NASA Technical Memorandum 101001

NASA Newsletters for the Weber Student Shuttle Involvement Project

E. R. Morey-Holton, P. D. Sebesta, A. M. Ladwig, J. T. Jackson, and W. M. Knott III

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National Aeronautics and Space Administration

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E. R. Morey-Holton
P. D. Sebesta, Ames Research Center, Moffett Field, California
A. M. Ladwig, NASA Headquarters, Washington, DC
J. T. Jackson, Johnson Space Center, Houston, Texas
W. M. Knott III, Kennedy Space Center, Florida

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National Aeronautics and
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Ames Research Center
Moffett Field, California 94035

TABLE OF CONTENTS

Left to right: Pearl Cheng, John Jackson, David Larson, Gerry Antognoli, Francine Salzman, Dan Weber, Bill Knott, Emily Holton, Bill Munsey, Tom Kessler, Jerry Moyer, Gregg Rexrod, Paul Sebesta, Bruce Yost, Al Moreland, Nancy Hannagan, Jerry Goldsboro, Sara Williams.

PREFACE

This document contains biweekly reports generated for the Weber Student Shuttle Involvement Project (SSIP). The reports document the evolution of science, hardware, and logistics for this Shuttle project aboard the eleventh flight of the Space Transportation System (STS-41B) which was launched from Kennedy Space Center on February 3, 1984, and returned to the center 8 days later. The reports were intended to keep all members of the team aware of progress in the project and to avoid redundancy and misunderstanding. Since the Weber SSIP was NASA's first orbital rat project, documentation of all actions was essential to ensure success of this complex project. Eleven reports were generated: on October 3,17, and 31; November 14 and 28; December 12 and 17, 1983; and January 3, 16 and 23; and May 1, 1984. A subject index of the reports is included (pp. 228-229).

The Weber SSIP began in January 1981, when Dan Weber (a junior at Hunter College High School in New York City) submitted a proposal entitled "Effects of Weightlessness on Arthritis" to the SSIP for Secondary Schools which is jointly sponsored by NASA and the National Science Teachers Association. The proposal was one of 10 national winners in the first competition, which was for the 1980-81 school year. Because of the complexity of this experiment, two corporate sponsors were selected: General Dynamics (GD) was tasked to design and develop an animal housing unit and Pfizer, Inc., was tasked to help Weber refine the science for the experiment. The NASA team assigned to this project assisted Dan Weber, GD, and Pfizer, Inc., as requested and made sure all NASA required hurdles were cleared.

The housing unit developed by GD for a middeck locker, called the Animal Enclosure Module (AEM), was designed to house two groups of three rats, each weighing approximately 300g. The first flight of the AEM was a hardware test aboard STS-8 in August-September 1983 (see Smith, M. C., Jr., Johnson, P. C., and Leblanc, A.: Animal Enclosure Module Inflight Test. In Results of the Life Sciences DSOs Conducted Aboard the Space Shuttle, 1981-1986, M.W. Bungo, T.M. Bagian, M.A. Bowman, and B.M. Levitan, eds., NASA-Johnson Space Center, 1987, pp. 75-77, to ensure that the unit would adequately support normal rats. The timelines and contingency planning for the hardware test served as guidelines for the flight of the Weber Project.

The first official meeting of the Weber team was at Johnson Space Center, Houston, TX, on Sept. 21-22, 1983; biweekly reports were initiated following this meeting and NASA's official participation in this project concluded with publication of the final newsletter, May 1, 1984. Some preflight and postflight procedures associated with this project are shown in figure 1 and 2 on the following pages..

The acknowledgements of many persons who were invaluable to this project begin on p. 160. In addition, we would like to thank Cathy Funderburk for her able assistance in reproducing, collating, and bringing this document to completion. Finally, we would again like to acknowledge the student, Dan Weber, who spent many hours of hard work to assure the success of this project. His final report (Appendix) which begins on p. 230 is probably the most complete and extensive of any SSIP project to date.

Figure 1. Snapshots of various phases of preflight preparation for the experiment. The upper left panel shows the inner cages of the AEM with the food bars installed. The bottom left panel shows the AEM. The bottom right panel shows the AEM with cages inserted and ready for flight and the middle upper panel shows the student, Dan Weber, watching the AEM being placed in the air-conditioned truck for transportation to the launch site. Other scenes depict many of the people involved in the AEM flight preparation.

Figure 2. Some postflight analyses performed in the clean room at Hanger L at Kennedy Space Center. The AEM is shown being delivered to the facility and moved into the clean room. The panels on the right show post-flight observations being made of the animals.

Weber Student Shuttle Involvement Project (SSIP)

Newsletters

TO: Weber Team

FROM: Project Manager/Scientist

SUBJECT: Biweekly report, October 3, 1983

This is the first of our biweekly communications. To keep all team members informed of progress, please call or write me with any updates at least every other week. This first communication has many enclosures for your information.

The first enclosure is Appendix A: Results of Animal Experiments. Also enclosed are: 1) information presented for the quarterly flight review at Ames, September 29, and 2) the action items generated at the meeting in Houston, September 22.

Those present at the meeting in Houston included:

Dr. David Larson: Pfizer, Inc.
Mr. Thomas Kessler, Mr. John Crenshaw: General Dynamics
Dr. Thora Halstead: NASA Headquarters
Mr. John Jackson, Mr. Neil Christie, Ms. Laura Staples, Dr. Malcolm Smith, Dr. Phil Johnson: NASA JSC
Dr. Emily Holton, Mr. Paul Sebesta: NASA ARC

Although the meeting in Houston was not scheduled to start until Wednesday, Dr. Wm. Thornton called late Tuesday afternoon to say that he would be out of town the following day, but would be willing to meet with the SSIP team that afternoon. John Jackson, Neil Christie, Laura Staples, Emily Holton, and Paul Sebesta met with Dr. Thornton. Notes from this meeting are attached.

Wednesday morning, the above team (except Drs. Smith and Johnson) met with Dr. Ron McNair, who will be coordinating the experiment aboard STS-11. The majority of the morning was spent presenting an overview of the Weber project to Dr. McNair and answering his questions. Dr. McNair requested a briefing of the entire crew prior to the launch of STS-11.

Wednesday afternoon, inflight pictures of rats were viewed and the group had a brief meeting to discuss all handouts and to prepare for the meeting on Thursday. Thursday was spent discussing all agenda items. From the agenda items, 34 action items were cited and responsible individuals were assigned.

The team prefered to use specific pathogen free (SPF) Lewis, male rats since all preliminary tests had been run on these animals. Also, the cost of barrier derived animals was estimated to be $115/animal and animal maintenance is significantly greater with barrier derived rats. Papers from Charles Rivers would be requested stating that the rats were, indeed, SPF from NASA specified pathogens. Birthdate, shipping weights, and building/room of origin of the rats would be requested from the vendor. Upon arrival at KSC, rats will be housed in groups of three and all animals in a cage will be as close as possible to the same weight.

Although the team would prefer to use water rather than potatoes, the water bottle being designed for the AEM may not be flight qualified in

time for STS-11. We will proceed with use of potatoes until the water bottle is ready. Rats will be placed on potatoes approximately a week before flight and the amount of potatoes consumed during that time will be measured and used as an estimate for flight. By placing the rats on potatoes prior to flight, the novelty of potatoes as a food/water source should be omitted during flight. Studies done at Pfizer suggest that rats on potatoes and lab chow gain weight at the same rate as rats on water and lab chow.

