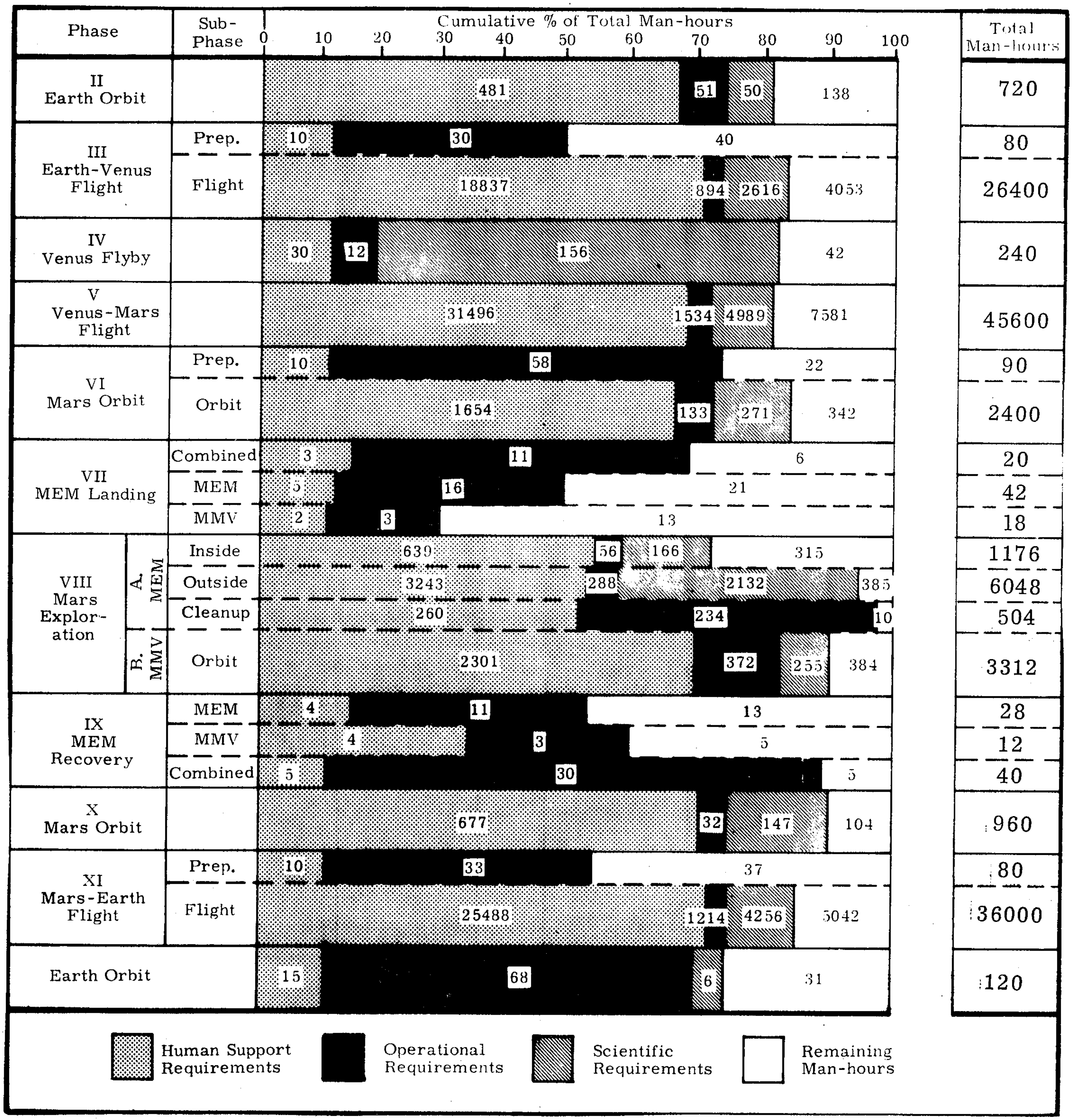


Figure 2. Crew Man-Hours for Mars Mission Phases. Crew Size of 10. (7 MEM, 3 MMV)

From Price (33)

TABLE III

DEEP SPACE CREW ASSIGNMENTS

Title	Phase III: Earth - Venus. (844 Working Hours Available per Crew Member)		Phase V: Venus-Mars. (1457 Working Hours Available per Crew Member)		Phase XI: Mars - Earth. (1150 Working Hours Available per Crew Member)	
	Activity	Req. Hrs.	Activity	Req. Hrs.	Activity	Req. Hrs.
1. Biologist	Physiology Subject	23	Exobiology Preparation	56	Exobiology Research	*
			Physiology Subject	33	Physiology Subject	32
2. Physical Scientist	Physical Sci. Research	434	Physical Sci. Research	835	Physical Sci. Research	808
3. Geologist	Physical Sci. Research	433	Physical Sci. Research	834	Physical Sci. Research	807
4. Monitor	Med. /Psych. Monitoring	315	Med. /Psych. Monitoring	419	Med. /Psych. Monitoring	385
			Exobiology Preparation	16	Exobiology Research	*
5. PS Technician	Physiology Subject	23	Physiology Subject	32	Physiology Subject	31
	Physical Sci. Research	773	Physical Sci. Research	1393	Physical Sci. Research	1050
6. Deputy	Operational Monitoring	294	Operational Monitoring	507	Operational Monitoring	400
					Physical Sci. Research	277
7. Engineer	Operational Monitoring	294	Operational Monitoring	507	Operational Monitoring	400
8. Commander	Operational Monitoring	294	Operational Monitoring	507	Operational Monitoring	400
			Exobiology Preparation	112		
9. Navigator	Navigation Readings	**	Navigation Readings	**	Navigation Readings	**
	Physical Sci. Research	778	Physical Sci. Research	1393	Physical Sci. Research	1050
10. Psychologist	Physiology Research	147	Physiology Research	229	Physiology Research	201
	Med. /Psych. Monitoring	315	Med. /Psych. Monitoring	490	Med. /Psych. Monitoring	385
			Exobiology Preparation	56		

* Level of Effort

** Intermittent Activity Minimal Time Cost

From Price (33).

amount of time in which to prepare for heavy duty periods. The design goal of keeping men meaningfully busy frequently has not been met, and thus, it produces an excessive amount of off duty time.

In addition to the lack of scheduled work in deep space portions, certain other factors may arise which further limit work opportunity. Some of the mission plans previously reviewed have allocated a contingency work period on a daily basis. By definition, contingencies may or may not occur. If they do not occur, there is an additional block of free time which is unscheduled.

Irrepairable equipment failures which may develop during the mission are another possible source of unscheduled time. After initial futile attempts to repair the equipment, the time which was scheduled for operations or scientific experiments employing the irrepairable equipment will no longer be used. Hence, there will be additional unscheduled time available to those crew members associated with that equipment.

One problem that would develop because of the reduced work possibilities due to contingencies is that those individuals who have work will generally be unwilling to share their limited work with other crew members. Personnel in restricted environments where work possibilities are limited, repeatedly show (40) this trait. Rohrer has indicated that, as a result of status leveling and reduction in the number and variety of available roles for men in confinement, each man jealously guards the prerogative of his own work role. He further indicates that this holds independently of the level of ability of the individual trying to take over the task.

In summary, although the mission design goal of keeping men occupied as a control of monotony and boredom is a justifiable one (16, 35, 40), the opportunities for work in space for the greater part of the time are lacking. As was shown by Serendipity's mission task analysis, there does not appear to be sufficient opportunity particularly with respect to the ability levels of crew members. When contingencies such as irrepairable equipment failures occur or when allocated contingency time is not used the amount of unscheduled time that becomes available is greatly increased. Additionally, as we have seen in the sleep section, men without adequate work opportunities tend toward symptoms related to both depression and anxiety (Table II). Hence, the mission analyst indeed has a very serious problem in properly managing the anticipated unscheduled time in long duration space flights.

SECTION IV: SCHEDULED AND UNSCHEDULED OFF DUTY TIME IN CURRENT MISSION STUDIES

The preceeding sections uncovered certain inadequacies in allocation of time in different phases of long term missions, especially for the deep space portions of the mission. This was particularly true with reference to the sleep requirements and opportunities to engage in meaningful work activities. Although still a tentative guide, the sleep experience of space flight to date would tend to indicate that 6 or fewer hours a day may be satisfactory for space flight. This is in excess of all the mission studies with the exception of the North American Aviation study (23). As a result of the reduced sleep time requirements alone, there will be an additional 2 hours a day for free time or off duty time. Furthermore, when we look at the Serendipity detailed analysis of work opportunities (33) particularly during the deep space portions of the mission, we realize there probably will be an insufficient amount of work to perform. Thus, the original mission design objective of keeping the men meaningfully occupied 10 and even more than 12 hours a day on a 7-day basis, apparently cannot be accomplished. In those mission studies which have allocated a contingency time portion in their planning, there is little indication concerning what the contingency time would be used for if contingencies did not arise. If we were to look at the scheduled off duty time without taking the above factors into account, the 1.5 to 3 hours a day allocated might appear to be insufficient;

however, when we add 2+ hours for an excessive time allotment to sleep, and 2-6+ hours for excessive time alloted to work, it is readily apparent that there is an excessive amount of free time in long duration space missions. These times will be evaluated in light of the facts about free time presented in Chapter III.

The average times for mission studies, together with estimates concerning the time required for contingencies, sleep and work, as determined in this study are presented in Table IV. The table then shows the calculations of unscheduled off duty time by subtracting the anticipated time required for the activity from the average time that was allocated in the mission studies for the activity. As can be seen, there is up to 2. 1 hours on the average alloted for contingency time which may not be used, 2. 2 hours allocated for sleep which may not be used, and 5. 5 to 5. 9 hours allocated for work which may not be used. Thus, the amount of scheduled and unscheduled off duty time possible can range from 11. 8 to 12. 6. Whether man can maintain sufficient equilibrium for the lengthy time period in the highly confining, hazardous spacecraft with such an uncommon amount of off duty time on his hands, is openly questioned.

TABLE IV

SUMMARY OF FREE TIME, CONTINGENCY TIME, SLEEP TIME, WORK TIME AND DAYS FOR EACH CREW MEMBER PER 24-HOUR DAY FOR LONG TERM SPACE FLIGHT

Time Estimate	Scheduled Off Duty	Time Allocation Contingency	Sleep	Work	Work Days 1 Week
Mission Studies	2. 1-2. 4	2. 0-2. 1	7. 2	9. 5-7. 9	7
Current Study		0-2. 1	5	4	5. 5
Unscheduled Off Duty Time		0-2. 1	2. 2	5. 5-5. 9	

Total
Off Duty Time: 11. 8 - 12. 6 hours per day.

CHAPTER III

FACTS ABOUT LEISURE TIME AND ACTIVITIES

Adequate evaluation of the off duty time available in long duration space flights should consider the off duty time possibilities that exist for the population in general and for groups in unique situations. Actual off duty time and activities suggested by these sources will be used to evaluate the time and activities suggested in the mission studies. Surveys on leisure time and leisure activities presented in Of Work, Time & Leisure, by deGrazia (11) and updated by Robinson (37) in 1967 are the principle data sources for the general population. Possibly the best source of information concerning off duty time and its utilization for groups in unique situations comes out of a synthesis of Antarctica time and activity studies currently in progress by the VA in Oklahoma (32) and by Gunderson. Consideration will be given to: (1) the importance of discretionary activities, (2) the generally inadequate provision for activities in remote sites, and (3) suggested time and activities from simulator and laboratory studies.

SECTION I: OPINION SURVEYS OF LEISURE TIME

Opinion surveys are one source of information on off duty utilization. We recognize that the types of men who will be selected for long term space flight are not represented by the people surveyed; however, the surveys do provide certain points of orientation. They provide information on the kinds of activities people of varying social, economic, and educational backgrounds actually perform; they provide some indication of the amount of time the various activities use and how frequently they are performed; and they give an orientation concerning the types of questions to ask potential crew members. With these points in mind critical time utilization surveys performed over the last 30 years have been reviewed (11, 31, 37, 38, 45).

A list of the major time use studies as compiled by Robinson is presented in Table V. This table represents the best summarization of time use studies currently available. Although the early studies by Lundberg, and Sorokin and Berger have some significance for individuals interested in social change, their relevance for the long duration space flights mission planner is not too great. More critical are the studies by John Ward, Inc. (45), the Opinion Research Corporation (31) and by Robinson and Converse (38).

Results of the Robinson and Converse study are presented in Table VI. The results are of value because they present the primary activity times on a total day basis. Results show that approximately 5 hours a day are spent as leisure time. Activities for 1.4 hours of the 5 allocated for leisure could not readily be performed in outer space. Substitutes for these activities should be considered to permit the crew members to engage in as many Earth-oriented activities as possible; e.g., performing as part of an organization, engaging in certain aspects of social and family life, walking, and participating in sports.

TABLE V

MAJOR TIME USE STUDIES COMPARED ON VARIOUS CHARACTERISTICS

Study	Sample	Time Budgets	Interviewing Period	Coding Categories	Special Features	Major Shortcomings
Lundberg et al (1934)	2460 residents of Westchester County, New York (of these almost 1600 were students)	3-7/person; total=4460	November-May 1931-32 and 1932-33	15 (but no code for shopping)	1) "Good time patterns" i.e., enjoyable parts of day	1) No day of week differences (possible oversample of weekends) 2) Low response rate 3) Affluent community with no illiterates and few working class respondents 4) No summer months 5) Respondents reconstruct days from memory 6) Possible restriction to activities over 30 minutes
Sorokin and Berger (1939)	176 adults in Boston	At least 28/ person; total=3476	May-November 1935	55 (reduced to 8 general categories)	1) Predictability of budgets 2) Motivations for activities 3) Social contacts for activities	1) Oversampling of unemployed, young women 2) Summer months only 3) Low response rates 4) Differences due to sex, employment marital status, etc. not available
J.A. Ward - Mutual Broadcasting (De Grazia, 1962)	Nationwide sample of all individuals over 5 years of age in 7000 households	2/person; total=17,000 for ages 20-59	March-April 1954	13 (no separate code for TV)	1) Nationwide probability sample 2) Day of week variations accounted for	1) Only 17 hours period covered 2) No summer months 3) Breakdowns by age, education, etc. not available
Opinion Research Corporation (DeGrazia 1962)	Nationwide sample of 5021 persons aged 15 and over	1/person total=5021	(Month?) 1957	20(only certain leisure activities)	1) Participation only	1) Actual time spent not ascertained
Converse & Robinson (1966)	Urban probability sample of 1244 adults in employed households + 788 adults in Jackson, Michigan	1/person total=1802 budgets 2/person total=440 budgets	November-December 1965; March-April 1966	96 (reduced to 27 activities)	1) Part of 10 nation study 2) Activities most easily given up 3) Most enjoyable part of the day 4) Yearly participation figures	1) No data for rural areas or unemployed households 2) No summer months

From Robinson (37).

TABLE VI

Allocation of Primary Activity Time for Men, Employed Women and Housewives in Hours per Day. Jackson, Michigan sample in parentheses.

	Men		Employed Women		Housewives		Total	
N =	543	(368)	342	(199)	359	(212)	1244	(779)
1. Regular work	5.8	(6.1)	4.7	(4.9)	.1	(.1)	3.8	(4.1)
2. Second job	.1	(.2)	.1	(*)	0	(0)	.1	(.1)
3. Non-work	.6	(.6)	.5	(.4)	*	(*)	.4	(.4)
4. Work transit	.7	(.5)	.5	(.3)	*	(*)	.4	(.3)
5. Prepare food	.1	(.1)	.8	(.8)	1.6	(1.7)	.7	(.7)
6. Clean house	.2	(.2)	1.1	(.9)	2.0	(2.0)	1.0	(.9)
7. Laundry, mending	*	(*)	.4	(.5)	1.0	(.9)	.4	(.4)
8. Other upkeep	.3	(.3)	.2	(.2)	.4	(.3)	.3	(.3)
9. Pets/garden	*	(*)	*	(*)	.1	(.1)	.1	(*)
10. Sleep	7.6	(7.6)	7.6	(7.8)	7.7	(7.9)	7.6	(7.7)
11. Personal care	1.0	(.9)	1.3	(1.1)	1.2	(1.0)	1.1	(1.0)
12. Eating	1.2	(1.1)	1.0	(.9)	1.3	(1.3)	1.2	(1.1)
13. Resting	.3	(.3)	.4	(.3)	.4	(.7)	.3	(.4)
14. Child care	.1	(.1)	.3	(.3)	1.1	(1.1)	.4	(.4)
15. Shopping	.4	(.3)	.5	(.7)	.7	(.7)	.5	(.5)
16. Non-work transit	.8	(.8)	.7	(.9)	.9	(.9)	.8	(.8)
17. Education	.3	(.2)	.1	(.1)	.2	(.1)	.2	(.1)
18. Organizations	.2	(.3)	.2	(.2)	.4	(.3)	.3	(.3)
19. Radio	.1	(.1)	.1	(*)	*	(*)	.1	(*)
20. Television	1.7	(2.0)	1.1	(1.2)	1.6	(1.6)	1.5	(1.7)
21. Reading	.7	(.6)	.4	(.5)	.6	(.5)	.6	(.6)
22. Social life	1.0	(1.1)	1.1	(1.0)	1.5	(1.4)	1.2	(1.2)
23. Conversation	.2	(.2)	.3	(.3)	.5	(.6)	.3	(.3)
24. Walking	*	(*)	*	(*)	*	(*)	*	(*)
25. Sports	.2	(.2)	.1	(.1)	.1	(*)	.1	(.1)
26. Various leisure	.2	(.2)	.3	(.3)	.5	(.5)	.3	(.3)
27. Amusements	.2	(.1)	.2	(.1)	.1	(.1)	.1	(.1)
Total	24.0	(24.1)	24.0	(23.8)	24.0	(23.9)	23.8	(23.9)
Free time (13; 17-27)	5.0	(5.1)	4.2	(4.1)	5.9	(6.0)	5.1	(5.1)

*Less than 3 minutes.

From Robinson, personal communication, 1967.

One could be involved in an organization-oriented activity by delivering lectures or informal talks to interested personnel. Although sports cannot be performed as we now recognize them, sports could be redesigned or created. In the area of social and family life, secure links with loved ones are essential to the well-being of crew members. If the use of private communications can be incorporated in the spacecraft, it will be possible for each crew member to communicate on a personal level. The crew member would be able to discuss conditions that might lead to problems of a personal nature and, thus, reduce or alleviate anxieties and depression. Consideration can be given to substitutes for child care and shopping. Shopping, particularly holiday shopping, may be a very good activity to develop via video communication as a way to delineate major time periods to look forward to, thus reducing monotony and boredom. Also, if there were fathers and mothers aboard, some way to enable the parent to enter into the development and correction of children should by all means be considered.

The Robinson and Converse data for occupational levels is presented in Table VII. Crew member time and activities would probably fall somewhere between the white collar worker and the executive and professional. Note that this table allocates approximately 6 hours to leisure time, but it includes eating as part of the leisure activity. Note also that television accounts for an hour and twenty minutes per day in contrast to reading times of 50 minutes for professionals and 36 minutes for white collar workers. Visiting accounts for over an hour a day in leisure time utilization whereas the total for entertainment, sports, radio, motoring and clubs is less than 2/3 of an hour for both the white collar and executive groups. Although educational activities are not specifically listed, it is assumed that they would be part of the miscellaneous leisure activity category. The Educational type activity which is generally given serious consideration as being one of the more frequently selected and therefore time consuming activities requires re-examination. This will be done later.

TABLE VII

TIME AND ACTIVITY PATTERNS FOR VARIOUS OCCUPATIONAL GROUPS OF MEN IN THE 1965-66 ROBINSON AND CONVERSE STUDY

Non-Leisure (Hours per Day)	Executives Professional	White Collar	Labor
Sleep	7.7	7.6	7.4
Work for Pay	6.8	7.2	7.5
Care of Self	0.9	1.0	1.3
Transportation	1.6	1.5	1.3
Household & Children	0.7	0.6	0.3
	17.7	18.1	17.8
Shopping	0.4	0.3	0.2
Leisure (Min. per Day)			
Eating	78	73	76
Visiting	68	74	39
Reading	50	36	24
Entertainment	11	13	13
Sports	10	12	5
Radio	5	4	10
Motoring	2	2	1
Clubs	5	8	5
Television	80	75	159
Miscelleneous	51	51	24
TOTAL LEISURE MINUTES	360	348	366
TOTAL LEISURE HOURS	6.0	5.8	6.1
TOTAL	24.1	24.2	24.1

Adapted from Robinson (37).

As an extended duration space flight may be the cooperative venture of a number of nations, it appears appropriate to consider time expenditures across nations. Such a study has been performed in conjunction with the Robinson and Converse study and the results are presented in Table VII. Surprisingly, time expenditure across nations is not nearly so diverse as one might anticipate. Since the study combines data for both men and women, including housewives, its results are difficult to relate as they are presented in the table. Thus, they should only be employed as relative guides to time expenditure, and if specific crew member data for a given country is required, it would be best to obtain some utilization data as a function of occupation and sex. Of principal interest in this international survey is the fact that the maximum free time allocated in the mission studies (three hours) is less than the average for any of the nations studied and two hours less than that found for the United States. Furthermore, the potential off duty time of 11-12 hours is more than twice the amount of free time available in any of the countries studied.

An excellent source of information concerning leisure time can be found in the nationwide study of living habits by J. A. Ward (45). The findings on time allocation for the general population are presented in Table VIII. One of the initial points to note is that there has been an apparent increase from the 1954 survey to the 1965-66 Robinson and Converse survey in leisure time from 4.5 to 5.0 hours for men. Also of interest to spacecraft designers is the fact that away from home leisure activities have increased from a half an hour to an hour for men during the same time period. The increase in time spent in shopping and in restaurants is significantly increased so that consideration should be given to phenomenally equivalent activities in the development of discretionary activities.

TABLE VIII
TIME EXPENDITURES IN HOURS FOR 27 ACTIVITY CATEGORIES ACROSS THE 13 SURVEY SITES IN THE MULTINATION TIME-BUDGET RESEARCH PROJECT

	United States (Cities 50,000)	United States (Jackson, Michigan)	France (6 cities)	Belgium (425 cities)	West Germany (100 districts)	West Germany (Osnabruck)	Hungary (Gyor)	Poland (Torun)	Yugoslavia (Maribor)	Yugoslavia (Kragujevac)	Bulgaria (Kazanlik)	Russia (Pskov)	Czechoslovakia (Olomouc)
1. Regular work	3.8	4.1	4.2	4.3	3.7	3.7	5.4	4.9	4.3	4.0	5.6	5.4	4.7
2. Second job	.1	*	.1	.1	*	*	*	*	.2	*	*	*	*
3. Non-work	.4	.4	.2	.2	.3	.2	.5	.3	.3	.4	.6	.6	.1
4. Trip to/from work	.4	.3	.4	.4	.3	.3	.7	.6	.5	.5	.7	.5	.5
5. Prepare food	.7	.7	.7	.8	1.0	.8	1.0	1.0	1.3	1.1	.8	.9	1.1
6. Clean house	1.0	.8	1.2	1.1	1.2	1.2	.9	.8	.9	.8	.7	.6	.9
7. Laundry, mending	.4	.4	.5	.4	.4	.4	.6	.6	.7	.5	.3	.4	.6
8. Other upkeep	.3	.3	.3	.2	.3	.3	.3	.3	.4	.4	.2	.3	.4
9. Pets/garden	.1	*	.2	.1	.5	.3	.6	*	.8	.1	.4	.1	.1
10. Sleep	7.6	7.8	8.2	8.3	8.3	8.1	7.7	7.5	7.8	7.6	7.8	7.6	7.8
11. Personal care	1.1	1.0	.9	.7	.9	1.0	.9	.9	.8	1.0	.8	.8	1.2
12. Eating	1.2	1.1	1.7	1.6	1.5	1.6	1.0	1.1	1.1	1.1	1.2	.8	1.0
13. Resting	.3	.4	.6	.5	.5	.6	.4	.6	.4	.7	.7	.3	.4
14. Child care	.4	.4	.6	.3	.4	.3	.4	.4	.4	.3	.3	.4	.4
15. Shopping	.5	.6	.4	.3	.4	.5	.3	.5	.3	.4	.4	.4	.6
16. Non-work trips	.8	.9	.5	.5	.3	.4	.5	.6	.6	.8	.6	.8	.4
17. Education	.2	.1	.2	.3	.1	.2	.3	.3	.3	.3	.2	.6	.2
18. Organizations	.3	.3	.1	.2	.1	.1	.1	.1	.1	.1	.1	.1	.1
19. Radio	.1	*	.1	.1	.1	.1	.2	.2	.1	.3	.3	.1	.2
20. Television	1.5	1.7	.9	1.4	1.0	1.2	.7	1.1	.7	.6	.3	.7	1.1
21. Reading	.6	.6	.4	.6	.4	.5	.4	.6	.5	.5	.5	.8	.6
22. Social life	1.2	1.2	.6	.7	.8	.9	.4	.6	.6	1.1	.2	.3	.4
23. Conversation	.3	.3	.3	.3	.3	.3	.2	.2	.2	.5	.2	.2	.2
24. Walking	*	*	.2	.2	.6	.5	.2	.2	.3	.2	.4	.2	.3
25. Sports	.1	.1	*	.1	.2	.1	.1	*	.1	*	.1	.1	*
26. Various leisure	.3	.3	.4	.5	.2	.3	.1	.2	.2	.6	.3	.2	.3
27. Amusements	.1	.1	.1	.2	.1	.1	.1	.1	.1	.2	.3	.3	.1
Total	23.8	23.9	24.0	24.4	23.9	24.1	24.0	23.7	24.0	24.1	24.0	23.5	23.7
Free time (13, 17-27)	5.0	5.1	3.9	5.1	4.4	4.9	3.2	4.2	3.6	5.1	3.6	4.1	3.9

*Average time less than three minutes

From Robinson (37).

The table also has value in pointing out the distribution of leisure time and work time in a 7-day period. In addition to presenting strong evidence for a $5\frac{1}{2}$ day work week in the general population, the table also presents an interesting distribution of time in relation to time of week and data on leisure time activities at home and away from home. The leisure time activities for men at home are 2.9 hours during the week, 3.7 on Saturday and 5.1 on Sunday, in contrast to .7 on weekdays, 1.8 on Saturday and 2.8 on Sunday for time away from home. Our space crew members will not have a physical opportunity to engage in leisure time activities away from the spacecraft; however, as has been previously suggested, activities phenomenally equivalent to those that can be performed away from home should be considered in developing activities.

Although the survey presents time factors for women, these times are not representative for women likely to be selected as crew members. Women crew members, being professionals, would, in all probability, show a much closer approximation to activity times for men than to activity times for women or even working women if this data were presented. Women in space flight would have only the work responsibilities connected with the mission and, thus, their off duty time needs would probably more reflect those of men than of women in any category.

Another dimension of leisure time, namely, off duty time in relation to time of day, is presented in Figure 3 of data derived by Ward (45). Most leisure time falls in the evening for both time spent at home and away from home. There are also two smaller peaks in the early morning and at noon. These periods correspond approximately to leisure periods recommended in the Serendipity analysis of free time requirements for long duration space missions (33), as depicted in Figure A-4 in Appendix A. Another point to note in Figure 3 is that due to curtailment of sampling at 11 p.m., the survey did not get the total leisure time that would be anticipated. Although the leisure time period is diminishing as indicated by the percent of time spent in

Table IX

AMOUNT OF TIME BETWEEN 6 A.M. AND 11 P.M. DEVOTED TO VARIOUS ACTIVITIES, MEN AND WOMEN 20–59 YEARS OF AGE, SPRING 1954[a]

(Hours)

Activity	Average Weekday Men	Average Weekday Women	Saturday Men	Saturday Women	Sunday Men	Sunday Women	Average Day[b] Men	Average Day[b] Women
Total	17.0	17.0	17.0	17.0	17.0	17.0	17.0	17.0
Away from home:								
At work	7.2	2.0	4.3	0.8	1.2	0.3	6.0	1.5
Traveling	1.4	0.6	1.4	0.7	1.3	1.0	1.4	0.7
Shopping	0.1	0.4	0.3	0.8	0.1	—	0.1	0.4
At restaurant, tavern, barber, etc.	0.3	0.1	0.3	0.2	0.1	0.1	0.2	0.1
At friend's or relative's home	0.4	0.8	1.2	1.2	1.4	1.4	0.7	1.0
Leisure (games, sports, church, etc.)	0.3	0.4	0.6	0.4	1.4	1.1	0.5	0.5
At home:								
Leisure (other than reading)	2.1	2.7	2.8	2.8	4.0	3.5	2.4	2.8
Reading	0.8	0.8	0.9	0.9	1.1	1.1	0.9	0.8
Miscellaneous work at home	0.6	1.2	1.0	1.1	0.8	0.7	0.7	1.1
Household chores or housekeeping	0.2	3.0	0.2	2.6	0.2	1.7	0.2	2.7
Eating or preparing food	1.2	2.5	1.2	2.5	1.3	2.5	1.2	2.5
Dressing, bathing, etc.	0.6	0.9	0.7	0.9	0.7	0.9	0.6	0.9
Asleep	1.8	1.8	2.1	2.1	3.4	2.7	2.1	1.9
All leisure activities[c]	3.6	4.7	5.5	5.3	7.9	7.1	4.5	5.1

Source: Derived from unpublished data in *A Nationwide Study of Living Habits,* a national survey conducted for the Mutual Broadcasting System by J. A. Ward, Inc., New York, 1954.

a. Based on diaries covering every quarter-hour period from 6 A.M. to 11 P.M. during March and April 1954.

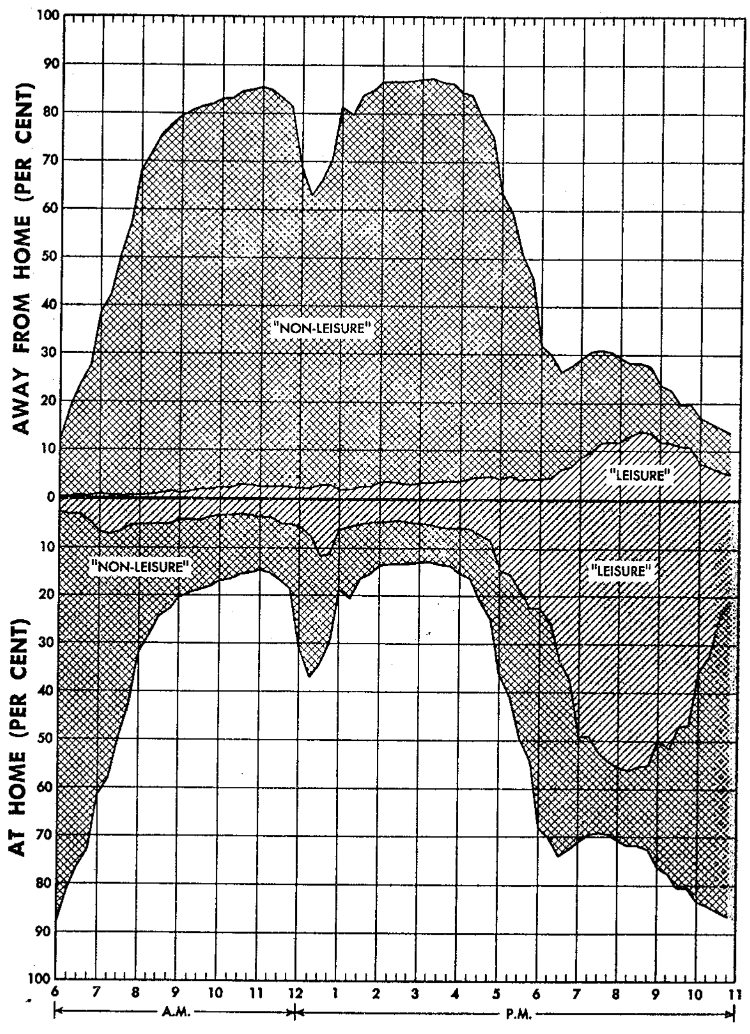
b. Represents average of all seven days of week.

c. Includes visiting at friend's or relative's home; games and sports, etc., as a spectator or participant, as well as other forms of leisure such as church, where one is part of an audience; and reading and any other activity at home that is not work (playing cards, listening to the radio, watching television, talking on the telephone, visiting with guests, etc.).