The responsibilities of the various team members include:

Weber:
- Science
- Data Analysis
- Final Report
- Preflight, during flight, and postflight support at KSC/Pfizer
- Other (TBD)

Pfizer:
- Science
- Animal Purchase/Postflight care
- Scientific instrumentation (paw volume/x-rays)
- Data Analysis
- Final Report
- Preflight, during flight, postflight support at KSC
- Blood draws (orbital vein)
- Other (TBD)

General Dynamics:
- Hardware
- Hardware refurbishing as required, eg. air flow, repack filter, etc.
- Preflight, during flight, postflight support at KSC JSC:
- Manifesting for flight/flight operations
- AEM middeck location
- In flight operations/data (schedule/obtain, distribute)
- Science /animal care support
- Scheduling preflight and postflight debriefing sessions with crew
- Contingency plans for non-US landing sites
- Other (TBD)

KSC:
- Animal care/science support
- Microbiology
- Rodent health book (health check list and data, re:food/water consumption, rat weight, etc.)
- Flight operations/recovery
- Other (TBD)

NASA Headquarters:
- SSIP administration/Final report
- Supplemental science
- Publicity Coordination
- Other (TBD)

ARC:

Project/Science management
Science support
Flight operations support/timelines
Contingency plans for US alternate landing sites/
recovery kits
Teklad Diet
Other (TBD)

The team decided that supplemental science should be done but should not impact or compromise the Weber experiment. The opportunities for such science could be provided through behavioral studies, blood studies, and possibly bone, immunological or other studies. A scheme of measurements for the Weber experiment (SE81-10) before, during, and after flight is attached.

ENCLOSURES:

1) Report to Quarterly Flight Projects Review
2) Project Action Items
3) Notes from meeting with Dr. Thornton
4) Table of measurements for SE81-10
5) Directory of SE81-10 team members

APPENDIX A: RESULTS OF ANIMAL EXPERIMENTS

Two major experiments were performed using the rat model simulating certain aspects of spaceflight. Animals on this model system are placed in tail-traction to elevate and unweight the hindquarters and to induce a cephalad fluid shift. Male, Lewis rats approximately 2 months of age were used for these studies. The Lewis strain is extremely sensitive to inoculation with complete Freund's adjuvant in the right paw and will consistently express this sensitivity by developing almost immediately a swelling at the site of injection. Later (1-2 weeks) a systemic inflammation will be manifested by a swelling of the opposite paw; this portion of the disease process is thought to involve the immune system. Other strains of rats do not respond with the consistency and predictability of inflammation noted in this strain.

The results of the two experiments suggest that spaceflight may, indeed, alter the pathogenesis of polyarthritis. The systemic inflammation was significantly less in rats on the model than in corresponding control animals.

The first experiment (Table 1, Figure 1) was performed while Mr. Weber was at ARC. Charles River Lewis male rats were supplied by Pfizer. Animals were injected by Mr. Weber and an assistant. Data from the experiment are found in Table 1 and the relative hindpaw thickness is graphed in Figure 1. Surprisingly, animals on the model showed less swelling in the uninoculated paw than did control arthritic animals, although no differences in the size of the inoculated paw were noted. Also, the data indicated that differences in the uninoculated paw may have merely been reflecting a delayed onset of the disease as paw thickness increased in arthritic unweighted animals the last day that measurements were made. In addition, rats were unweighted seven days after inoculation rather than the recommended nine days and injections and measurements were made by novices. Thus, a second experiments was performed.

For the second experiment, Dr. Larson and his family traveled to Charles River and inoculated the animals immediately prior to shipment of the animals to ARC. In Dr. Holton's laboratory at ARC, animals were unweighted for either one week or three weeks beginning nine days after inoculation. The body mass changes (Figure 2) correspond closely with those noted in the first experiment (Table 1) but in the second experiment a nonarthritic control group was also followed to assure that no technical problems developed during the experiment. Figure 3 shows the paw circumference in all arthritic rats at different times after injection and treatment. The paw circumference in this experiment was measured with a calibrated millimeter tape rather than the micrometer used in the first experiment.

The tape was felt to be more accurate since the paw was edematous and the calipers would depress the paw making the measurement less accurate and more subjective. Thus, paws in the second experiment were measured as circumference whereas data from the first experiment was expressed as relative paw thickness. Since the difference between unweighted and control arthritic rats in the first experiment appeared to be a delayed onset of the disease process, rats with less swollen paws were removed from the model after 7 days. This decision was unfortunate as paws in these animals did not swell after removal from the model and the paw circumference in this group of rats turned out to be significantly less than the paw circumference of the animals unweighted for 16 days. However, these data do demonstrate that the model does not simply delay onset of the systemic disease. X-rays of the paws (see attached and Table 2) showed that unweighted animals did not develop systemic inflammation/joint deterioration to the same degree as control rats although deterioration of the joint at the injection site was similar in all animals. Animals removed from the model at the end of one week showed "protection" from development of the systemic disease. The x-rays show dramatically that lack of swelling is associated with a more normal ankle joint, ie. less bone deterioration.

These data suggest that unloading the rear limbs protects against the systemic inflammation and that after one week animals can be removed from the model and not display a delayed onset of the systemic disease. If the model does simulate flight, then animals launched into space between 7 to 9 days after inoculation of the adjuvant should be more active and have less bone involvement in the arthritic degenerative process than should inoculated ground controls; return to earth should not reactivate the disease process but should, indeed, "protect" against development of systemic arthritis. These findings are new and are presently unpublished. The data were not anticipated and would not have been gathered without the impetus of the SSIP. Mechanisms involved in the "protection" afforded rats on the NASA model system are being pursued by Pfizer, Inc. These preliminary experiments suggest that the hypothesis posed by Mr. Weber may be valid and that the pathogenesis of arthritis may involve a gravity component.

The Weber SSIP, "The Effects of Weightlessness on Arthritis": Progress and Potential

The Weber proposal was submitted in January 1981 and was among 10 national winners of the first SSIP competition. The major hypothesis of this proposal is that the pathogenesis of arthritis involves a gravity component.

Two industry sponsors were necessary for this project: General Dynamics for hardware design and development and Pfizer, Inc. for science. The Animal Enclosure Module (AEM) was successfully flight tested on STS-8. The science of this project has been evolving along with hardware development.

Mr. Weber has spent summers and weekends at Pfizer, Inc. working with Dr. David Larson and refining scientific endpoints of the proposal. He has learned much about experiment design, statistics, and the use of rats for studies on polyarthritis. In conjunction with Dr. Emily Holton, NASA consultant for this project, experiments were performed using the rat model simulating certain aspects of spaceflight. The results of the experiments suggest that spaceflight may, indeed, alter the pathogenesis of polyarthritis. Unweighted animals did not develop systemic inflammation/joint deterioration to the same degreee as control rats although deterioration of the joint at the injection site was similar in all animals. Animals removed from the model at the end of one week showed "protection" from development of systemic disease. These data suggest that unloading the hindquarters protects against systemic inflammation and that after one week animals can be removed from the model and not display a delayed onset of systemic disease.

The SSIP experiment will use 6 rats, 3 healthy and 3 inoculated with complete Freund's adjuvant, in each experimental group. The two experimental groups will include the flight group and the ground controls. Preflight, animal weight, food consumption, water consumption, and paw volume will be measured at least weekly beginning with injection of adjuvant. Left and right paw volume will also be measured with a mercury displacement devise or with a calibrated millimeter tape. One blood draw will be made in all animals prior to flight. This sample will be used for baseline studies of blood parameters associated with the arthritic process. Activity will be monitored since animals move less as the disease progresses. During the flight period, video tapes will be taken to compare the activity of arthritic and control rats both inflight and on the ground. Postflight, a blood draw will be taken for comparison with preflight parameters. Also, preflight measurements will be resumed for at least 3 weeks. X-rays will be taken immediately postflight and again at the end of the 3 week postflight period; x-rays will be examined for joint deterioration and rated according to the extent of deterioration. Preflight monitoring will be done at KSC, but postflight monitoring will be done at Pfizer, Inc. where more sensitive equipment for the measurements exists.

Although the investigators realize that three animals per group is not sufficient for valid statistical analysis, the number is sufficient to determine whether the hypothesis is worth pursuing. Minimal swelling of the left paw, minimal joint deterioration, difference in blood picture, or greater activity in flight rats inoculated with adjuvant as compared to group control inoculated rats would validate the hypothesis and the use of the rat model to predict spaceflight effects. Results from ground based experiments suggest that differences will occur and that the use of three animals will be sufficient to give meaningful data while minimizing the number of animals exposed to the disease process. Noninoculated controls are necessary for comparison and to assure that the flight environment, per se, is not masking or creating artificial differences in experimental groups.