From Ward (45).

FIGURE 3

Per Cent of Men Aged 20–59 Engaged in Leisure and Non-leisure Activities, at Home and Away from Home, at 15-Minute Intervals, from 6 A.M. to 11 P.M. on an Average Weekday, Spring 1954



SOURCE: Derived from unpublished data in *A Nationwide Survey of Living Habits,* a national survey conducted for the Mutual Broadcasting System by J. A. Ward, Inc., New York, 1954.

NOTE: The total percentage at any particular point on the time scale may exceed 100 because individuals may engage in more than one activity during a given 15-minute period.

From Ward (45).

leisure activity at 11 p.m., it is still higher at this point than at any time prior to 6 p.m. Probably, the half hour time discrepancy between this 1954 survey and the 1966 Robinson and Converse survey is an artifact of the fact that sampling ceased at 11 p.m. Hence, we have further indication that off duty time for the general population is in excess of the 4.5 hours presented in Ward's summary table.

Another point to note in these leisure time survey studies is that time allocated to leisure activities may be less than what it should be. Activities such as sleeping, napping, being at a restaurant or tavern, performing miscellaneous work activities frequently are considered leisure time activities by many participants. If these activities were included in the average weekday in the Ward survey, 6.3 hours a day would be the average for leisure time activities. Also, there are activity time requirements on Earth which are not possible in spacecraft, such as travel requirements and certain work activities related to home and family maintenance. As has already been noted, the allotted off duty time in mission planning is less than that which is found in the general population; however, the actual off duty time is greater.

SECTION II: OFF DUTY TIME IN ISOLATED GROUPS

The best data source for off duty time problems again comes from isolated groups. Data from Antarctica (14, 16, 30), remote aircraft and warning sites (3), Navy findings (24), space simulator studies (2, 7, 10, 13, 17), air-raid shelter studies (4, 43), and other sources (20, 41), consistently indicate that off duty time is a problem for isolated groups. In fact, at the AC&W sites, leisure time was the greatest personnel problem (3) and was significantly related to personnel turnover. Of all of the above listed groups, the most definitive work in the area of off duty time and activities is being performed in Antarctica. Because of the lack of adequate data in completed studies, data in the studies currently being performed by the Veterans Administration in Oklahoma and Gunderson at the Navy Neuropsychiatric Center was obtained and analyzed. Thus, although all of the above isolated groups contribute to our understanding the problem, the information available from Antarctica will be emphasized.

Antarctic Studies

The most extensively studied intact group is the military and civilian personnel who winter over on the Antarctic continent. The techniques of study and analysis of the reactions of these personnel by contemporary researchers (e. g. , Gunderson and the Oklahoma Veterans Administration) have markedly improved from the early self reports of Byrd (9) and the clinical observations of Rohrer (39, 40). Although the problems of off duty time have often been brought out in earlier studies and in fact related to performance, social compatibility, and crew size factors; only now have specific studies that relate to off duty time and activities been undertaken.

In earlier studies by Rohrer (40), Gunderson (14), and Nelson and Gunderson (30) there has been a consistent finding of difficulties in relationship to the off duty time period. Gunderson (16) indicates that men with strong needs for activity and achievement might be expected to suffer more in such an environment than "men with lesser needs for mastery over their environment." He also indicates that of the sources of stress judged by station members"... recreation facilities are generally reported to be inadequate and represent a significant problem to many individuals." In addition, Gunderson and Nelson (30) have shown that the need for personal or avocational activities is negatively related to adjustment in small stations. They indicate that individuals who had several hobbies, were active in sports and belonged to various clubs did not tend to socialize as much as others. How this finding relates to Smith's finding (42) that scientists' effectiveness in Antarctica was not affected by their ability to get along with people should be evaluated. Smith goes on to state that the scientist who could function in a group or ignore it with equal ease was particularly well suited for the duty. Since interpersonal relations in a small, confined crew are necessarily strained, Hagen's (17) statement that interaction in off duty time should be avoided if problems exist may have merit. The principal point from the above is that individuals with many interests in leisure time activities may not adjust as well in long term confinement.

Critical data on off duty time activities for small groups comes from a recent activity analysis of the Antarctic summer period (32). It should be pointed out that the summer period is the least confining of the two Antarctic periods since personnel have the opportunity to work outdoors at least one day a week. Table X shows that talking is the most time consuming of the free time activities, averaging almost 4 hours a day over the three bases. Note that the average time is in excess of 24-hours per day due to the fact that individuals engage in more than one activity simultaneously. One other interesting point is that the off duty time period was shortest in the smallest station, Plateau, where there were 8 people. However, there was little difference between

TABLE X

Mean Activity Times* for Work, Off Duty and Sleep Functions
At Three Antarctic Bases During The Summer Period.

Location	Plateau N=8		Pole N=20		Scott N=10		Grand Mean
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	
Sleep	7.40	.93	8.05	.57	7.07	.94	7.65
Drowsy	.58	.13	.50	.33	.55	.36	.53
WIA	8.24	.79	5.54	.57	5.25	1.86	6.03
WIP	.36	.36	1.87	.38	2.90	1.18	1.82
WOA	2.22	.63	.55	.17	.16	.23	.80
WOP	1.21	.65	1.07	.43	.84	.47	1.03
Eating	1.68	.17	1.58	.16	2.45	.29	1.83
Talk	2.69	.87	4.10	.47	4.82	.82	3.99
Games	.20	.10	1.58	.37	1.33	.59	1.22
Read	.98	.59	1.42	.29	1.27	.55	1.29
Movies	1.91	.39	1.31	.38	1.09	1.13	1.38
Radio	.09	.19	.08	.08	.38	.31	.16
Un acc't	.01	.04	.00	.00	.07	.13	.02
Total Work Time	12.03		9.03		9.15		9.69
Total Off Duty Time	5.88		8.49		8.96		8.06

*Varies from 24 hours since crew could engage in more than one activity simultaneously.

Code: WIA: work indoors alone; WIP: work party indoors; WOA: work outdoors alone, WOP: work party outdoors.

From Pierce (32)

Scott or Pole base where there were 10 and 20 people. At the Plateau base, off duty time activities accounted for 5.7 hours in contrast to 8.5 and 8.9 for Pole and Scott, respectively. The time period is far in excess of off duty time scheduled on all of the long term missions to date. The time does not vary greatly from anticipated free time that can be extracted from the task time requirements of the Serendipity analysis. However, when one looks at the work opportunities at Antarctic stations, it is rather clear that there is an extensive amount of work possible in contrast to that found in the Serendipity mission task analysis. An average of almost 9.7 hours per day is allocated to work in the mission studies reviewed. Furthermore, it should be emphasized again that the off duty time activities occur concurrently with other activities. For example, the talking portion of the activity profiles accounting for about four hours per day is spent around or during the meal times. Thus, because of the possibility of putting down more than one category, the actual off duty time cannot be calculated from the findings in Table X.

The most comprehensive coverage of work, sleep, and free time activities currently available comes from organizing data presented in Table X, together with recently received TWX's from Antarctica. The TWX's were sent to Dr. Shurley at the VA Hospital in Oklahoma; copies were forwarded to us and relevant information from these sources is included in Table XI. The results are most interesting in light of previous findings concerning sleep difficulties and work opportunities in Antarctica. The table shows little difference in the average amount of sleep between the three periods. In fact, if there is any difference, more sleep is obtained during the late portions of the winter, a time frequently said to contain many sleep disturbances (Table II). Some of the more notable changes between summer and winter are: (1) eating occupies almost twice as much time during the winter season as during the summer season, (2) talking tends to take up 45 more minutes a day during the winter, (3) winter has between 2 and 2-2/3 hours a day fewer work

TABLE XI

Mean Activity Times for Work, Off Duty and Sleep Functions
at the Antarctic Pole Station (N=20) for Summer, Early Winter and Late Winter

Hours Per Day

	Summer	Early Winter	Late Winter
Sleep	8.05	7.92	8.19
Insomnia		.99	.53
WIA	5.54	4.50	4.94
WIP	1.87	1.66	1.32
WOA	.55	.10	.16
WOP	1.07	.06	.12
WIT (Work in Tunnels)		.09	.45
Eating	1.58	3.00	2.92
Talk	4.10	5.20	4.46
Games	1.58	2.28	1.55
Reading	1.42	1.58	2.18
Movies	1.31	1.50	2.03
Total Work	9.03	6.41	6.99
Total Off Duty Time	8.41	10.56	10.22

From Shurley, personal communication, 1967 opportunities and an increase in recreation activity time of approximately 2 hours. Notable changes from early to late winter are: (1) there seems to be a slight trend toward more individual activity as there is a shorter period of time during which games are played, (2) the reading period increases by more than ½ hour a day, (3) there is a slight increase in attendance at movies, and (4) there is less time per day spent talking.

The implications of the above Antarctic findings for long term space flight are: (1) the most likely off duty activity is talking, which obviously has no weight, power, and volume penalty, (2) there may be a tendency for games to occupy less time as the mission progresses; however, this might be related to the stage at which games are introduced in a mission, (3) movies or a video equivalent would appear to be a good daily activity since time spent in movies increased with length of time in confinement, (4) time spent in reading may increase with mission duration, (5) the importance of eating as an acceptable free time activity should not be overlooked since eating time was double during short working opportunity periods, (6) earlier discussion concerning reduced sleep requirements of confinement may bear re-examination as there were few findings concerning sleep loss in the activity sampling at the Pole station, (7) although work opportunities available during the wintering-over period are reduced in contrast to the summer period, they appear to be almost double those calculated for the Serendipity space mission. In light of the previous findings relating work opportunities to incidence of abnormal symptoms, it would appear that the limited work opportunities in the spacecraft may cause an even greater incidence of these kinds of crew problems.

Another source of Antarctic off duty time activity data is a study currently being performed by Gunderson[1]. This study is an attempt to evaluate free time activities and their utilization frequency for civilians, Seabees, and other Navy enlisted personnel in Antarctica. It permits a test of Rohrer's hypothesis that there was a leveling of activities with

1/ This data was obtained in personal communication with Dr. E. K. Eric Gunderson. It is currently unavailable in the literature, but can be obtained from Dr. Gunderson at the Navy Medical Neuropsychiatric Research Unit in San Diego, California time in confinement (40). The hypothesis states that although individuals have lofty motives with reference to reading and self-improvement before entering confinement, in actuality the off duty activity goals would not be effected as a function of time in confinement. The current data cannot prove or disprove Rohrer's hypothesis completely because it does not give any indication concerning participants' activity plans prior to confinement and actually studies the two later periods of the confinement phase, early and late winter. The summer period had already passed -- a period which may have enabled status leveling to have been complete and any change in activity characteristics may not be discernable since prior data is unavailable.

Since the most likely candidates for long term space flight would appear to most closely resemble civilians and enlisted personnel (except Seabees), the activity questionnaire responses of these two groups are presented in Tables XII and XIII respectively. One caution in interpreting the findings for civilians is that 10 of them did not fill out the questionnaire at the end of the wintering-over period. This makes comparisons between early and late periods somewhat difficult to interpret.

Significantly, it should be noted that communications with home as indicated by the categories "writing letters" and "Ham radio" tend to decrease during the wintering period for both the enlisted personnel and civilians.[1] Note also that playing cards, chess, or checkers -- activities frequently suggested for long term space flight -- are performed infrequently. Physical exercise, an activity which is definitely required in the gravity-free spacecraft, is engaged in infrequently by most of the participants. Bull sessions, past, present or general do not appear to vary with time in confinement or between civilian and enlisted population. There is a tendency to read fiction rather than biography, religious material, or technical material by both the civilian and enlisted personnel.

1/ Whether there is a decreased need for personal communications for people in confinement shall not be concluded from these findings. Letter writing decreases primarily because there is no mail. Also, the difficulties in effective utilization of the ham radio is a more probable cause of the reduced use of the activity over time.

TABLE XII

Activities Questionnaire Responses in the Antarctic at Two Time Periods (Early Winter "E" - Late Winter "L") Enlisted Navy - Except Seabees (Deep Freeze 1964-1965)

Activities	Winter Period	Not at All	A Few Times per Month	Once a Week	A Few Times per Week	Every Day	Blank
1. Movies	E	1	0	3	19	26	4
	L	2	6	2	13	27	3
2. Bull Session (present)	E	1	8	10	17	13	4
	L	3	5	6	22	14	3
3. Bull Session (past)	E	0	9	9	22	9	4
	L	1	4	9	25	11	3
4. Bull Session (general)	E	8	17	7	13	4	4
	L	10	21	4	8	7	3
5. Read Fiction	E	9	12	5	16	7	4
	L	5	15	5	17	9	3
6. Read Biography	E	29	16	1	1	2	4
	L	23	18	4	3	2	3
7. Read Religion	E	34	9	2	3	1	4
	L	35	9	3	1	1	3
8. Read Technical	E	10	13	9	12	5	4
	L	8	18	6	13	5	3
9. Study Courses	E	8	10	4	20	7	4
	L	9	8	4	26	2	3
10. Ham Radio	E	11	15	8	7	8	4
	L	15	15	3	12	5	3
11. Write Letters	E	9	15	4	19	2	4
	L	28	9	6	2	3	3
12. Physical Exercise	E	18	9	2	16	4	4
	L	18	12	4	9	6	3
13. Paint-Draw	E	31	9	1	7	1	4
	L	24	16	1	6	3	3
14. "Happy Hour"	E	14	12	7	11	4	4
	L	19	11	8	8	3	3
15. Play Cards	E	18	14	3	11	3	4
	L	15	15	5	11	5	3
16. Chess or Checkers	E	28	13	3	4	0	4
	L	25	19	1	4	1	3
17. Shoot Pool	E	24	9	2	9	4	4
	L	20	9	5	12	4	3
18. Classical Music	E	13	14	0	11	9	4
	L	14	20	1	9	6	3
19. Popular Music	E	2	5	1	15	27	4
	L	1	7	2	16	23	3
20. Western Music	E	8	10	3	15	13	4
	L	6	8	4	14	16	3

From Gunderson, personal communication 1967.

TABLE XIII

Activities Questionnaire Responses in the Antarctic at Two Time Periods
(Early Winter = "W"; Late Winter = "L")
Civilians (Deep Freeze 1964-1966)

Activities	Winter Period	Not at All	A Few Times per Month	Once a Week	A Few Times per Week	Every Day	Blank
1. Movies	E	5	7	6	22	18	0
	L	1	4	3	28	10	10
2. Bull Session (present)	E	2	8	7	31	10	0
	L	2	5	7	23	9	10
3. Bull Session (past)	E	2	16	12	26	2	0
	L	3	10	5	26	2	10
4. Bull Session (general)	E	2	23	12	14	4	0
	L	3	17	8	15	2	10
5. Read Fiction	E	4	21	5	21	7	0
	L	6	9	6	18	6	10
6. Read Biography	E	29	15	6	2	0	0
	L	21	12	6	1	1	10
7. Read Religion	E	37	14	4	19	0	0
	L	34	10	1	18	0	10
8. Read Technical	E	3	16	6	12	14	0
	L	3	7	8	9	9	10
9. Study Courses	E	21	10	6	14	9	0
	L	11	12	5	7	9	10
10. Ham Radio	E	9	18	10	14	6	0
	L	13	11	12	1	3	10
11. Write Letters	E	7	22	13	14	1	0
	L	27	12	5	14	0	10
12. Physical Exercise	E	22	11	5	0	6	0
	L	17	9	1	2	5	10
13. Paint-Draw	E	43	10	4	9	1	0
	L	34	9	1	4	0	10
14. "Happy Hour"	E	18	19	8	9	3	0
	L	13	17	9	4	2	10
15. Play Cards	E	36	12	3	6	1	0
	L	32	3	0	8	3	10
16. Chess or Checkers	E	33	13	3	9	0	0
	L	23	10	3	7	3	10
17. Shoot Pool	E	34	8	5	6	5	0
	L	25	11	3	6	1	10
18. Classical Music	E	3	12	3	20	21	0
	L	4	7	5	12	17	10
19. Popular Music	E	4	11	3	28	17	0
	L	5	5	3	16	7	10
20. Western Music	E	27	12	2	12	14	1
	L	22	11	4	7	2	10

From Gunderson, personal communication 1967.

Enlisted personnel show relatively little interest in reading religious material, whereas civilian personnel exhibit a slight bimodal characteristic concerning religious reading. In contrast to civilian personnel, enlisted personnel display a higher incidence of interest and participation in study courses. Neither group apparently has much interest in painting, drawing, or "happy hour." There is a marked difference in musical preference. Civilian personnel are more interested in classical music, whereas enlisted personnel prefer western music, particularly during the period of late winter. Contrasting musical preference can lead to potential problems as exemplified by Gunderson's statement that the medical director at one of the stations having listened to western music for months violently smashed the recorder to avoid listening to such music[2]. Implication for long term space flights from the above findings are as follows:

(1) From early to late confinement periods a vast change in activity preferences is not evident.

(2) Study courses appear to have less appeal for civilian personnel than for military personnel.

(3) Use of the ham radio and letter writing generally indicative of personal communications, is reduced over time but was attributed to artifacts of the situation and not a reduced need for communication.

(4) Availability of fictional material seems to take precedence over biographical and religious reading material.

(5) Technical material is appropriate to both classes of personnel.

(6) Free time activities, such as chess, checkers, cards, "happy hour", painting and drawing, and physical exercise seem to be less important than one might expect.

2/ Personal communication, 1967.

(6) The military and civilian personnel differ in musical preference; this may be a consideration for selection of crew members or presentation of music in space missions.

Navy Findings

Possibly the philosophy that men are to be kept busily engaged in work activities during long duration space missions was adopted from the manning and work concept aboard Navy ships. The work week aboard ship is frequently in excess of 70 hours for watch standers. On the other hand, very little off duty time is allocated in the Navy's standard work week afloat. The standard work week for a destroyer (DDG-2) is presented in Table XIV. As seen in the table, 18 hours during a six day work week are allocated to personal needs, including free time; however, time allocated to other work includes service diversions, which in turn includes activities relatable to off duty time, such as visiting the ship's store and post office. Note that Sunday is a non-work day except for those who are standing watch. With the exception of some service oriented operations, such as restaurants and transportation, Sunday off is standard procedure for most work situations reviewed. Even where there is adequate opportunity to reflect the adage, "a busy man is a happy man", there is still a reasonable amount of free time aboard ship. More specifically, there is more off duty time available aboard ship than would appear to be present in the design goal time schedules viewed in the various missions.

Space Simulation Studies

Although only one space simulation study to date has dealt directly with off duty time activities (25) the topic has been covered in a number of studies. Most studies point out the need to select activities to relieve boredom (10, 13).

TABLE XIV

NAVY STANDARD WORK WEEK AFLOAT

AT SEA

(Six Day Work Week)

WATCH STANDER		NON-WATCH STANDER
168	Total Hours Available	168
48	Sleep	48
12	Messing	12
18	Personal Needs	18
56*	Watch *	0*
18*	Other Work * (includes service diversions, productivity allowance and training)	48*
0*	Available for cross utilization in watch standing where appropriate*	18*
16	Sunday (Non-work)	24
168		168
74*	Total Work Week (Work & Watches) (Includes Training)	66* Hours

*Included in computation of maximum work week hours.

From Personnel Research Laboratory, personal communication, 1967.

Two Soviet scientists, Kuznetsov and Lebedev (25) studied the problem of non-regulated activity in prolonged isolation with sensory deprivation. They indicate that prior to the experiment many of the subjects mistrusted their ability to productively use free time. The subjects were given crayons, paper, wood, and a knife. Initially, they were inactive, but by the second or third day they were spending their off duty time in a variety of ways: singing, whistling, writing stories and poems, drawing and building structures and toys with the wood and other available materials. The subjects adapted well, and the writers indicated that the activities performed were closely related to the personal psychology of each subject. Activities evolved toward collective as opposed to individualistic actions, expressed by gifts made for friends. The experiment ran for 10-15 days with a 4-hour period each day devoted to a specified program. The principal point to note is that this is the only study directly related to free time activities in a confined, small group. Thus, there is indeed a need for further study before definite answers relative to off duty time and activities can be established.

The American space simulation studies which have indicated an awareness of the problem include the Boeing Manned Environmental System Assessment study (7), Cramer and Flynn (10), Grodsky and Bryan (13), Hagen (17), and Adams and Chiles (2). Adams and Chiles (2) allocated 18% of the time, or 4-1/3 hours to off duty activities including reading, playing cards, and relaxing. Actually, the range of off duty time was from 3-6 hours. Hagen's (17) solution was to avoid interaction in off duty time if crew problems exist. This study dealt with two Air Force pilots who were confined in a space capsule simulator for a 30-day period. Grodsky and Bryan (13) suggest a music system to relieve boredom during their Lunar mission simulator studies with NASA test pilots. Cramer and Flynn (46) indicate that monotony is a great problem in the extended SAM (School of Aviation Medicine) 2-man space capsule simulator study. They noted that the off duty time activities of their subjects evolved around day-dreaming, reading, and drowziness. The

DOCUMENT RELEASE FORM

DOCUMENT TRAVELER NO. ______

TITLE: ______

______

ORIGINATING ORGANIZATION: ______

CONTRACT OR GRANT NO.: ______ ORIGINAL DOCUMENT NO.: ______

SECURITY CLASSIFICATION OF DOCUMENT: ______ DATE OF DOCUMENT: ______

TO BE COMPLETED BY RESPONSIBLE PROGRAM OFFICE OR ITS DESIGNEE

Completion of this form will provide the Scientific and Technical Information Division with guidance concerning announcement and distribution of the document identified above. Please return this original form and the document, if attached, to, Code ATSS-AC.

I. PUBLIC ANNOUNCEMENT AND DISTRIBUTION

☐ **Announce in STAR** (Items announced in **STAR** are made available to the general public. No limitations on distribution.)

II. LIMITED ANNOUNCEMENT AND DISTRIBUTION

A. ☐ **Announce in CSTAR** (Items announced in **CSTAR** may be security classified or unclassified. If security classified the document will be released only to those having a proper security clearance and need-to-know.) Please check the appropriate statement below.

- ☐ **U. S. Government Agencies and Contractors Only** (The document contains information that should be used only for purposes of the U. S. Government and its contractors.)
- ☐ **U. S. Government Agencies Only** (The document should not be released beyond Federal agencies.)
- ☐ **NASA and NASA Contractors Only** (The document is to be released only in direct support of a **NASA** contract.)

B. ☐ **Announce in SAB** (Items announced in **Special Announcement Bulletin (SAB)** may be security classified or unclassified. All announcement and distribution of the document will be limited to **NASA** Headquarters Offices and Research Centers.)

III. OTHER

☐ Use this space for any special instructions. ______

______

______

The document described above may be processed by Code ATSS-AC in accordance with the above instructions.

______

Signature of Program Officer or His Designee and Office Code   Date

(SEE REVERSE SIDE OF GREEN COPY FOR GENERAL POLICY REGARDING CONTRACTOR REPORTS)

ATSS-AC USE ONLY

NASA-CR Number ______ NASA-TMX Number ______

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)

FACILITY FORM NO. 545

GENERAL STID POLICY REGARDING NASA AND NASA-SPONSORED DOCUMENTS

It is the policy of NASA that all significant scientific and technical findings of NASA activities, including NASA contracts, sub-contracts, and grants, will be disseminated to the widest practicable and appropriate audience by the Scientific and Technical Information Division, Code ATS.

It is the desire of Code ATS to receive classified and unclassified scientific and technical documents generated by NASA activities expeditiously and automatically in order that they may be placed under a centralized bibliographic control for subsequent retrieval and use in accordance with the desires of the responsible NASA Program Office.

It is the procedure that all reports generated by NASA contractors are introduced into the NASA information system only after appropriate written release has been received from the responsible NASA Program Office or its designee. Any administrative or distribution limitations which may be placed on such documents individually or collectively are fully honored by this office.

Upon receipt of the release authority, the reports are reviewed by this office to determine the type of processing and depth of indexing required to ensure adequate bibliographic control.

Based upon guidance provided by the NASA Program Office, or its designee, classified and unclassified documents that are not intended for internal NASA use only will be, as appropriate, announced in either of NASA's regular abstract journals *Scientific and Technical Aerospace Reports*, *Classified Scientific and Technical Aerospace Reports*, or *Secret Supplement to Classified Scientific and Technical Aerospace Reports*.

Those classified and unclassified documents which the NASA Program Office, or its designee, determines to be for internal NASA use only will be announced in the *Special Announcement Bulletin* which is not released outside NASA.

Boeing Study (7), allocated 2 hours a day to recreation, however, this period was not time shared with other participants, and the most frequent activity was troubleshooting the environmental simulator[1]. Thus, from the limited amount of data presented concerning off duty time, there seems to be little awareness of the problem as it would exist in a long duration mission. However, as most of these studies were 30-days or less, the lack of concern may be appropriate.

Shelter Studies

In the Strobe shelter study (43), 4-5 hours a day for free time activities appeared to be sufficient. One hundred male subjects were confined for 2 weeks, and discretionary activities included exercising, table games, shuffleboard, stereo music, movies, and library service. Also, pinochle, chess, and whist tournaments were held. No one withdrew from the 14-day study voluntarily. The important thing to note is that the 4-5 hours a day for off duty activities is comparable to that found in the general population (Robinson (37) and Ward (45)).

In the Altman, et al study (4) four experimental groups were confined one to two weeks. Their recreational activities included cards, checkers, monopoly, scrabble, pocketbooks, magazines, and comic books. However, more group games, modeling, pencils, pens, and writing paper were suggested. Authors found very little interpersonal conflict during the study. The fact that subjects sought group games is somewhat at variance with the Antarctic findings where group game activity tended to deteriorate over time; however, this may simply be attributable to the short time period of the current study.

An extensive series of shelter studies has been performed by the University of Georgia (18) in which both recreational and religious

1/ Personal communications, Seward Smith, 1967.

activities were found to be positively related to group morale. The most time consuming activities in order of magnitude were sleep, quiet reflection, conversation, and recreation. All of the occupancy studies included recreation and exercise; however, recreation activities were often individual, spontaneous, and informal undertakings of the groups. One of the two week studies offered great variety in entertainment including a square dance, a May-Day celebration, a make-shift circus, a mock wedding, a mock divorce trial, and a farewell banquet. Religious activities tended to boost morale and tended to increase tolerance of the shelterees for each other. The best principle with regard to the religious requirements is to provide for the needs while considering selecting individuals who either practice regularly or who do not practice an organized religion. (The selection recommendation is based primarily on the relationship between adjustment and religious participation in the Antarctic studies (16)).

The results of the shelter studies indicate that participants used the same amount of leisure time as the population in general. Also, there appears to be sufficient creativity among the participants such that individuals are able to provide some of their own discretionary activities. However, it should be noted, that at least in some of the studies, there was a request for additional discretionary activities.

Minuteman Missile Study

Interesting human factor aspects of confinement were examined by Hartman, Flinn, et al (19). The authors observed two civilians for 30-days in a Minuteman missile site where there was minimum opportunity for interaction due to the work/sleep schedule - a factor which may have contributed to interpersonal adjustment. The subjects were both able to combat boredom by using their off duty time constructively with light reading. Recreational items available were correspondence material, technical and non-technical books, a pocketknife and sharpening stone, a chess set and playing cards. The subjects also had a fairly extensive, well-designed isotonic and isometric exercise program. The subjects, who were college graduates, were able to accomplish a great deal of planned study during the test in contrast to findings in Antarctica (40). Also, the study noted that the subjects were preoccupied with the passage of time and attempted to combat boredom by structuring activities and setting intermediate goals for themselves--advice frequently given by individuals who have spent a long time in isolation, for example, Byrd (9). Thus, some principles related to combating the effects of confinement are the establishment of intermediate goals; i.e., give participants something to look forward to, and also provide reasonably structured environment for the long duration space flights.

Laboratory Studies

Among the various laboratory studies on sensory deprivation and confinement, the most notable are the extensive efforts of the Navy Medical Research Institute (5,21,22,41). The Institute is conducting a program of research to study social and psychological factors influencing isolated individuals. Although the institute has not directly examined utilization of off duty time some studies give related findings. For example, in the study of stimulus-seeking behavior by Smith, et al (41), control subjects had access to T.V., radio, music, books, magazines, papers, cards, and the opportunity for conversation, whereas experimental subjects had only the opportunity to listen to boring stock reports. There was a high incidence of abort among the experimental subjects during the 7-day study. Nineteen out of forty confined subjects requested early release compared with one control subject. Furthermore, the confined subjects listened to more boring stock reports when they were presented on days 4 and 7 than the control subjects. Significantly, listening to stock reports after 6 hours in isolation predicted in general, who later would request release. This finding could have implications for the design of selection devices for

13. Religious activities (23)
14. Musical instruments (8)
15. Physical exercise (8)
16. Music (33)
17. Chess and checkers (26)

It is obvious that this list is not inclusive of all activities that should be considered by the designer in the development of off duty time activities. Furthermore, it is questionable that the list is representative of the general or more typical activity requirements.

A study by Eddowes (12) looked into the leisure time activities of aerospace engineering personnel by means of a leisure time activity questionnaire. There were 80 male respondents who averaged 30 years of age and whose education ranged from four years of high school through post graduate training. The rank order of leisure time activities engaged in by the group is presented in Table XV. It should be noted that all of the first 8 ranked activities can be performed in space. However, there would be some restriction in the degree to which some of these activities could be participated in, for example, social activities and manual activities. Almost all (96%) of the activities were of a sedentary nature such as watching T.V., listening to music, talking, writing, reading, cards, chess, study, art, musical and manual activities. All of these activities can be performed during long term space flight with the manual activities requiring changes as a function of weightlessness.

In a second part of the Eddowes survey the subjects rank ordered equipment that would be desirable for a hypothetical space journey. The results of this rank ordering is presented in Table XVI.[1] The results in the table show that the subjects generally selected equipment that was in agreement with their leisure time activities. There was one exception to this, namely, chess, which ranked low as a leisure time activity but high as an item of equipment. If we refer back to the activity

1/ Activities suggested by Eddowes' subjects but not suggested in mission studies include having a pet or garden, photography, art, handicrafts, and sexual responses.

TABLE XV

Rank Order of Current Leisure Time Activities of Aerospace Engineers

Rank	Activity	Relative Frequency (F/N)
1	Reading	.725
2	Television	.300
3	Musical activities	.275
4	Manual activities	.213
5	Playing bridge	.163
6	Educational activities	.150
--	Miscellaneous Work	.125
--	Social activities	.125
9	Traveling and driving	.100
--	Family activities	.100
--	Photography	.100
12	Sports	.088
--	Hunting and fishing	.088
14	Gardening	.075
15	Chess	.063
16	Art activities	.050
17	Playing golf	.038
--	Sailing	.038
--	Solving crossword puzzles	.038
--	Walking	.038
21	Making Models	.025
--	Attending movies & plays	.025
23	All others	.025

From Eddowes (12)

TABLE XVI

RANK ORDER OF EQUIPMENT DESIRED FOR HYPOTHETICAL SPACE JOURNEY BY AEROSPACE ENGINEERS

Rank	Equipment	Relative Frequency (F/N)
1	Books	.925
2	Playing cards	.613
3	Chess	.525
4	Musical instruments	.425
5	Record equipment	.413
6	Handicraft equipment	.313
7	Art supplies	.288
8	Writing supplies	.275
9	Athletic equipment	.263
10	Puzzles & games	.250
11	Photographic supplies	.225
12	Flowers & pets	.063
--	Sex responses	.063
--	Food & drug responses	.003

From Eddowes (12)

preferences by the civilians in the Gunderson study, we find that they too showed a low preference for chess or checkers. This shows the need to determine what people actually do rather than what people think they need in the way of off duty time activities.