The educational and scientific values of this project make it an excellent candidate for flight.

TABLE I

WEIGHT, gm

Group	n	7/9	7/12	7/14	7/15	7/19	7/21	7/23
AC	7	210±6.9	209±5.9	211±4.8	213±4.7	216±7.8	2o2±8.4	211±7.8
AU	7	211±7.6	212±8.3	210±11.5	215±10.2	219±14.1	215±11.2	213±10.3

RELATIVE HINDPAW THICKNESS

		INJECTED PAW (Right)					NON-INJECTED PAW (Left)				
Group	n	7/13	7/15	7/19	7/21	7/23	7/13	7/15	7/19	7/21	7/23
AC	7	329±26.7	316±28.8	373±26.9	312±24.1	346±42.0	167±9.5	158±15.2	221±34.0	142±4.9	191±6.9
AU	7	357±43.9	317±38.6	361±30.2	301±44.5	326±41.6	167±22.1	153±7.0	179±31.5*	144±15.4	156±14.4*

Adjuvant injected: 7/19/82
Animals unweighted: 7/16/82
Experiment ended: 7/23/82

A=arthritic, C=control, U=unweighted

*=significantly different from control, p at least 0.05

Data expresses as mean±S.D.

TABLE II

BONE DETERIORATION
QUALITATIVE ANALYSIS OF X-RAYS
(ARBITRARY SCALE: 0-10)

Time post arthritic induction		RIGHT (Injected Paw)		LEFT (Non-Injected Paw)
32 days	n		n	
Unweighted (16 days)	7	7.7 ± 1.5	6	2.7 ± 2.3
Unweighted (7 days)	6	8.2 ± 1.8	6	0.5 ± 0.5
Control (single-housed)	5	9.4 ± 0.9	5	5.8 ± 1.3
Control (group-housed)	9	9.6 ± 1.0	9	5.9 ± 2.8
17 days (end of 1 wk unweighting)				
Unweighted (7 days)	7	4.4 ± 1.0	7	0.0 ± 0.0
Control (single-housed)	7	4.9 ± 1.2	7	0.6 ± 0.8
9 days (beginning of unweighted time)				
to be unweighted (7 days)	7	0.7 ± 1.5	6	0.0 ± 0.0
to be unweighted (16 days)	7	0.6 ± 1.0	7	0.0 ± 0.0
Control (single-housed)	7	1.0 ± 1.9	7	0.0 ± 0.0
Control (group-housed)	9	0.6 ± 1.0	9	0.0 ± 0.0

Animal unweighted using tail-traction to elevate and unload hindquarters.

Difference in n are due to incorrect exposure or loss of X-ray resolution.

Data expressed mean ± S.D.

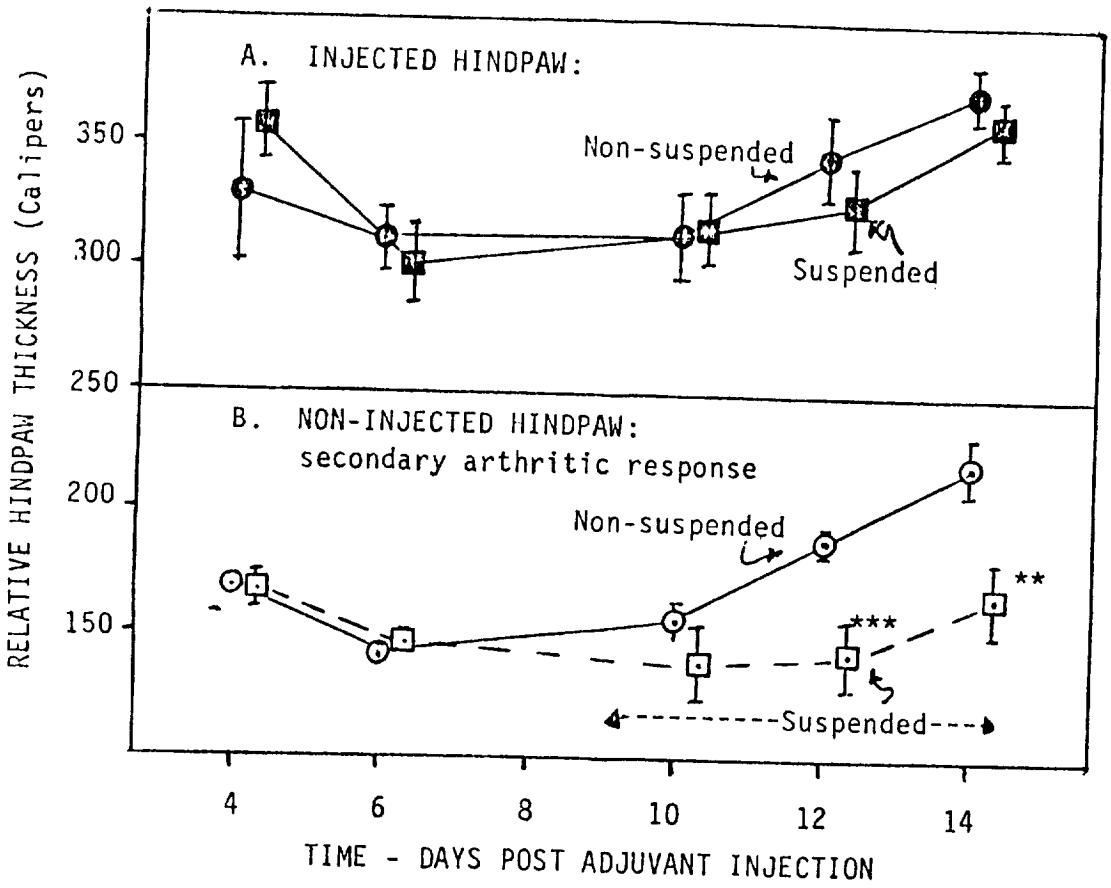
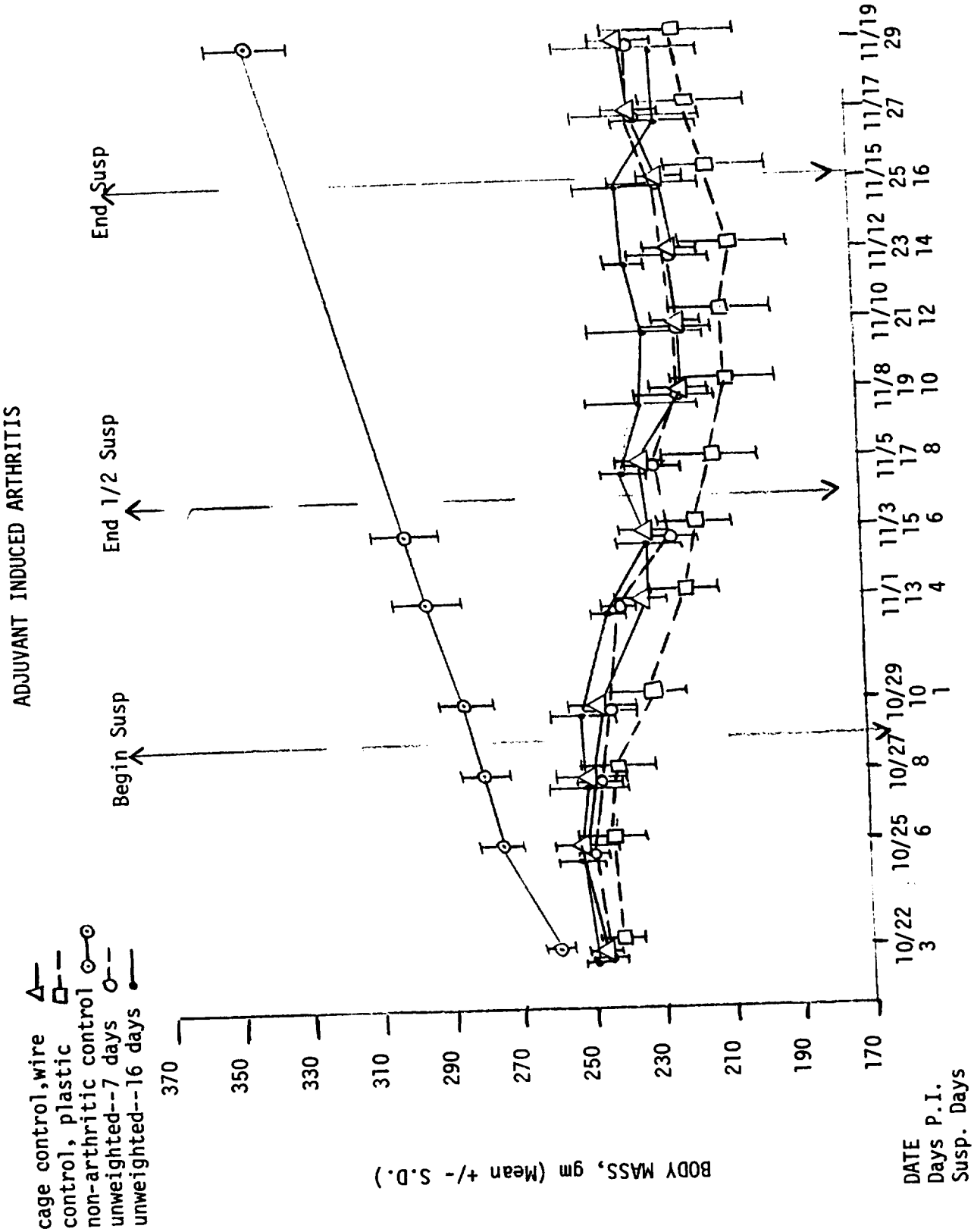
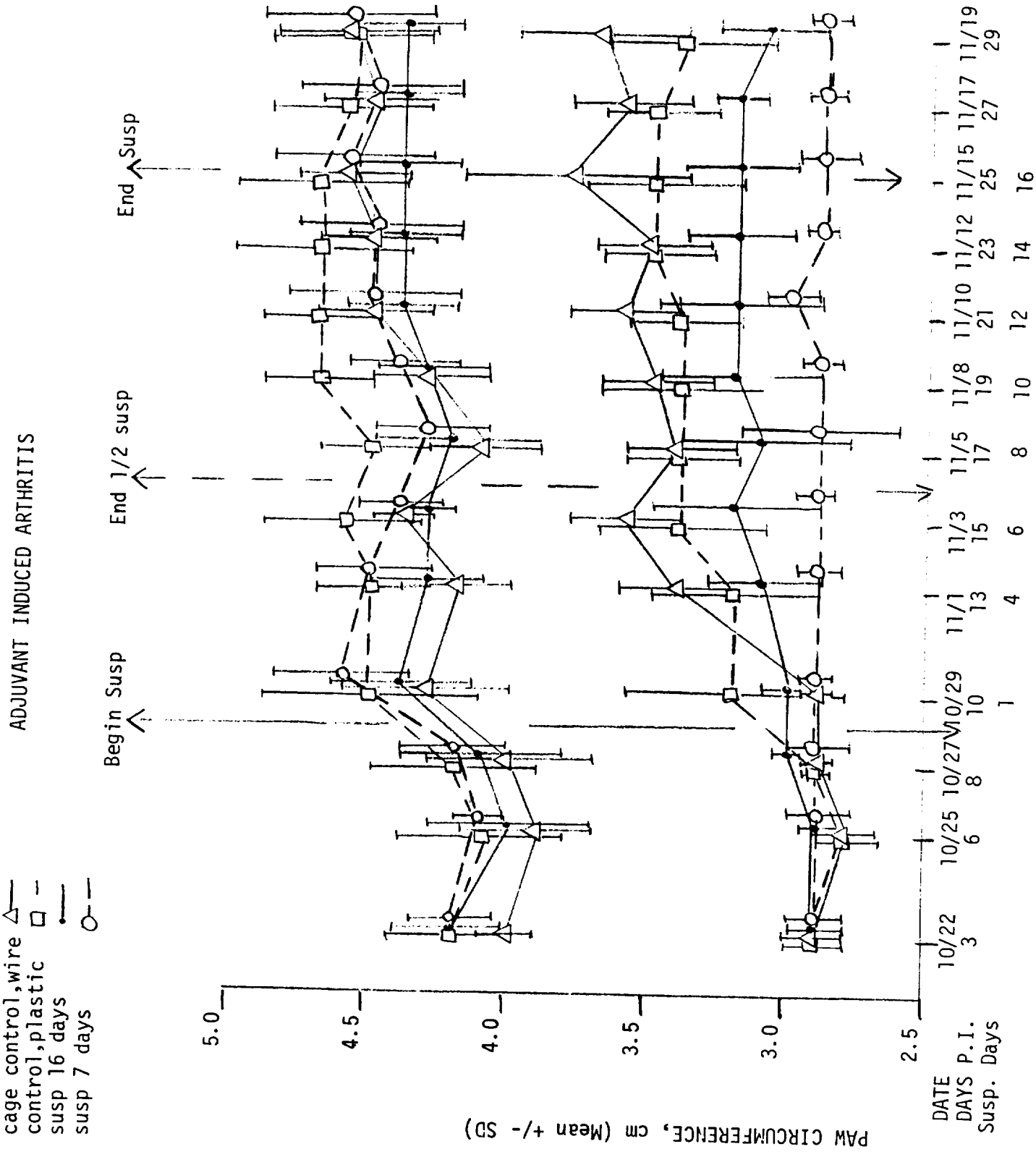


Figure 1. Effect of Weightlessness Induced by Suspension on Adjuvant-Induced Arthritis in the Rat (DW, SSIP, 08/03/82). Arthritis was induced in male Wistar-Lewis rats (260-270 g) by subplantar injection of 0.1 ml of complete Freund's adjuvant (CFA) into the right hindpaw as earlier described (Larson and Lombardino, Agents Actions 10: 246-251, 1980). Measurements of hindpaw thickness were performed with calipers on rats from each group (N=7 rats/group) at the denoted times following CFA injection. One group of rats was suspended at a 30° tilt to simulate (squares) weightlessness and resultant osteoporosis (Holton and Wronski, Physiologist 24: Suppl. S45-S48, 1981) for the denoted times and the other non-suspended group (circles) served as controls. Closed and open symbols respresent injected (Fig. 1 A) or non-injected (Fig. 1B) thickness, respectively. Results are expressed as mean hindpaw thickness ± standard error ($\bar{X} \pm SE$) and significance was tested by the Student's T-test (two-tailed) for non-paired data (**= $p < .05$; ***= $p < .001$).