Another question asked the subjects dealt with their athletic activity preferences and participation. This information was categorized as to whether the activity was sedentary, non-sedentary, exercise, or energetic. Results are presented in Tables VII, VIII, and XIX. Although none of the athletic activities referred to can be performed in the weightless environment, the data may give some clue to types of sports which may be developed for long duration space flights, for example, space swimming. In the Gunderson study, both enlisted and civilian personnel showed a general disinterest in physical exercise (See Tables XII and XIII). Since exercise is more appropriately a part of the scheduled human support system time and not off duty time, we present this data only to indicate that performance of exercise may present a problem in long duration space flight. Off duty time specialists might be able to help solve that problem through the development of interesting exercise or sport competitions to take the place of routine exercise periods.

Leisure Time Activities Performed "Yesterday"

The Opinion Research Corporation (31) in 1957 conducted a study of the activities people performed "yesterday". A national probability sample of 5,000 persons over 15 years of age was given a checklist of 20 activities and then asked to check the ones engaged in on the previous day. The results of this survey are presented in Table XX. The table breaks up the activity patterns according to age, sex, employment status, car ownership, rural/urban characteristics, region of country, educational attainment, and family income. This breakdown should aid the off duty time specialists in obtaining characteristic activities for potential crew members related to their specific background.

TABLE XVII

RANK ORDER OF PREFERRED ATHLETIC ACTIVITIES BY AEROSPACE ENGINEERS

Rank	Activity	Relative Frequency F/N
1	Swimming	.463
2	Base/softball	.425
3	Football	.413
4	Basketball	.350
5	Tennis	.275
6	Bowling	.263
7	Table Tennis	.238
8	Golf	.213
9	Hiking/Walking	.150
10	Boating/Sailing	.113
11	Hunting/Fishing	.100
--	Badminton	.100
13	Volleyball	.050
14	All others	.050

TABLE XVIII

RELATIVE FREQUENCY OF FOUR CATEGORIES OF LEISURE TIME ACTIVITIES OF AEROSPACE ENGINEERS

Category	Relative Frequency (F/N)
Sedentary activity	.963
Non-sedentary activity	.400
Exercise activity	.150
Energetic activity	.075

From Eddowes (12)

TABLE XIX

RANK ORDER OF ATHLETIC ACTIVITIES
PARTICIPATED IN MOST FREQUENTLY
BY AEROSPACE ENGINEERS

Rank	Activity	Relative Frequency (F/N)
1	Swimming	.288
2	Bowling	.188
3	Football	.175
--	Basketball	.175
5	Base/Softball	.163
6	Table tennis	.150
7	Golf	.138
8	Tennis	.100
--	Hiking/Walking	.100
10	Boating/Sailing	.088
--	Hunting/Fishing	.088
12	Badminton	.063
--	Exercise	.063
14	Weight lifting	.050
--	Water skiing	.050
--	Skating	.050
17	Handball	.038
18	Volleyball	.025
--	Gymnastics	.025
--	Darts	.025
21	All Others	.025

From Eddowes (12)

TABLE XX

PER CENT OF POPULATION ENGAGING IN VARIOUS LEISURE ACTIVITIES "YESTERDAY,"[a] BY PERSONAL CHARACTERISTICS

			Years of Age						Sex and Employment Status			
										Women		
Rank	Activity	Per Cent of All Respondents	15–19	20–29	30–39	40–49	50–59	60 and over	Men	All	Employed	Not Employed
1	Watching television	57	56	57	56	61	56	53	56	57	56	58
2	Visiting with friends or relatives	38	46	41	40	36	33	37	32	42	42	43
3	Working around yard and in garden	33	20	24	33	39	38	42	36	34	27	38
4	Reading magazines	27	31	29	25	25	23	27	25	27	26	28
5	Reading books	18	21	19	17	15	15	21	17	18	16	19
6	Going pleasure driving	17	25	21	18	14	11	11	15	16	16	16
7	Listening to records	14	35	16	14	10	6	6	9	13	15	11
8	Going to meetings or other organization activities	11	11	9	10	11	11	12	10	11	11	11
9	Special hobbies (woodworking, knitting, etc.)	10	11	9	10	10	12	11	8	12	9	14
10	Going out to dinner	8	7	10	8	8	8	6	7	9	12	7
11	Participating in sports	8	26	8	8	7	3	2	8	4	5	3
12	Playing cards, checkers, etc.	7	12	7	6	7	5	6	6	7	6	7
13	None of those listed	7	3	7	8	7	8	9	8	8	10	6
14	Spending time at drugstore, etc.	6	20	7	5	5	3	1	5	3	5	3
15	Singing or playing musical instrument	5	10	5	5	5	3	3	4	4	4	4
16	Going to see sports events	4	7	4	4	4	4	2	5	2	4	1
17	Going to movies in regular theater	3	9	4	3	3	2	1	2	3	4	2
18	Going to drive-in movies	2	6	4	2	2	1	0	2	2	2	1
19	Going to dances	2	8	4	1	1	1	0	1	1	2	1
20	Going to a play, concert, or opera	1	1	2	1	1	0	1	0	1	1	1
21	Going to lectures or adult school	1	1	1	0	2	1	1	1	1	0	1

		Car Ownership		Rural-Urban				Region			
					Urban						
Rank	Activity	Own Car	Do Not Own Car	Rural	Below 100,000	100,000–999,999	1,000,000 & over	Northeast	North Central	South	West
1	Watching television	59	48	56	56	59	56	60	60	51	56
2	Visiting with friends or relatives	39	38	40	42	37	35	36	38	40	41
3	Working around yard and in garden	35	26	43	34	31	23	26	39	32	38
4	Reading magazines	28	20	27	31	28	22	30	24	23	34
5	Reading books	18	19	18	18	18	18	18	16	18	20
6	Going pleasure driving	19	8	15	20	17	15	17	17	16	16
7	Listening to records	13	15	11	13	15	17	14	14	12	17
8	Going to meetings or other organization activities	11	9	11	12	11	9	10	9	13	9
9	Special hobbies (woodworking, knitting, etc.)	11	8	9	11	13	9	11	10	9	12
10	Going out to dinner	8	6	6	8	8	10	8	8	6	12
11	Participating in sports	9	5	7	10	8	9	11	9	6	8
12	Playing cards, checkers, etc.	7	7	7	8	6	7	7	7	6	7
13	None of those listed	6	11	7	6	7	8	6	6	10	7
14	Spending time at drugstore, etc.	6	7	6	5	5	9	9	5	5	6
15	Singing or playing musical instrument	5	5	6	5	4	4	5	4	5	7
16	Going to see sports events	4	2	3	4	5	4	3	4	5	3
17	Going to movies in regular theater	3	4	2	3	3	5	4	2	4	2
18	Going to drive-in movies	2	1	1	3	3	2	1	3	2	2
19	Going to dances	2	2	2	1	3	3	3	2	3	1
20	Going to a play, concert, or opera	1	1	1	1	1	1	1	0	1	1
21	Going to lectures or adult school	1	1	1	1	1	1	1	1	1	0

Continued on following page.

TABLE XX
(cont'd)

Rank	Activity	Educational Attainment of People 20 Years and Older: Less than 8th Grade	8th Grade	High School, Incom-plete	High School, Complete	College	Annual Family Income: Under $3,000	$3,000–4,999	$5,000–6,999	$7,000 and over
1	Watching television	51	56	59	61	55	47	60	59	59
2	Visiting with friends or relatives	38	35	40	38	36	39	38	38	39
3	Working around yard and in garden	35	36	34	35	37	35	30	33	34
4	Reading magazines	12	19	24	29	40	23	25	27	33
5	Reading books	12	15	15	15	30	20	16	18	20
6	Going pleasure driving	10	11	17	18	18	13	17	18	17
7	Listening to records	8	8	11	11	13	13	12	14	15
8	Going to meetings or other organization activities	11	8	9	11	14	11	10	10	11
9	Special hobbies (woodworking, knitting, etc.)	9	9	11	11	11	8	12	11	11
10	Going out to dinner	5	6	7	9	12	6	7	7	12
11	Participating in sports	3	4	5	7	9	3	8	10	11
12	Playing cards, checkers, etc.	5	7	7	6	7	5	6	8	8
13	None of those listed	13	9	7	6	5	10	8	5	6
14	Spending time at drugstore, etc.	3	3	6	4	4	5	6	7	7
15	Singing or playing musical instrument	3	3	4	4	7	5	4	5	4
16	Going to see sports events	1	3	4	4	4	3	4	5	5
17	Going to movies in regular theater	3	2	2	3	3	3	3	2	4
18	Going to drive-in movies	1	1	3	2	1	1	3	3	2
19	Going to dances	2	1	1	2	2	2	2	1	1
20	Going to a play, concert, or opera	1	1	0	1	1	1	1	1	1
21	Going to lectures or adult school	1	0	1	1	1	0	1	1	1

Source: "The Public Appraises Movies," *A Survey for Motion Picture Association of America, Inc.*, Opinion Research Corporation, Princeton, New Jersey, December 1957, Vol. II.

a. Day prior to that on which respondents were visited.

From Opinion Research Corporation (31).

Atypically, a large number of respondents indicated they were working around the yard or in the garden, unfortunately, the time of year was not reported. Possibly, from the frequent mention of gardening, we may have a sample of the first warm days of Spring, during which there is an unrepresentative amount of gardening activity. Perhaps the survey was performed on the weekend when one might expect frequent mention of yardwork and visiting friends or relatives. Activities reported which have not been suggested for long duration space flight include garden work, pleasure driving, participating in sports, witnessing sports events, dining out, and going to a drive-in movie. Obviously, pleasure driving, dining out, and drive-in movies are not possible in space.

In summary, there has been some limited amount of thought given to the problem of discretionary activities. However, there is a need for careful examination of possible activities; consideration should be given not only to activities people think they might like to perform but to what activities participants, particularly confined individuals, are most likely to perform. This is exemplified most dramatically by the fact that none of the mission studies mentioned conversation as a key off duty time activity, while actually it would appear to be the most time consuming activity. Also, care should be taken to avoid the trap of selecting activities that readily come to mind, such as chess and checkers, and certain card games. Furthermore, in contrasting the activity data for the isolated Antarctic group with the general population there appears to be a marked difference in the time participation and in the types of activities performed.

CHAPTER IV
OFF DUTY TIME IN THE DEVELOPMENT OF LONG DURATION MISSIONS

This chapter recommends ways of optimizing available off duty time periods and utilization in long duration missions. Since the actual off duty time in mission studies is excessive when contrasted to all other groups studied, suggestions for reducing the time are developed. The suggestions were developed around the impact of excessive off duty time on total mission planning. In addition, a list of discretionary activities, together with their probable utility by the crew, is presented.

SECTION I: SUGGESTIONS FOR REDUCING OFF DUTY TIME IN MISSION TIME LINE DEVELOPMENT

Guidance in reducing or handling excessive off duty time during the deep space phases will be developed in this section. Consideration will be given to such factors as crew size, crew composition, mission day and week length, selection requirements, use of pharmacological agents in depressing the excessive off duty time periods, and hardware and energy requirements for the spacecraft.

Crew Size

To reduce excessive off duty time in the development of a mission, the focal point should be crew size. As has been indicated, crew size is normally determined in relation to short term highly critical phases of the interplanetary mission. Not only do these highly critical phases require a certain number of personnel, but the skill levels of these personnel also have to reasonably high. This skill level is the inverse of what might be desirable for the extended space phases of the mission. Thus a careful analysis of manning the highly critical phases is required. All possible means should be employed to try to reduce both crew size and crew skill level requirements to permit a more uniform workload throughout the total mission. This is not to say that a heavily demanding work schedule will not be required during the critical phases of the mission. In order to accomplish the mission objectives, crew members must be willing to extend themselves (and evidence suggests they can) during these short duration phases such as the Venus Fly-By and the Mars Exploration. More specifically, one should look at the design of the work activities during these time phases to determine the extent to which (1) they can be carried out by fewer personnel with the support of automatic and semi-automatic systems in the collection and analysis of relevant information and (2) demanding work schedules can be imposed for short periods of time. Hardware system developments for the space craft including more automatic monitoring, and fault isolation and correction during the critical phases of the mission should be given additional consideration to free personnel from the orbiting vehicle to assist where necessary in surface exploration. Priority consideration should also be given to the use of auxiliary unmanned vehicles to assist in data collection and analysis under the guidance of the manned module. All possible means to reduce the crew size should be studied. Reduction in crew size for the heavy work portions will increase work opportunities for a smaller crew during the deep space portions.

Length of Day

There is no demanding reason why a 24-hour mission day should be the standard. There is obviously physiological acclimation on the part of the crew members for a 24-hour day; however, most, if not all, individuals can with time acclimate to a different diurnal cycle. By reducing the length of the mission day, activity scheduling can become more proportionate to the activities that are performed on Earth. Also, by reducing the day length we also reduce the number of times per day that onerous tasks such as exercise and crew medical and psychological monitoring are required. Furthermore, there will be a decrease in the overall off duty time over the length of the mission by increasing personal hygiene time requirements. For example, shaving once a day will probably be performed no matter what the length of the mission day is.

One interesting alternative to the current 24-hour day for space travel is related to making the number of hours of sleep required in space proportional to the length of the space day. That is, if 6 hours of sleep are required in space in contrast to 8 on Earth, then, possibly, three-fourths of the 24-hour day or 18 hours might be an optimum day length to consider. This reduction in day length would decrease the off duty time available to less than 6 hours, somewhere in the neighborhood of the free time available to the men in the general population.

One of the arguments against a decrease in day length is related to the increase in number of mission days. One of the activities that the crew members are almost sure to do is perform an accounting of the number of days remaining before a significant event occurs. Thus, by reducing the length of the day we increase the number of days between significant events. Whether the reduction in the amount of off duty time in a given day is sufficient to overcome the problem of being faced with an extended number of days is difficult to ascertain. Another argument against the reduction in day length is related to the fact that there is no Earth precedent for the reduced day. Although this is true, it is only through Earth orbital research that we will be able to obtain an adequate appraisal of whether the 24-hour day is a requirement for space travel.

In summary, if there is a reduction in the number of sleep hours required and if there is only a certain amount of time in which crew members can satisfactorily perform work activities, then, a definite consideration should be given to reducing the number of hours in the mission day. It is our contention that they key to mission day length should be the ability to keep the crew member meaningfully occupied--a task that would be extremely hard to accomplish if there were 10 or more hours a day for discretionary activities.

Length of Work Week

Current mission studies have suggested a 7-day work week; however, lack of sufficient work opportunities and data from both general and special populations support a 5 or $5\frac{1}{2}$ day work week. The latter; i.e., 5 or $5\frac{1}{2}$ days, is suggested. This suggestion applies only to those activities that can be scheduled on a 5-day basis. It is also not suggested during the heavy work activity periods such as preparation for Venus and/or Mars Fly-By and preparation for and exploration of Mars. The main reason for suggesting the 5-day work week is the precedent for such a week in our society which all of the previous time activity surveys would tend to indicate (11, 31, 37, 38, 45). Furthermore, one of the crew recommendations of the thirty day Boeing study (7) was to have a day simulating Sunday to break or relieve the monotony. Finally, a break in the mission week will increase the work opportunities during the work week while permitting a more Earthlike schedule.

Personnel Selection

One possible way to handle excessive off duty time is to develop selection criteria that consider the ability of candidates to handle off duty time. Individuals differ in their ability to cope with free time. As has been shown in the Antarctic studies (16), individuals who have needs of a gregarious, outgoing social nature when compared with individuals less inclined in this direction, generally do not adapt well, have higher incidents of abnormal symptoms, and perform poorly. Therefore, the guideline is to select people who can handle the inordinate amount of off duty time available in the confined quarters of the spacecraft.

Use of Drugs and Time Depressants

Another approach to handling the free time of the deep space portions has been suggested from time-to-time, namely, the use of drugs and other time depressants. Both the interest in and advisability of such an approach waxes and wanes; however, serious consideration should be given to knowing what the advisability of the alternatives are, if, in fact, such an approach should become warranted.

Spacecraft Energy Capability

Most of the above approaches to handling the off duty time problem have been centered around the man and his abilities. One other approach is to reduce the length of time in the deep space portions of the mission, by increasing the propulsion capability of the spacecraft. During the time frame for which these studies are being developed it is quite possible that advances in the technology of propulsion systems may enable the reduction of time required for deep space flight, thus alleviating, at least to a certain extent, the problem of off duty time.

In summary, several considerations have been presented for reducing real or apparent off duty time for long duration missions. These (and other alternatives) to reduce time should be fully explored before the design of discretionary activities is considered.

SECTION II: POTENTIAL DISCRETIONARY ACTIVITIES

Lists of activities that are feasible in space were generated based upon an analysis of habitability and crew problem areas in relatable isolated groups. Consideration was given to selecting activities that are positively related to crew well-being and performance. Tables also present the frequency of use of suggested activities based upon the following scale: (5) daily; (4) a few times a week; (3) weekly; (2) a few times a month; and (1) a few times a year. Furthermore, estimates concerning the probability that one or more crew members would use the activities is given in probabilities of .1, .25, .5, .75, and .9. These estimates were based upon the use of the activity or related activity by the various groups studied during the course of this contract. The estimates are presented as a rough guide to selecting activities and should be supplemented as a function of further developments of discretionary activities in space, or from discretionary activity profiles of potential crew members.

The activities have been categorized into intellectual (Table XXI), religious (Table XXII), social (Table XXIII), and physical (Table XXIV). These tables have been further divided into activities that can be performed by individuals and those that can be performed by groups. Although the list may not be inclusive, it lists more than twice the number of activities that have been found in the review of almost 400 sources.

TABLE XXI

Potential Intellectual Discretionary Activities for Space Flight

Activity	Crew Utilization p	Crew Utilization f
Individual		
Mission related.		
Preparation for operation	.9	4
Preparation for experiment	.9	4
Analysis of data	.9	4
Update mission requirements	.9	2
Personal Improvement		
Advancement in grade	.75	4
Course work for (advanced) degree	.5	4
General course work	.5	3
Writing dissertation	.5	5
General communication		
Mission reporting	.9	5
Personal diary - personal use only	.25	4
Personal diary - future or current public use	.25	4
Write articles relative to mission	.25	3
Personal communication		
Private communication - personal secure data link	.9	4
Family stereo theatre - family get-togethers	.25	4

f = frequency of use of suggested activities: (5) daily; (4) a few times a week; (3) weekly; (2) a few times a month; and (1) a few times a year.

p = probability that one or more crew members would use the activity given in probabilities of .1, .25, .5, .75, and .9.

TABLE XXI
(cont'd)

Activity	Crew Utilization p	Crew Utilization f
Individual (cont'd)		
Entertainment		
Watching television	.9	5
Watching movies	.9	4
Listening to radio	.75	4
Musical activities		
Listening to music	.9	4
Making tape (voice or music)	.1	4
Playing a musical instrument	.25	2
Music arrangement and composition	.1	2
Electronic music composition	.1	2
Reading		
Reading books - fiction	.9	4
Reading magazines	.75	4
Reading newspaper equivalent	.75	4
Reading books - non-fiction (except technical and religious)	.50	2
Professional activities		
Reading journals, technical books	.75	3
Writing technical papers, books	.25	2
Presenting technical papers at conferences	.1	2
Group		
Mission related		
Discuss current mission objective	.5	3
Discuss failures	.5	3
Writing books and articles	.25	2
Group diary	.25	3

TABLE XXI

(cont'd)

Activity	Crew Utilization p	Crew Utilization f
Group (cont'd)		
Musical activities		
Writing	.1	3
Arranging	.1	3
Band	.25	3
Listening	.5	4
Criticism and discussion	.1	1
Educational		
Tutorial - on board expert	.25	4
Pre-programmed courses	.5	3
Developed during mission	.25	3
Communications		
Mission control	.9	4
Personal interest group	.5	2
Professional organization	.25	1
Technical paper presentation	.25	1
Writing books and articles	.25	2

TABLE XXII

Potential Religious Discretionary Activities for Space Flight

Activity	Crew Utilization	
Individual		
Reading material	.25	2
Religious	.25	
Special religious communications	.25	1
Religious rites handbook	.5	1
Religious exercise	.25	3
Radio/TV presentation of religious exercise	.25	1
Group		
Denominational service	.1	2
Non-denominational service	.25	3
Inter-faith (group) discussion periods	.1	1
Crisis services - death, sickness, hazard	.75	1
Bible and religious reading	.25	1

TABLE XXIII

Potential Social Discretionary Activities for Space Flight

Activity	Crew Utilization p	Crew Utilization f
Individual		
Personal communication with family, friends (writing letters)	.9	4
Personal reflection - daydream	.9	5
Joining in family activities	.75	3
Video shopping tours	.75	1
Doing nothing	.9	4
Cat-nap	.75	3
Ham radio	.9	3
Games:		
Solitaire	.9	5
Puzzles	.5	1
Autobridge	.1	2
Group		
Talking sessions	.9	4
Parties: birthdays, New Year's, anniversaries	.9	1
Special events - personal, national	.9	1
View and discuss sports	.75	4
Discuss viewed material (play, lecture, news)	.9	4
"Happy Hour"	.5	2
Contact with Earth organizations	.5	1
Shows and skits	.1	1
Gambling: sports events, political events	.75	2

TABLE XXIII
(cont'd)

Activity	Crew Utilization p	Crew Utilization f
Group (cont'd)		
Clubs:		
Stock market club	.25	2
Literary discussion club	.1	2
Space mission opportunity - market and control of the experience Space, Inc.	.75	3
Games:[1]		
Acey-Ducey	.1	1
Bridge	.5	2
Cards	.5	3
Charades	.25	1
Checkers	.25	2
Chess	.25	2
Cribbage	.1	2
Crossword puzzles	.5	3
Electronic shooting range	.25	3
Electronic sports games	.25	2
Intellectual games	.25	1
Monopoly	.25	1
Puzzles	.75	3
Scrabble	.5	2

1/ The list of games is not intended to be exhaustive, only representative of likely games. A more comprehensive list of games and sources of information on games is presented in references 28, 29, and 44.

TABLE XXIV

Potential Physical Discretionary Activities for Space Flight

Activity	Crew Utilization	
Individual		
Personal effects		
Store for personal articles	.75	4
Personal living area change	.9	3
Reconfigure	.25	1
Redecorate	.25	1
Repair	.75	2
Personal belongings		
Keeping things in order	.9	4
Clean house	.25	4
Exercise program	.9	5
Space walk	.5	3
Manual		
Handicraft	.25	2
Art: Paint-draw	.25	2
Group		
Living quarter habitability		
Sleeping quarters swap	.1	1
Reconfigure group activities area	.5	2
Exercise		
Cooperative exercise program	.9	5
Competitive exercise program	.5	5
Group space walks	.5	2
Space sports	.75	4
Special eating: Sunday dinners, special occasions	.75	3

APPENDIX A

SCHEDULED ACTIVITIES AND OFF DUTY TIME IN LONG DURATION SPACE MISSION STUDIES

The best point of departure for evaluating and determining off duty time requirements based upon total mission planning is the completed space flights and those planned for long duration space flight. The completed flights present data relative to certain problem areas, for example, the differences between Earth and space sleep routines. The planned long duration missions present data relative to planned time allocation and utilization.

All mission studies allocated off duty time; however, the rationale behind the allocation was frequently absent. An analysis of some of the time allocations for various classes of long term missions are presented by Brower in the Douglas MORL study (8), Price, et al, 1965, in the Serendipity Final Report of a Study of Crew Functions and Habitability Requirements for Long Duration Manned Space Flights (33), Moran and Tiller in the Aerospace Vehicle Crew Station Criteria Report (27), Douglas in the Mars Contingency Planning (26), Jones and MacRae in the North American Aviation Manned Mars Landing and Return Study (23), and Lockheed's Early Manned Interplanetary Study (35). Representative data of time and activities for the work/rest/sleep for these studies are presented. A review of these data makes it immediately obvious that different planners employ different criteria in incorporating activities that are suitable for performance during the off duty time period. The discrepancy evolves around what activities are scheduled. For example, some of the mission time lines have discrete time for food preparation and consumption, personal hygiene, exercise, housekeeping, biological and psychological monitoring and sleep. Others include certain of these activities in the off duty time period.

In the Douglas MORL studies (8), the time allocation for each man with a 4-6 man configuration is presented in Table A-I. As can be seen from this table, $1\frac{1}{2}$ hours are allocated to rest and recreation; however, there is also a 10% contingency time factor of 2.4 hours per man per day.

TABLE A - I

CREW WORKLOAD AVERAGE DUTY HOURS PER DAY
IN DOUGLAS MORL

Activity	Man-Hours Per Day Each Man	 4 Men	 6 Men
PERSONAL MAINTENANCE			
Sleep	8.0	32.0	48.0
Food Preparation, Eating Cleanup	2.0	8.0	12.0
Personal Hygiene	0.8	3.2	4.8
Rest and Recreation	1.5	6.0	9.0
TOTAL	12.3	49.2 (51%)	73.8 (51%)
STATION OPERATION AND MAINTENANCE	variable	10.0 (11%)	10.0 (7%)
BEHAVIORAL EXPERIMENTS (including re-entry training)	1.0	4.0 (4%)	6.0 (4%)
BIOMEDICAL EXPERIMENTS (including physical fitness)	variable	8.0 (8%)	12.0 (8%)
CONTINGENCY FACTOR (10%)	2.4	9.6 (10%)	14.4 (10%)
TOTAL		80.8 (84%)	116.2 (80%)
TOTAL man-hours available/day		96.0	144.0
Man-hours/day remaining for engineering and scientific experiments		15.2 (16%)	27.8 (20%)

From Brower (8)

No indication is given concerning what is to be done with this time if the contingencies do not arise. With reference to scheduling the off duty time Brower recommends that the activities should not be rigidly scheduled and suggests that the time should be the crew's free choice. The off duty time period occurred at the same time for the entire crew to permit maximum development of the interaction of the crew, if desired. Other points of note are that 8 hours were allocated for sleep, and that there was not a separate breakdown for exercise or housekeeping. Brower apparently included exercise as part of the rest and recreation period since physical conditioning was included in the list of off duty time activities.

Slightly different workload estimates for crews varying from 6-14 men are presented in the Douglas Mars Contingency Mission Planning study (26). The mission under consideration has a nominal launch date of 1975, a duration of about 1,000 days, a stay in the vicinity of Mars of about 500 days, and a personnel compliment of 4 men in the orbiting vehicle and 6 men on the Martian surface (26, page 89). There is also a possibility that the 4 men in the orbiting vehicle will remain in the Mars orbiting module for the entire duration of the mission. From Table A-II it would appear that $1\frac{1}{2}$ hours rest and recreation per day were allocated to each man. (The table actually notes 0.5 hours; however, the calculations for the various crew sizes would seem to indicate that this is a typographical error). Other points of note in this workload table are: (1) that the number of hours of sleep is 7; (2) there seems to be adequate consideration given to the exercise, hygiene, and housekeeping functions as being distinct operations within mission planning; and (3) a 10% contingency factor for the mission day exclusive of mission oriented functions is included. Some additional findings for crew mission time line planning are presented in Figures A-1, A-2, and A-3.

The first thing to note in Figures A-1 and A-2 is that the rest period is not the $1\frac{1}{2}$ hours recommended in Table A-II but 3 hours. Another unusual scheduling feature is the somewhat limited social interaction permitted with some of the schedules.

TABLE A- II

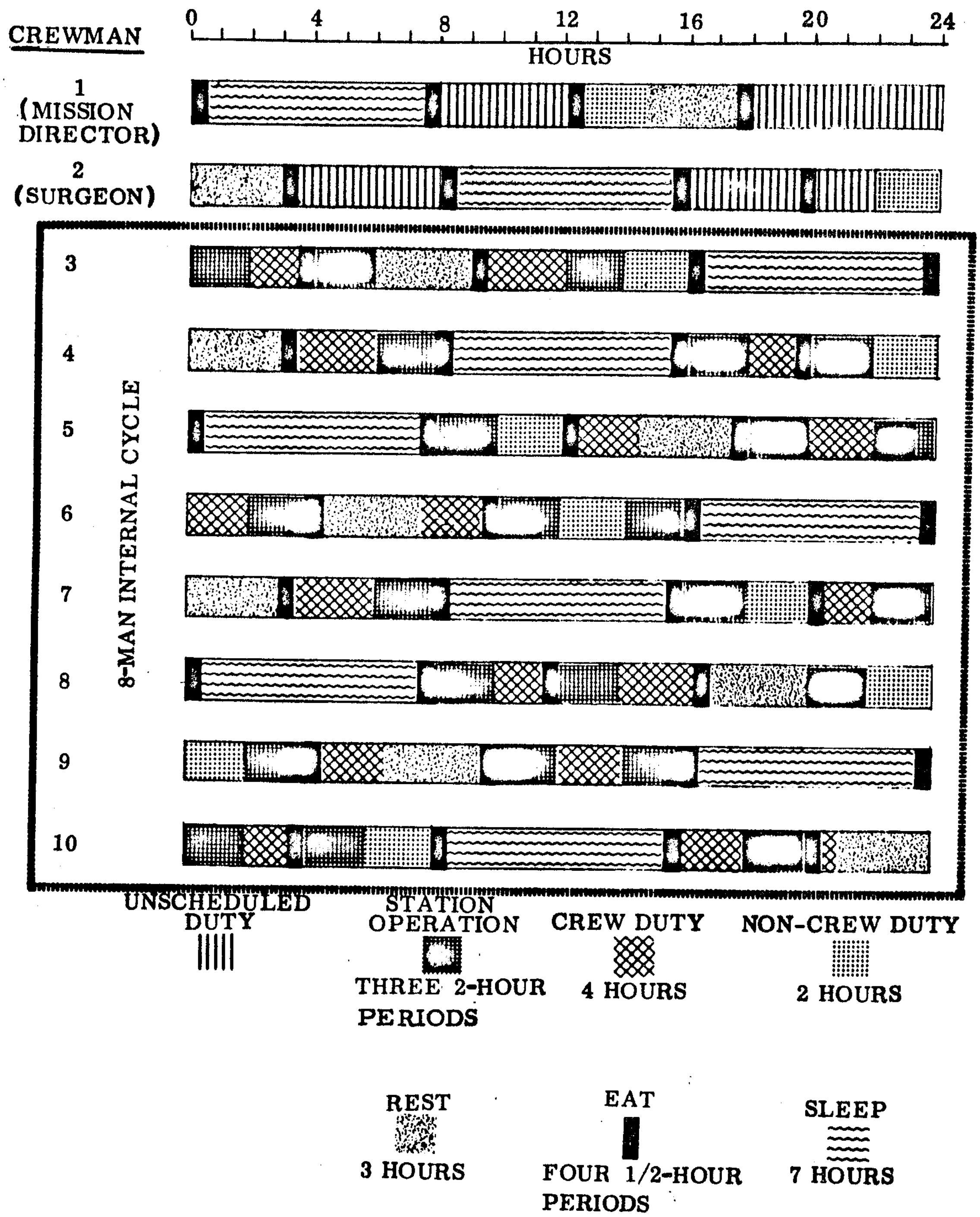
WORKLOAD AS A FUNCTION OF SURFACE CREW SIZE (hr.) IN DOUGLAS MARS CONTINGENCY STUDY

Function	Each Man	Crew Size 3	4	5	6	7	8
Personnel-oriented							
Eating: food input	2.0	6.0	8.0	10.0	12.0	14.0	16.0
Sleep	7.0	21.0	28.0	35.0	42.0	49.0	56.0
Hygiene	0.6	1.8	2.4	3.0	3.6	4.2	4.8
Exercise	0.4	1.2	1.6	2.0	2.4	2.8	3.2
Rest and recreation	0.5	4.5	6.0	7.5	9.0	10.5	12.0
Vehicle-oriented							
Management		24.0	24.0	24.0	24.0	24.0	24.0
Housekeeping		0.6	0.8	1.0	1.2	1.4	1.6
Maintenance		0.9	1.2	1.5	1.8	2.1	2.4
Subtotal		60.0	72.0	84.0	96.0	108.0	120.0
10% contingency		66.0	79.2	92.4	105.6	118.8	132.0
Available for mission-oriented functions		6.0	16.8	27.6	38.4	49.2	60.0

From McKay (26).