ADJUVANT INDUCED ARTHRITIS
cage control,wire
control, plastic
non-arthritic control
unweighted--7 days
unweighted--16 days
Begin Susp
End 1/2 Susp
End Susp
BODY MASS, gm (Mean +/- S.D.)
370
350
330
310
290
270
250
230
210
190
170
DATE
Days P.I.
Susp. Days
10/22 3
10/25 6
10/27 8
10/29 10 1
11/1 13 4
11/3 15 6
11/5 17 8
11/8 19 10
11/10 21 12
11/12 23 14
11/15 25 16
11/17 27
11/19 29


ADJUVANT INDUCED ARTHRITIS
cage control,wire
control,plastic
susp 16 days
susp 7 days
Begin Susp
End 1/2 susp
End Susp
PAW CIRCUMFERENCE, cm (Mean +/- SD)
5.0
4.5
4.0
3.5
3.0
2.5
DATE
DAYS P.I.
Susp. Days
10/22 10/25 10/27 10/29 11/1 11/3 11/5 11/8 11/10 11/12 11/15 11/17 11/19
3 6 8 10 13 15 17 19 21 23 25 27 29
1 4 6 8 10 12 14 16

AEM/SSIP STATUS REPORT
AMES RESEARCH CENTER
SEPTEMBER 29, 1983

DSO 0421: LESSONS LEARNED

USE OF GERM-FREE RATS: HEALTHY BUT EXPENSIVE (CARE AND COST)

USE OF POTATOES: NOVELTY VS WATER SOURCE

POTENTIALLY INADEQUATE AIR FLOW

NECESSITY FOR TIMELINESS, TEAMWORK, AND CHECKLISTS

NECESSITY FOR CONTINGENCY PLANS: LIFE SCIENCES AND FLIGHT OPS

NECESSITY TO DISCUSS AND PREPARE FOR ALL MEASUREMENTS ON ANIMALS AND HARDWARE PRIOR TO FLIGHT

NECESSITY FOR CONTINUOUS COMMUNICATION BETWEEN ALL TEAM MEMBERS

NECESSITY FOR DEFINED RESPONSIBILITIES FOR EACH TEAM MEMBER/NASA CENTER/CORPORATE SPONSOR

NECESSITY FOR REBURISHING HARDWARE/FILTERS BETWEEN FLIGHT (ESPECIALLY IF ONLY 1 UNIT)

EFFORT NECESSARY TO SUPPORT DSO/AEM:

- NUMBER OF PEOPLE
- ANIMAL CARE/COST
- LOGISTICS
- OTHER

DSO 0421: DATA OBTAINED

ANIMAL WEIGHTS

BLOOD COUNTS: PREFLIGHT AND POSTFLIGHT

MICROBIOLOGY: PREFLIGHT AND POSTFLIGHT
- AEM: INSIDE AND OUTSIDE
- RATS: FECES AND NASOPHARYNGEAL SWABS
- FOOD BARS
- POTATOES

VIDEO TAPES: PREFLIGHT, INFLIGHT, POSTFLIGHT

DSO 0421

ANIMAL DATA

Rat #	Cage #	GROUP	Estimated Birth Date (1983)	WEIGHT, gm 8/18	8/25	8/29	9/5 (0600)	9/6 (1300)	9/7 (1200)	9/9	9/10	9/11	9/12	9/13	9/14
1	1	KSC Controls (bled)	6/11	235	268	279	290						303		
2			6/10	253	296	311	314						329		
3			6/21	197	229	245	245						263		
							(0200)								
4	2	FLIGHT (A)	6/11	239	278	288	288	293	294	297	302	312	315	315	318
5			6/11	244	285	297	286	292	293	299	300	309	312	314	319
6			6/10	244	282	293	273	291	295	299	299	311	316	317	322
7	3	FLIGHT (B)	6/21	183	234	243	242	254	257	267	269	277	280	286	292
8			7/5	153	201	219	222	234	239	245	249	260	263	269	274
9			7/5	154	201	221	229	238	240	247	249	258	262	266	272
10	4	KSC Controls	6/21	173	218	234	263						275		
11			6/10	256	290	300	330						338		
12			6/21	196	237	258	285						303		
13	5	ARC Controls	6/10	264	291	300	300	332	330	329	329	336	337	340	345
14			6/11	233	271	282	286	317	317	318	319	326	327	331	332
15			6/11	239	286	293	296	323	324	310	310	331	338	336	342

Numbers in parentheses are time of day

DSO 0421 ANIMAL DATA

Cage #	Group	FOOD CONSUMPTION, gm/3 rats 8/18-25	8/25-29	8/25-9/5	WATER CONSUMPTION, ml/3 rats 8/18-25	8/25-29	8/29	(POTATOES, 80% water) 8/29,30-9/5
1	KSC Controls (bled)	371	198	216 {308}	696	370	50	1054 {1228}
		[53]	[50]	[31]	[99]	[93]		[176/141] (0300)
2	FLIGHT (A)	399	219	186 {421}	761	385		1170+ {1260}
		[57]	[55]	[27]	[109]	[96]		[167/134] (1100)
3	FLIGHT (B)	329	189	165 {419}	590	368		1162+ {1231}
		[47]	[47]	[24]	[84]	[92]		[166/133] (1100)
4	KSC Controls	351	205	252	658	338	50	1059 1251
		[50]	[51]	[36]	[94]	[85]		[177/141] (0300)
5	ARC Controls	331	181	202 {202}	566	372	50	1155+ {1231}
		[47]	[45]	[29+]	[81]	[93]		[193/154] (0300)
	Average intake/day:	51±4	50±4		93±11	92±4		[potato wt./ml water]
	7 day estimate:	357	350		Water: 651	644		
					Potatoes: 814	805		

[n] = consumption/day, (n) = time of day that period started, {n} = amount supplied
NOTE: controls put on potatoes after launch

BLOOD COUNTS, DSO 0421
FLIGHT RATS

DATE: PARAMETER:	9/5/83	9/14/83
White Blood Count	Increased	10.5 +/- 0.8 BIL/L (4-11)
Red Blood Count	Increased	9.0 +/- 0.3 TRIL/L (4.4-5.9)
Hemoglobin	Increased	16.6 +/- 0.5 GM/DL (13.5-17.7)
Mean corpuscular volume	Increased	53 +/- 1.1 FL (80-100)
Mean corpuscular hemoglobin	Increased	18.4 +/- 0.4 PG (27-34)
Mean corpuscular hemoglobin conc.	Increased	34.6 +/- 0.9 GM/DL (31-36)
Platelets	Increased	Increased

Numbers in parenthesis are normal values

PRELIMINARY MICROBIOLOGY
DSO 0421

PREFLIGHT (8/29):

AEM/Outside: None
AEM/Inside: Staph. Epidermatis (cage only; no growth on filter)

Rats/Feces: Lactobacillus, Bacteroides distasonis (anaerobic rod)
Rats/Nasopharyngeal swabs:

Food Bars: None
Sipper Tube: Lactobacillus
Food in vivarium cage: Lactobacillus
Potatoes: Left Side — Right Side

CDC Group VE Bio Type I — Strep. (not enterococcus)
Bacillus species — Enterobacter agglomerans

POSTFLIGHT (9/6):

AEM/Outside: Enterobacter cloacae, Staph. aureus
AEM/Inside: Klebsiella oxytoca, Enterobacter cloacae, Enterococcus, Staph. aureus

Rats/Feces: #1: Klebsiella oxytoca, Citrobacter freundii, Enterobacter cloacae, Enterococcus
#2: Klebsiella oxytoca, Citrobacter freundii, Enterococcus
Staph. epidermidis
Rats/Nasopharyngeal swabs: Klebsiella oxytoca (6 of 6 rats), Citrobacter freundii (5 of 6 rats), Enterobacter cloacae (5 of 6 rats), Enterococcus (6 of 6 rats), Strep. viridans group (6 of 6 rats), Staph. aureus (1 rat side A), Staph. epidermidis (6 of 6 rats).

Food Bars: Klebsiella oxytoca, Enterococcus, Enterobacter cloacae, Staphalococcus aureus
Potatoes: Klebsiella oxytoca, Enterobacter cloacae, Enterococcus, Staph. epidermidis, Staph. aureus

Control Rats: Cage 1 food: Serratia liquefaciens, Kleb. ocytoca, Bacillus species, Enterococcus
potato: Kleb. ocytoca, Citrobacter freundii, Proteus mirabilis, Bacillus species, Enterococcus, Yeast--probable Geoprichum sp.
Cage 4 food: CDC group VE BIO type I, Bacillus sp., Enterococcus
potato: Kleb. ocytoca, Citrobacter freundii, Enterobacter cloacae, Bacillus sp., Enterococcus, Yeast--probable Geoprichum sp.