FIGURE A-1

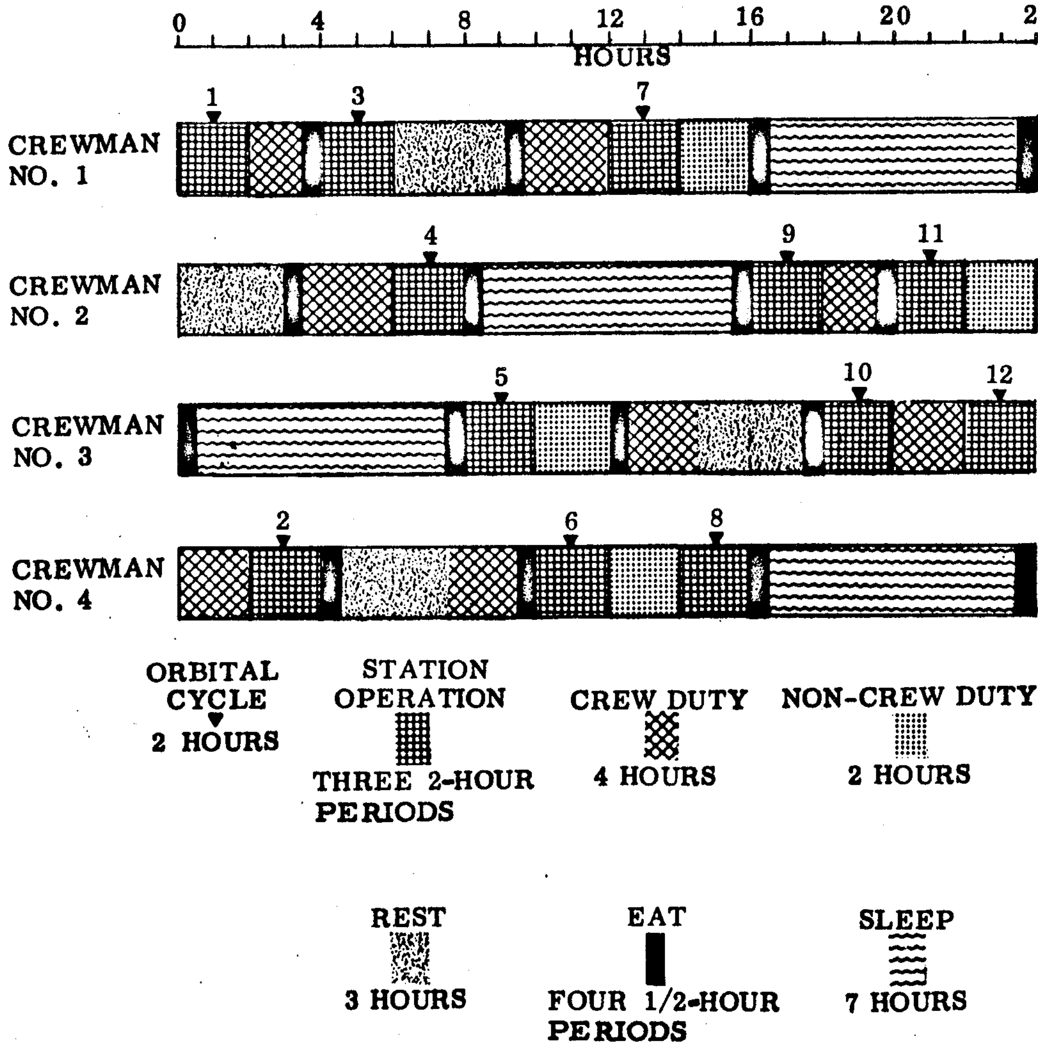
Enroute Work/Rest Cycle for
Douglas Mars Contingency Study



From McKay (26).

FIGURE A-2

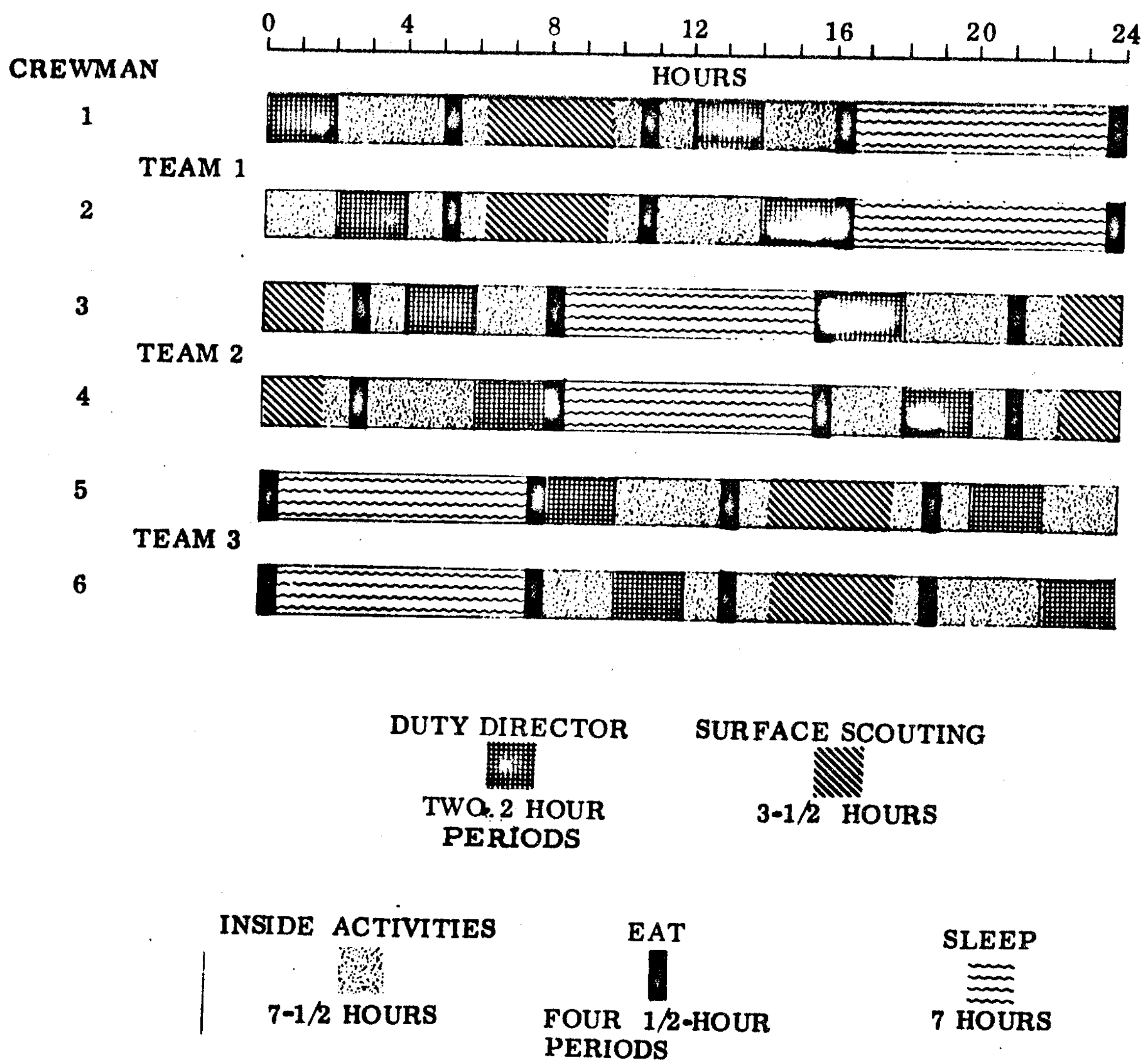
Mars Orbit Work/Rest Cycle for
Douglas Mars Contingency Study



From McKay (26).

FIGURE A-3

Surface Work/Rest Cycle for
Douglas Mars Contingency Study



From McKay (26).

For example, crewman number 10 has his 3 hours of rest at a time period which does not overlap with any of the other crew members. In Figure A-2, not only do the crew members not recreat together, but there is a tendency to also eat alone. This is for a 500 day period. The surface work/rest cycle shown in Figure A-3 does not clearly differentiate the rest and recreation from the other inside activities times so it is difficult to evaluate the interactive processes; however, the team members do eat together. Another possible problem is that the interplanetary 7-hour sleep schedule is retained on the Martian surface for 500 days; however, it may be adequate for the .4g Martian gravity.

The Serendipity analysis of crew functions and vehicle habitability for long duration (450-500 days) space flights (33) allocated approximately 2-3/4 hours to free or off duty time (see Figure A-4). The mission time requirements were developed from a detailed analysis of the activities required for different mission phases. A 7-day work week was assumed for th 3-15 man crew sizes studied for this mission, which is true of all the mission studies reviewed. Another distinct feature in the work/human support cycle is that there were distinct times allocated to exercise, hygiene, medical and psychological monitoring. It should also be noted that there were 7 hours and 41 minutes allocated to sleep per day, per man. Also, three free time periods a day are allocated - a half hour after breakfast and lunch and 90 minutes after dinner. The content of the off duty time period is open to individual choice.

Lockheed, in their Early Manned Interplanetary Mission Study (35), allocates 1.9 hours for recreation. Other things to note in this 3 man, one year Venus Fly-By Mission or the 600-day Mars Fly-By Mission, are that neither the recreation nor the eating periods overlap for any of the crew members (Figure A-5). Also, work is scheduled on a 12-hour day, 7-day week, period. The pattern for the daily schedule is 10 hours on duty, 2 hours off, 4 hours on duty, and 8 hours off. They specify that the 10 hour period is divided among command, maintenance, and scientific tasks in order to reduce the extended periods of vigilance associated with

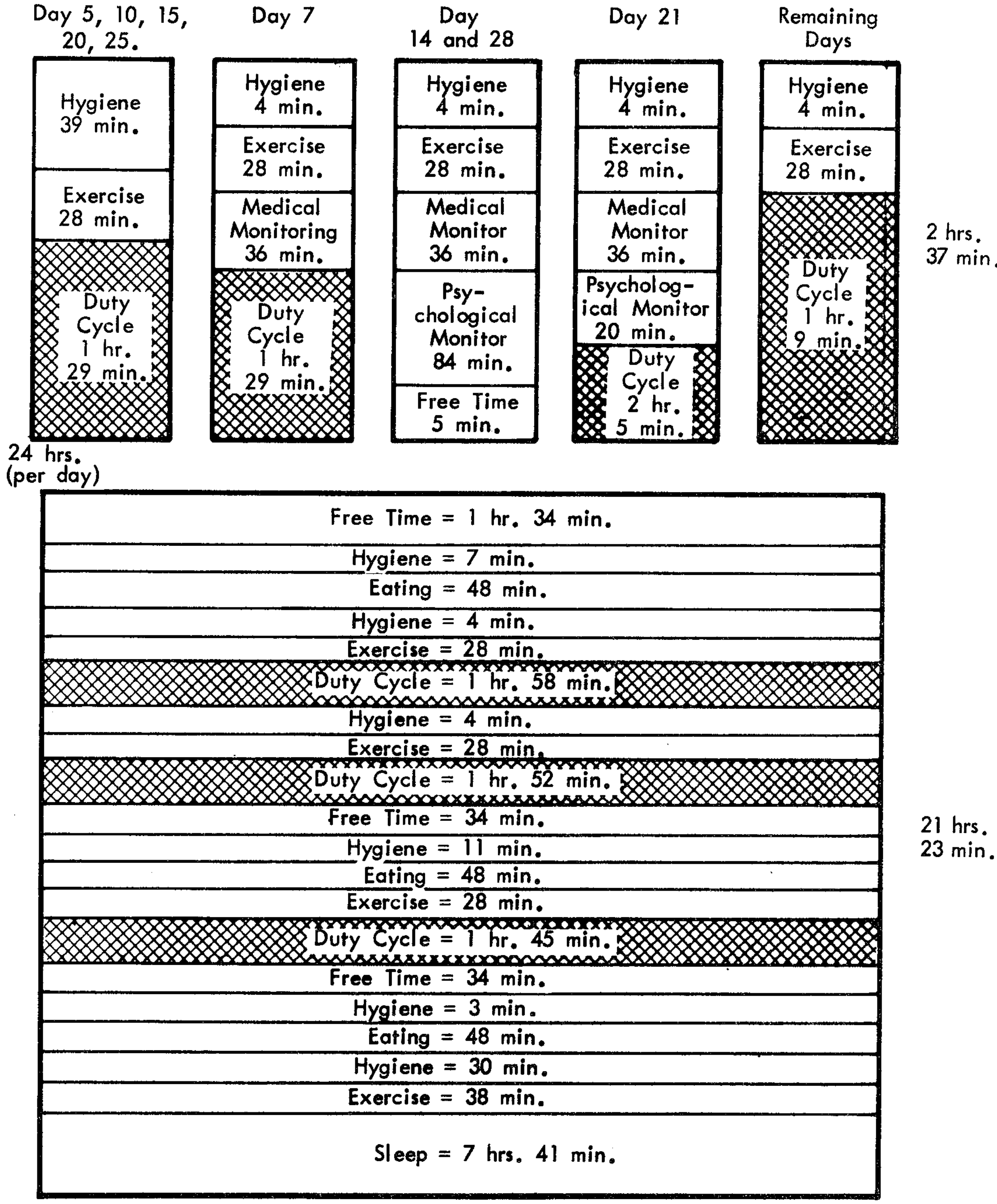


Figure A-4: Work/Human Support Cycle for a Crew Member During a 28-Day Month for Serendipity Mars Landing Study.

From Price (33)

From Lockheed (35)

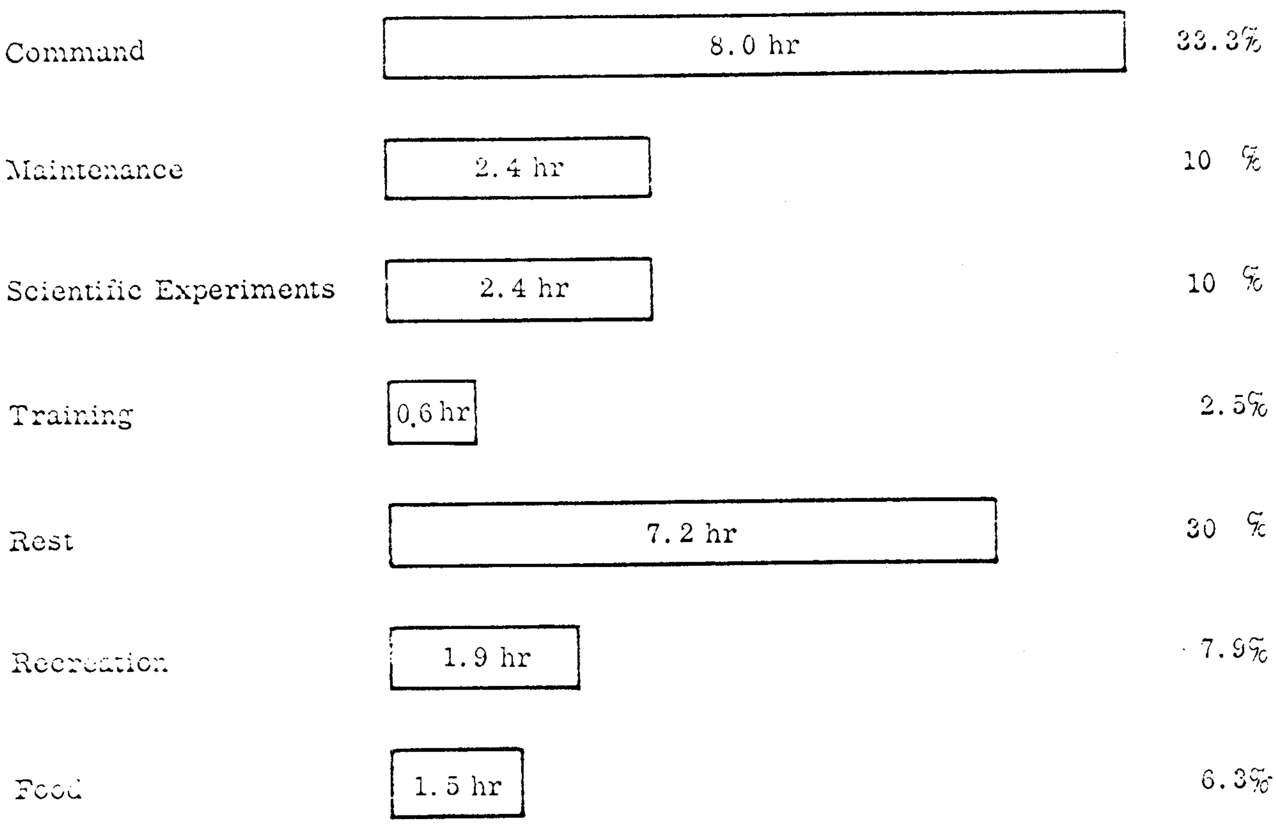
Time	A	B	C
0000	Command	Scientific Experiments	Rest
0100	Command	Food	Rest
0200	Command	Recreation	Rest
0300	Command	Recreation Training	Rest
0400	Food	Command	Rest
0500	Maintenance	Command	Rest
0600	Maintenance	Command	Rest
0700	Scientific	Command	Food Training*
0800	Experiments	Rest	Command
0900	Food	Rest	Command
1000	Recreation	Rest	Command
1100	Training	Rest	Command
1200			

Time	A	B	C
1200	Command	Rest	Food
1300	Command	Rest	Maintenance
1400	Command	Rest	Maintenance
1500	Command	Food Training	Scientific
1600	Rest	Command	Experiments*
1700	Rest	Command	Food
1800	Rest	Command	Recreation
1900	Rest	Command	Recreation Training
2000	Rest	Food	Command
2100	Rest	Maintenance	Command
2200	Rest	Maintenance	Command
2300	Food Training	Scientific Experiments	Command*
2400			

Fig. A 5 Threeman Crew Activities During a Typical 24-Hour Period of Outbound or Inbound Phase of Mission For Lockheed Early Manned Interplanetary Study command duties. Although the sleep period per se is not broken down, a 7.2 hour rest period is allotted to each of the three crew members. The 12 hour work day was suggested to reduce the unwanted effects of extended confinement (35, page 5-23); however, Figure A-6 indicates that 12.8 hours are scheduled for command, maintenance or scientific experiments.