Nasopharyngeal swabs: Kleb. ocytoca (6 of 6), Enterobacter cloacae (4 of 6), Bacillus sp. (2 of 6), Enterococcus (6 of 6), Group D Strep. not enterococcus (3 of 6), Strep. viridans (2 of 6), Staph. epidermidis (2 of 6)

Fecal, cage 1: Kleb. ocytoca, Citrobacter freundii, Proteus mirabilis, Bacillus species, Enterococcus, Strep. viridans
Cage 4: Kleb. ocytoca, Citrobacter freundii, Enterobacter cloacae, Bacillus species, Enterococcus, Group D Strep. not enterococcus

SE81-10

STS 11: WEBER EXPERIMENT, "THE EFFECTS OF WEIGHTLESSNESS ON ARTHRITIS", STATUS REPORT OF 9/29/83

SSIP TEAM: (PRIME/BACKUP)

STUDENT: DANIEL J. WEBER

CORPORATE SPONSORS:

GENERAL DYNAMICS: THOMAS KESSLER/GERRY HUSTON

PFIZER: DR. DAVID LARSON/DR. IVAN OTTERNESS

PROJECT MANAGER/SCIENTIST: DR. EMILY HOLTON/PAUL SEBESTA

SUPPORTING ORGANIZATIONS:

NASA HEADQUARTERS:

SSIP OFFICE: ALAN LADWIG/MICHAEL BOWIE

LIFE SCIENCES DIVISION: DR. THORA HALSTEAD

PUBLIC AFFAIRS OFFICE: EVVIE RASMUSSEN

NASA-JSC:

SSIP OFFICE/FLIGHT OPS: JOHN JACKSON/NEIL CHRISTIE

ASTRONAUT OFFICE: DR. RON MCNAIR

LIFE SCIENCE: DR. MALCOLM SMITH

NASA-KSC

SSIP OFFICE/FLIGHT OPS: FRANK BRYANT

LIFE SCIENCES: DR. WILLIAM KNOTT

NASA-ARC

LIFE SCIENCES: DR. EMILY HOLTON

LIFE SCIENCES FLIGHT EXPERIMENTS PROJECT OFFICE: PAUL SEBESTA

SCIENCE (SEE ATTACHED)

HARDWARE: SUCCESSFULLY FLOWN ON STS-8

PUBLICITY: TO BE CLEARED THROUGH NASA HEADQUARTERS

COST

STS 14: FRAS EXPERIMENT, "THE EFFETS OF WEIGHTLESSNESS IN SPACE FLIGHT ON THE HEALING OF BONE"

SSIP TEAM: (PRIME/BACKUP)

STUDENT: ANDREW FRAS

CORPORATE SPONSORS:

ORTHOPAEDIC HOSPITAL, LA: JACK SWEENEY/DR. G. JUNE MARSHALL

GENERAL DYNAMICS: THOMAS KESSLER/GERRY HUSTON

NASA: SAME AS STS-11

HARDWARE: DEVELOPMENT OF WATER BOTTLE

SE81-10
ACTION ITEMS
September 22, 1983

ITEM	PERSON RESPONSIBLE	DATE DONE
1. Distribution of inflight timelines for SE81-10/STS-11	Jackson	
2. Distribution of STS-11 crew names and NASA addresses	Jackson	
3. Inflight check list for rat health/behavior	Larson/Weber	
4. STS-11 PAO rat downlink/yea or nay	Halstead	
5. AEM air flow measurements	Kessler/General Dynamics	
6. STS-8 Project Report including: Microbiology Hematology Food/Water/Rat Weights Timelines Contingency Plans Launch/landing facilities used	Holton	
7. Charles River SPF rats	Larson to get guarantee	
8. Teklad Diet Purchase	Sebesta	
9. List of pathogens NASA does not allow inflight	Holton/Smith	
10. STS-8 (DSO 0421) and STS-11 (SE81-10) preflight, flight, postflight coordinated videotapes	Sebesta/Holton	
11. Check for inflight temperature recorder with remote probe	Holton	
12. Repack AEM filters/prepare under clean conditions if possible	Kessler/Christie	
13. Make new lid for AEM	Kessler	
14. Check out antifog spray for AEM lid	Johnson	
15. Microbiology of AEM filter after repacking and before STS-11	Smith	

ITEM	PERSON RESPONSIBLE	DATE DONE
16. Contingency plans for nonUS landings	Jackson	
17. Contingency facilities for US landing sites	Sebesta	
18. STS-11 Launch windows	Jackson	
19. Directory of personnel (addresses/phones) for SE81-10	Sebesta/Smith	
20. Publicity coordination policy	Halstead	
21. Holder for transporting AEM to launch pad	Jackson	
22. Ground unit mock-up of AEM	Kessler	
23. KSC photographic support/ physicals and clearances necessary	Knott/Sebesta	
24. Experiment measurements table for supplemental science: agreed/ recommended	Halstead	
25. Animal handlers physicals/ requirements and updates for team	Knott	
26. Clear Kessler to launch pad	Knott	
27. Letter to Pfizer requesting services of person qualified for orbital vein bleeding	Halstead	
28. Biweekly newsletter	Holton	
29. Crew Briefing Date Preflight	Jackson	
30. Historical videotape of NASA Life Sciences past animal flights	Halstead	
31. Postflight trip to Pfizer for rats	Halstead/Knott/Sebesta (contingency landing sites)	
32. Letter to Gene Rice requesting service of Dr. Smith for SE81-10	Holton	
33. Questions for postflight crew debriefing	Team	
34A. AEM to General Dynamics for refurbishing	Jackson	
34B. AEM to JSC for flight storage	Kessler	

CONVERSATIONS WITH DR. WILLIAM THORNTON, 9/20/83

The first question asked Dr. Thornton was what the temperature in the AEM was throughout the mission. He responded that the temperature the first day was 81F, but that he could not read the temperature probe after that time. He thought that the temperature was not lower than 78F and was probably 78-79F.

Dr. Thornton then described the animals according to flight days. He felt that the first flight day the animals wanted out of the cage. Every time he inspected the animals they were in corners or around edges. The animals were active, but appeared mainly trying to escape. The animals were holding on with the front paws and the rear end was floating up. The animals showed no evidence of diarrhea; the feces were well formed. The animals did not show any signs of physical distress. The animals appeared to hold onto the cage or each other and did not attempt to use the tail for grasping.

By the second day, the potatoes were well chewed. The rats were also eating their feces. The animals were still trying to escape. The animals showed no evidence of grooming activity, but they did not appear to be ungroomed. The animals were using the front paws to hold and the rear paws for stabilization.

The rest of the flight appeared to be increasing familiarity with the cage and with spaceflight. The animals did start grooming and continued feeding. Just before reentry, the animals appeared to be teasing each other and were doing backward summersalts suggesting that the rats were well habituated by this time. Only scraps of potatoes remained.

The video for the inflight films used bounce light as the crew felt that the interal lights were insufficient for filming.

The velcro straps on the exterior of the cage broke when trying to force the AEM from the middeck locker for observations and for filming. The front panel of the AEM is apparently much stronger than previously thought as the crew used the panel to pull the AEM out of the locker after the straps broke. The position of the middeck locker for the AEM was difficult to access and fit very tightly.

The Weber experiment team expressed their gratitude for the time he spent briefing us on his impressions of the AEM and animals during the mission. The session was most imformative.

Measurements For SE81-10
(As of 09/22/83)

TIME: PREFLIGHT

LOCATION: KENNEDY SPACE CENTER (KSC)

RESP INVEST: (KNOTT/HOLTON/SEBESTA)

DATE		LAUNCH DAY	BODY WT.	PAW VOLUME	X-RAY	BLEED	MICROBIOLOGY	VET EXAM	VIDEO	POTATOES/ TEKLAD -356 WEIGHT	GROSS OBS.	LIGHT CYCLE (FLIGHT)
8	JAN	-21	KINGSTON ALERT									
9		-20					X (5 rats to KSC for Micro					
10		-19										
11		-18										
12		-17										
13		-16										
14		-15					X (5 rat to KSC)					
15		-14										
16		-13										
17		-12										
18		-11										
19		-10					X (5 rats to KSC)					
20		-9										
21		-8	X KINGSTON (LARSON) INDUCE ARTH;(all rats to KSC)]									
22		-7	X	X			X	X		X X	X	X
23		-6									X	X
24		-5									X	X
25		-4	X	X		X		X	X		X	X
26		-3									X	X
27		-2									X	X
28		-1	X	X				X	X	X X	X	X

Kingston is the location of Charles River Lewis strain rats (SPF) in Mass.