North American's study for a Manned Mars Landing and Return Mission for a 6-man crew does not break out a specific time for recreation although it recognized the need for such a time (23). As can be seen in Figure A-7, a $5\frac{1}{2}$ hour sleep period is allocated. Two $5\frac{1}{2}$ hour duty periods separated by a block of 6 hours are scheduled. Also note that the number 2 scientist's miscellaneous activities period, including recreation, does not overlap with any of the other crew members. In Figure A-8, the three crew members in the Mars orbit do not share any time periods during which miscellaneous activities are performed. However, the three crew members who are part of the Mars excursion team have an Earth-like work/rest/sleep schedule, with a $7\frac{1}{2}$ hour sleep period, a $7\frac{1}{2}$ hour duty period, and an 8-hour miscellaneous activities period, including rest and recreation.

In the AFSC 30-day low orbital requirements by Moren and Tiller (27) three hours a day per man was allocated for recreation and relaxation (Table A-III). This amount was obtained by extracting the recreation time out of leisure time category and relaxation time out of the optional time category found in the table. Under leisure time Moren and Tiller also include one hour a day for exercise and under optional time they also include a two hour standby status time. As in the Douglas studies there is no clear indication as to how the optional standby status would be used if it were not required. It behooves the person responsible for off duty time to determine who is responsible for having activities to perform if the optional time is not required. Other points are that 8 hours a day are allocated for both sleep and work and that there are distinct times for personal hygiene and exercise.



From Lockheed (35)

Fig. A-6 Proportion of 24-Hour Day Spent in Various Activities by Crew Members During Outbound and Inbound Phases of Lockheed Early Manned Interplanetary Study.

FIGURE A-7: Duty Cycle for Trans-Mars and Trans-Earth Phases, 6-Man Crew for NAA's Manned Mars Landing Study.

Commander	Sleep	Duty	Miscellaneous	Duty
Deputy Commander	Duty	Miscellaneous	Duty	Sleep
Operations Crewman #1	Sleep	Duty	Miscellaneous	Duty
Operations Crewman #2	Duty	Miscellaneous	Duty	Sleep
Scientist #1	Sleep	Duty	Miscellaneous	Duty
Scientist #2	Miscellaneous	Duty	Sleep	Duty

0 2 4 6 8 10 12 14 16 18 20 22 24

← Hours →

Sleep - $5\frac{1}{2}$ hours plus 1/2 hour for eating and hygiene.

Duty - S/C operation (navigation, communications, spin-up, etc.)
Scientific observations (radioactivity, meteorological, astronomical)
$5\frac{1}{2}$ hours plus 1/2 hour for eating and hygiene.

Miscellaneous - Maintenance, repair, housekeeping, biomedical and psychological monitoring, physical exercise, training, inventory control, recreation, eating, medical diagnosis and treatment, data analysis, and free time.

From North American Aviation (33)

FIGURE A-8: Duty Cycles for Mars-Orbit and Mars-Excursion Phases for NAA's Manned-Mars Landing Study.

Commander	Sleep	Duty	Miscellaneous	Duty
Operations Crewman #1	Duty	Miscellaneous	Duty	Sleep
Scientist #1	Miscellaneous	Duty	Sleep	Duty
	0 2 4	6 8 10	12 14 16	18 20 22 24

Hours

SLEEP - 5½ hours, plus ½ hour for eating and hygiene
DUTY - S/C operations, Scientific operations 5½ hours plus ½ hour for eating
MISCELLANEOUS - Maintenance, repair, housekeeping, bio-medical and psychological monitoring, physical exercise, training, inventory control, recreation, eating, medical diagnosis and treatment, data analysis, free time.

MARS EXCURSION - 3-MAN CREW

Deputy Commander	Sleep	Duty	Miscellaneous
Operations Crewman #2	Sleep	Duty	Miscellaneous
Scientist #2	Sleep	Duty	Miscellaneous
	0 2 4 6	8 10 12 14	16 18 20 22 24

Hours

SLEEP - 7½ hours, plus ½ hour for eating and hygiene.
DUTY - Communications with MM, Mars surface exploration, lab. analysis. 7½ hours, plus ½ hour for eating and hygiene.
MISCELLANEOUS - Maintenance, repair, report writing, bio-medical and psychological monitoring, physical exercise, training, inventory control, recreation, eating, medical diagnosis and treatment, data analysis, free time.

From North American Aviation (23)

Table A-III - Distribution of Man-Hours (21-Man Crew - 504 Man-Hours Per Day) in AFSC 20-Day Low Orbit Study.

Function	Man-Hours			
	Team 1 (7 Men)	Team 2 (7 Men)	Team 3 (7 Men)	Total (20 Men)
Sleep	56.00	56.00	56.00	168.00
Personal hygiene	7.00	7.00	7.00	21.00
Eating	7.00	7.00	7.00	21.00
Leisure time				
Exercise	7.00	7.00	7.00	21.00
Recreation	7.00	7.00	7.00	21.00
Optional time				
Standby status, emergencies, etc.	14.00	14.00	14.00	42.00
Relaxation	14.00	14.00	14.00	42.00
Assigned duties				
Experimental program				
Safety package	6.54	6.54	24.80	37.88
Engineering Laboratory	1.96			1.96
Physical science laboratory		45.46		45.46
Biological laboratory			21.70	21.70
System operation				
System management	8.00			8.00
Communication	6.00	1.00	1.00	8.00
Monitoring	24.00			24.00
Maintenance	7.00	0.50	0.50	8.00
Food preparation	2.50	2.50	3.00	8.00
Dispensary		5.00	5.00	5.00
Totals	168.00	168.00	168.00	504.00

From Moran (27)

REFERENCES

1. Adams, O. S. and Chiles, W. D.: Human Performance as a Function of the Work-Rest Cycles. WADD-TR-60-248, March 1960.

2. Adams, O.S. and Chiles, W. D.: Human Performance as a Function of the Work-Rest Ratio During Prolonged Confinement. WADD-ASD-61-720, November 1961.

3. Department of the Air Force: Human Relations at AC&W Sites. Part III. Heads of Site Personnel. HR-10. (AD 131870), 1952.

4. Altman, J. W., Smith, R. W., Meyers, R. L., McKenna, F. S., and Bryson, S.: Psychological and Social Adjustment in a Simulated Shelter: A Research Report. (Contract No. CDM-SR-60-10), American Institute for Research, 1960.

5. Altman, I., and Haythorn, W. W. L.: The Ecology of Isolated Groups. Behavioral Science, Vol. 12, No. 3, 1967, pp. 169-182.

6. Berry, C. A., Coons, D. O., Catterson, A. D., and Kelly, G. F., Man's Response to Long Duration Flight in the Gemini Spacecraft. Gemini Midprogram Conference, NASA, SP-121, 1966, pp. 235-262.

7. The Boeing Company: Manned Environmental System Assessment. NASA CR-134, November 1964.

8. Brower, J. D.: Systems Analysis - Flight Crew. Vol. IV of Report on the Optimization of the Manned Orbital Research Laboratory (MORL) System Concept. (Douglas Report SM 46075, Contract No. NAS-1-3612) Douglas Aircraft Company, Inc., September 1964.

9. Byrd, Richard E.: Alone. G. P. Putnam's Sons, 1938.

10. Cramer, E. H., and Flinn, D. E.: Psychiatric Aspects of the SAM Two-Man Space Cabin Simulator. SAM-TDR-63-27, September 1963.

11. deGrazia, Sebastian: Of Time, Work, and Leisure. The Twentieth Century Fund, New York, 1962.

12. Eddowes, E. E.: Survey of Leisure Time Activity -- Implications for the Design of a Space Vehicle. Aerospace Medicine, June 1961, pp. 541-544.

13. Grodsky, M. A., and Bryant, J. P.: Crew Performance During Simulated Lunar Missions. MAR-ER-12693, (N63-10782), Martin Space Systems Division, August 1962.

14. Gunderson, E. K. E., Nelson, P. D., and Orvick, J. M.: Personal History Correlates of Military Performance at a Large Antarctic Station. Report No. 64-22, (AD 609 542), Navy Neuropsychiatric Research Unit, August 1962.

15. Gunderson, E. K. E.: Adaptation to Extreme Environments: The Antarctic Volunteer. Report No. 66-4 (AD 632 571), Navy Neuropsychiatric Research Unit, March 1966.

16. Gunderson, E. K. E.: Adaptation to Extreme Environments: Prediction of Performance. Report No. 66-17 (AD 632 996), Navy Neuropsychiatric Research Unit, April 1966.

17. Hagen, D. G.: Crew Interaction During a Thirty-Day Simulated Space Flight. SAM 61-66 (AD 262 581), June 1961.

18. Hammes, J. A., and Ahearn, T. R.: Shelter Occupancy Studies at the University of Georgia. (AD 653 881), Civil Defense Research, University of Georgia, December 1966.

19. Hartman, B. O., Flinn, D. E., Edmunds, A. B., Brown, F. D., and Schubert, J. E.: Human Factors Aspects of a 30-Day Extended Survivability Test of the Minuteman Missile. SAM-TDR-64-62, October 1964.

20. Haythorn, W. W.: Isolation, Stress and the Design of Closed Ecologies. Paper presented at the Human Factors Society Convention (Anaheim, California), November 1966.

21. Haythorn, W. W.: Project ARGUS 1967: Five Year Review and Preview. Naval Medical Research Institute, August 1967.

22. Haythorn, W. W., and Altman, I.: Personality Factors in Isolated Environments. Chapter 13 in Psychological Stress, M. H. Appley and R. Trumbull, eds., Appleton-Century-Crafts, 1967.

23. Jones, A. L. and McRae, W. V.: Manned Mars Landing and Return Mission Study, Volume III. SID 64-619-3, (Contract No. NAS 2-1408), North American Aviation, Inc., April 1964.

24. Kinsey, J. L.: Report of Psychiatric Studies on Operation Hideout. MRL 230 (AD 646 65), Naval Medical Research Laboratory, July 1953.

25. Kuznetsov, O. N., and Lebedev, V. I.: On the Problem of Nonregulated Activity in Conditions of Prolonged Isolation with Sensory Deprivation. (N66-15007), Problems of Psychology USSR (or Voprosy Psichologii), no. 4, Moscow, 1965, pp. 98-102.

26. McKay, L. M., and Wall, J. K.: Conjunction Class, Manned Mars Trip, Mid-term Progress Briefing. (X65 17107), Douglas Aircraft Corporation, 1965.

27. Moran, J. A., and Tiller, P. R.: Investigation of Aerospace Vehicle Crew Station Criteria. FDL-TDR-64-86 (AD 452 187, Contract No. AF 33(615)-1297), North American Aviation, Inc., July 1964.

28. National Recreation and Park Association: A Guide to Books on Recreation, Eleventh Annual Edition. 1966.

29. National Recreation Association: Recreation Activities for Adults. Association Press, New York, 1950.

30. Nelson, P. D., and Gunderson, E. K. E.: Personal History Correlates of Performance Among Military Personnel in Small Antarctic Stations. Report No. 63-20 (AD 432 145). Navy Medical Neuropsychiatric Research Unit, November 1963.

31. Opinion Research Corporation: The Public Appraises Movies. Volume II. Found in Of Time, Work, and Leisure, Sebastian de Grazia, The Twentieth Century Fund, New York, 1962.

32. Pierce, C. M., Shurley, J. T., Natani, K., and Brooks, R. E.: Sleep and Activity Patterns on the Antarctic Continent. Part I: Summer 1967. University of Oklahoma School of Medicine, Veterans Administration Hospital, 1967.

33. Price, H. E., et al.: Final Report of a Study of Crew Functions and Vehicle Habitability Requirements for Long Duration Manned Space Flights. Volume II. Technical Program (Contract No. NAS 2-2419), Serendipity Associates and Aerojet-General Corporation, August 1965.

34. Price, H. E., et al.: Final Report of a Study of Crew Functions and Vehicle Habitability Requirements for Long Duration Manned Space Flights. Volume III. Technical Appendices. (Contract No. NAS 2-2419), Serendipity Associates and Aerojet-General Corporation, August 1965.

35. Ragsac, R. V., McLaughlin, J. F., Vliet, G. C., et al.: Early Manned Interplanetary Mission Study, Volume I. Summary Report. (Contract No. NAS 8-5024), March 1963.

36. Rathert, G. A., Jr., McFadden, N. M., Weick, R. F., Patton, R. M., Stinnet, G. W., and Rogers, T. A.: Minimum Crew Space Habitability for the Lunar Mission. NASA-TN D-2065, February 1964.

37. Robinson, J. P.: Social Change as Measured by Time Budgets. Survey Research Center, University of Michigan, August 1967.

38. Robinson, J. P., and Converse, P. E.: The Impact of Television on Mass Media Usage: A Cross-National Comparison. Paper read at the Sixth World Congress of Sociology (Evian, France), September 1966.

39. Rohrer, J. H.: Interpersonal Relationships in Isolated Small Groups. Chapter in Psychopsyiological Aspects of Space Flight, B. E. Flaherty, Ed., Columbia University Press, 1961.

40. Rohrer, J. H.: Human Adjustment to Antarctic Isolation. (Contract No. NONR 1530 (07), Office of Naval Research, September 1960.

41. Smith, S., Myers, T. I., and Johnson, E.: Stimulation Seeking Throughout Seven Days of Sensory Deprivation. Perceptual and Motor Skills, Vol. 23, 1966, pp. 1151-1163.

42. Smith, W. M.: Scientific Personnel in Antarctica: Their Recruitment, Selection and Performance. Psychological Reports, Vol. 9, 1961, pp. 113-182.

43. Strope, W. E., Etter, H. S., Goldbeck, R. A. Heiskall, R. G., and Sheard, J. H.: Preliminary Report on the Shelter Occupancy Test of 3-17 December 1959. USNRDL-TR-418 (AD 237 130), May 1960.

44. U. S. Department of Health, Education, and Welfare: Handbook for Recreation. Welfare Administration, Children's Bureau, 1960.

45. J. A. Ward, Inc.: A Nationwide Study of Living Habits. Found in Of Time, Work, and Leisure, Sebastian de Grazia, The Twentieth Century Fund, 1962.

46. Warshofsky, F.: "Mars and Beyond" an Episode in The 21st Century.