INFLIGHT

SPACE / (KSC)

(McNAIR/HOLTON/SEBESTA)

DATE		LAUNCH DAY	LIGHT CYCLE	BEHAVIOR (FILM)	GROSS OBS.	VIDEO	BLEED	VET EXAM	BODY WT.	POTATOES/FOOD WT.
30	JAN	+1	X		X					
31		+2	X	X	X					
1		+3	X		X					
2		+4	X	X	X					
3		+5	X		X					
4		+6	X		X					
5		+7	X	X	X					
6		+8	KSC			X	X	X	X	X

POSTFLIGHT

PFIZER

(LARSON)

DATE		DATE OF LAUNCH	BODY WT.	PAW VOLUME	X-RAY	BLEED	BEHAVIOR	VET EXAM	GROSS OBS.	WATER/FOOD CONSUMPTION
6	FEB	+8	X	X	X		X	X	X	X
7		+9				X	X		X	X
8		+10					X		X	
9		+11					X		X	
10		+12	X	X			X		X	
11		+13					X		X	
12		+14					X		X	
13		+15	X	X	X	X	X	X	X	
14		+16					X		X	
15		+17					X		X	
16		+18					X		X	
17		+19	X	X			X		X	
18		+20					X		X	
19		+21					X		X	
20		+22	X	X	X	X	X	X	X	
21		+23					X		X	
22		+24					X		X	
23		+25					X		X	
24		+26	X	X			X		X	
25		+27					X		X	
26		+28					X		X	
27		+29	X	X	X	X	X	X	X	
28		+30					X		X	
01	MAR	+31					X		X	
02		+32					X		X	

DIRECTORY OF TEAM MEMBERS FOR SE81-10

STUDENT:

Daniel J. Weber
950 Park Avenue
New York City, NY 10028
212/249-1020
or
709 Stewart Ave.
Ithaca, NY 14850
607/273-2447

CORPORATE SPONSOR:

PFIZER:

Dr. David Larson
Central Research Division
Pfizer, Inc.
Eastern Point Road
Groton, CT 06340
203/441-4691 (office)
203/441-4656 (lab)
203/739-0856 (home)

Dr. Ivan G. Otterness
Central Research Division
Pfizer, Inc.
Eastern Point Road
Groton, CT 06340
203/441-4688

GENERAL DYNAMICS:

Mr. Thomas Kessler
DOD Advanced Space Programs
General Dynamics - Convair Division
PO Box 80847, Mail Code 41-6110
San Diego, CA 92138
619/277-8900, Ext. 2233
619/755-4779 (Home)

Mr. Gerry Huston
DOD Advanced Space Programs
General Dynamics - Convair Division
PO Box 80847, Mail Code 21-9530
San Diego, CA 92138
619/277-8900, Ext. 1219
619/487-5287 (Home)

NASA ARC:

Dr. Emily Holton
Biomedical Research Division
M/S 239-14
NASA-Ames Research Center
Moffett Field, CA 94035
415/965-5471 (FTS = 448)
415/965-5247
408/246-7440 (Home)

Mr. Paul Sebesta
Life Sciences Flight Experiments
Project Office
M/S 240A-3
NASA-Ames Research Center
Moffett Field, CA 94035
415/965-6455 (FTS = 448)
408/996-8335 (Home)

Dr. Jerome Goldsboro, Jr.
Biosystems Division
M/S 236-5
NASA-Ames Research Center
Moffett Field, CA 94035
415/965-6703 (FTS = 448)
415/965-6390
415/921-3552 (Home)

NASA-JSC:

Mr. John Jackson
Crew Station Integration Section
Mail Code EN-43
NASA-Johnson Space Center
Houston, TX 77058
713/483-3173 (FTS = 525)
713/333-4542 (Home)

Mr. Neil Christie
Crew Station Integration Section
Mail Code EN-43
NASA-Johnson Space Center
Houston, TX 77058
713/483-3173 (FTS = 525)

Dr. Malcolm Smith
Mail Code SD-3
NASA-Johnson Space Center
Houston, TX 77058
713/483-5457 (FTS = 525)

Dr. Ron McNair
Mail Code CB
NASA-Johnson Space Center
Houston, TX 77058
713/483-3856 (FTS = 525)

NASA HEADQUARTERS:

Mr. Alan Ladwig
Office of Space Flight
Code ME
NASA Headquarters
Washington, DC 20546
202/453-1138
202/244-4290 (Home)

Mr. Michael Bowie
Office of Space Flight
Code MC-7
NASA Headquarters
Washington, DC 20546
202/453-1139

Dr. Thora Halstead
Life Sciences Division
Code SBE-3
NASA-Headquarters
Washington, DC 20546
202/755-3114
703/356-1397 (Home)

Ms. Evvie Rasmussen
Public Affairs Office for OSSA
Code E-6
NASA-Headquarters
Washington, DC 20546
202/755-3054

NASA-KSC:

Dr. William Knott
Code MD-RSB-2
NASA-Kennedy Space Center, FL 32899
305/867-3152 (FTS = 823)
305/267-1321 (Home)

Mr. Jerry Moyer
BIO-3, Hanger L
NASA-Kennedy Space Center, FL 32899
305/853-3165 (FTS = 824)
305/268-0672 (Home)

Mr. John Bryant
Code CS-SED-4
NASA-Kennedy Space Center, FL 32899
305/867-3044 (FTS = 823)

TO: Weber Team

FROM: Project Manager/Scientist

SUBJECT: Biweekly report, October 17, 1983

WATER SYSTEM: Development of the water bottle is proceeding and is based on the prototype design of Jack Sweeney. Tom Kessler/General Dynamics is fabricating a container of extruded aluminum which will be light-weight and will contain about 1400 ml water (2 bags of 700 ml each). Each infusion bag will be attached to two lixit valves (one valve providing water to each compartment within the AEM); thus, the rats in each compartment have 2 lixit valves which provide access to both water bags. In case of failure of one lixit valve or bag, the other will be available to rats in both compartments. Either the General Dynamics model or the Sweeney original system will be tested on the KC 135 parabolic flights at Dryden on Nov. 9. Jerry Moyer (Bionetics/KSC) has graciously consented, with approval from Dr. Robert Clark of JSC, to carry the water system onboard the aircraft and test it as possible during postflight data gathering for SL1. Tom Kessler is drafting objectives and protocol for Jerry Moyer for these tests. STS-9 (SL-1) is landing at Dryden on Nov. 6, 1983, and the KC 135 is scheduled to arrive at Dryden on Nov. 7. The parabolic flights will occur on Nov. 9. Three runs are presently planned with 20-40 parabolas per run and about 35 sec. of nearweightlessness per parabola. John Jackson is proceeding with the necessary paperwork at JSC to try to get the watering system flight qualified prior to STS-11.

NOTE: STS-9 LAUNCH HAS BEEN DELAYED! THE NEW LAUNCH DATE SHOULD BE ANNOUNCED WEDNESDAY, OCTOBER 19, 1983. This delay will probably impact testing of the water system prior to STS-11.

TEMPERATURE RECORDER: Tom Kessler is hopeful that the NASA temperature recorder developed for the Cosmos experiments will fit in the aluminum container for the watering system. He has received blue prints of the recorder as well as the electric schematics to determine whether the recorder will fit and to determine whether an exterior LCD can be wired into the system so that the temperature can be read manually as well as recorded in memory. The temperature recorder is a sealed aluminum box about the size of a cigarette pack and about the weight of two packages of cigarettes. The recorder has flown in the middeck on multiple shuttle flights. The temperature is continuously recorded, but the unit must presently be taken apart to access the memory and requires a special ground unit to decode the memory. The NASA-Ames systems are in Russia for the Cosmos flight scheduled for the end of Nov.; if the launch is on schedule, the recorders should be available around the first of Jan. Ed Michaels, JSC, is checking to see if and when the JSC units might be available; these units are to fly on STS-9, but may not be scheduled for STS-11. John Jackson will be informed about the availability of the JSC units and will be responsible for integrating any system that may be available.

POTATO CONSUMPTION/FOOD CONSUMPTION/GROWTH: Dr. Larson is to provide data on water/potato consumption, food consumption, and growth of rats from baseline studies which were done at Pfizer to determine whether potatoes were adequate as a water source.

MOTEL RESERVATIONS: Dr. William Knott is investigating the possibility of reserving a block of rooms at a motel or reserving a condominium to the entire team. You will be notified of the success of this endeavor. Please let me know whether you intend to find your own room or whether you wish to be included with the team and whether you prefer a motel or a condominium.

METHOD FOR MARKING FLIGHT ANIMALS: Animal identification on STS-8 was a problem because of the complexity of the color labels on each rat. We need to decide how to mark the animals for this mission to avoid past problems. The animals should be tatooed with a number and then marked additionally for the flight period. If the animals are to be housed in groups of three, then perhaps one rat could have its tail completely dipped in indelible ink, another rat could have only the distal half of its tail dipped in indelible ink, and the third rat would not have any tail marking. Think about the problem as we will discuss it in our meetings prior to launch.

STS-11 CREW BRIEFING: Briefing of the entire STS-11 crew is presently scheduled for 8AM, Wed. October 19, at JSC. All team members are invited; critical personnel are Dan Weber, David Larson, Tom Kessler, Emily Holton, and John Jackson.

ARRIVAL/DEPARTURE OF TEAM AT KSC: The present schedule for the Weber experiment is as follows: Arrival at KSC, Tuesday, January 24, 1984. First meeting, 8:30 AM, conference room of Hanger L, Wednesday, January 25, 1984. The Pfizer crew will probably depart as soon as the postflight testing is finished on the flight animals on Monday, Feb. 6. The rest of the team will depart on Wed. Feb. 8 to allow time for all postflight testing, clean up duties, documentation required, etc. Please make sure you put these dates on your calendar. NOTE: THESE DATES ARE DEPENDANT UPON A LAUNCH DATE OF JAN. 29, 1984.

ACTION ITEMS: Please let me know when you complete your action items so I can check them on the master list. The list is updated and sent with each newsletter.

ADDITIONAL STS-8 DATA: Enclosed you will find the blood data obtained by Dr. Malcolm Smith and Dr. Phil Johnson on the control rats preflight at KSC and on the flight rats immediately following landing at Dreyden. The postflight samples were taken at Ames according to specifications of Dr. Johnson.

UPDATED DIRECTORY: Enclosed is the updated directory. Note particularly changes in Dr. Larson's backup and in Tom Kessler's mail code and phone number.

SPF CRITERIA: Organisms recommended for exclusion are attached.

ENCLOSURES:
1) Updated Action Items
2) STS-8 Blood Data
3) Updated Weber Team Directory
4) SPF Criteria for Rats

SE81-10
ACTION ITEMS

ITEM	PERSON RESPONSIBLE	DATE DONE
1. Distribution of inflight timelines for SE81-10/STS-11	Jackson	
2. Distribution of STS-11 crew names and NASA addresses	Jackson	
3. Inflight check list for rat health/behavior	Larson/Weber	
4. STS-11 PAO rat downlink/yea or nay	Halstead	
5. AEM air flow measurements	Kessler/General Dynamics	
6. STS-8 Project Report including: Microbiology Hematology Food/Water/Rat Weights Timelines Contingency Plans Launch/landing facilities used	Smith/Holton	
7. Charles River SPF rats	Larson to get guarantee	
8. Teklad Diet Purchase	Sebesta	
9. List of pathogens NASA does not allow inflight	Holton/Smith	10/17/83
10. STS-8 (DSO 0421) and STS-11 (SE81-10) preflight, flight, postflight coordinated videotapes	Sebesta/Holton	
11. Check for inflight temperature recorder with remote probe	Holton	10/17/83
12. Repack AEM filters/prepare under clean conditions if possible	Kessler/Christie	
13. Make new lid for AEM	Kessler	
14. Check out antifog spray for AFM lid	Johnson	
15. Microbiology of AEM filter after repacking and before STS-11	Smith	
16. Contingency plans for nonUS landings	Jackson	

ITEM	PERSON RESPONSIBLE	DATE DONE
17. Contingency facilities for US landing sites	Sebesta	
18. STS-11 Launch windows	Jackson	
19. Directory of personnel (addresses/phones) for SE81-10	Sebesta/Smith	
20. Publicity coordination policy	Halstead	10/4/83
21. Holder for transporting AEM to launch pad	Jackson	
22. Ground unit mock-up of AEM	Kessler	
23. KSC photographic support/ physicals and clearances necessary	Knott/Sebesta	
24. Experiment measurements table for supplemental science: agreed/ recommended	Halstead	
25. Animal handlers physicals/ requirements and updates for team	Knott	
26. Clear Kessler to launch pad	Knott	
27. Letter to Pfizer requesting services of person qualified for orbital vein bleeding	Halstead	
28. Biweekly newsletter	Holton	ongoing; initiated 10/3/83
29. Crew Briefing Date Preflight	Jackson	10/6/83
30. Historical videotape of NASA Life Sciences past animal flights	Halstead	
31. Postflight trip to Pfizer for rats	Halstead/Knott/Sebesta (contingency landing sites)	
32. Letter to Gene Rice requesting service of Dr. Smith for SE81-10	Holton	10/17/83
33. Questions for postflight crew debriefing	Team	

ITEM	PERSON RESPONSIBLE	DATE DONE
34A. AEM to General Dynamics for refurbishing	Jackson	
34B. AEM to JSC for flight storage	Kessler	
35A. Build water system for AEM	Kessler/Sweeney	
35B. Flight qualify water system	Jackson	
36. Potato consumption/food consumption/growth data from baseline studies	Larson	
37. Motel/condo reservations for team at KSC	Knott	
38. Method for marking rats preflight and during flight	Team	
39. Objectives/protocol for KC135 test of water system	Kessler	
40. Status of JSC temperature recorders	Jackson	

BLOOD COUNTS, DSO 0421

DATE: Group/route	8/30/83 Control/jugular	9/5/83 Flight/tail vein	9/14/83 Flight/tail vein
PARAMETER:			
White Blood Count (4-11 BIL/L)	9.8 +/- 0.7	15.2 +/- 2.4	10.5 +/- 0.8
Red Blood Count (4.4-5.9 TRIL/L)	8.7 +/- 0.2	9.9 +/- 0.2	9.0 +/- 0.3
Hemoglobin (13.5-17.7 GM/DL)	17.6 +/- 0.2	19.6 +/- 0.4	16.6 +/- 0.5
Hematocrit (%)	45.6 +/- 1.0	54.6 +/- 1.5	47.8 +/- 1.3
Mean corpuscular vol. (80 - 100 FL)	52.2 +/- 0.3	55.0 +/- 0.5	53.0 +/- 1.1
Mean corpuscular hemoglobin (27-34 PG)	20.1 +/- 0.1	20.0 +/- 0.2	18.4 +/- 0.4
Mean corpuscular hemoglobin conc. (31-36 GM/DL)	38.5 +/- 0.4	35.8 +/- 0.3	34.6 +/- 0.9
Platelets (x 1000)	539 +/- 59	752 +/- 42	greater than 600

Numbers in parenthesis are normal values

DIRECTORY OF TEAM MEMBERS FOR SE81-10

STUDENT:

Mr. Daniel J. Weber
950 Park Avenue
New York City, NY 10028
212/249-1020
or
709 Stewart Ave.
Ithaca, NY 14850
607/273-2447

CORPORATE SPONSOR:

PFIZER:

Dr. David Larson
Central Research Division
Pfizer, Inc.
Eastern Point Road
Groton, CT 06340
203/441-4691 (office)
203/441-4656 (lab)
203/739-0856 (home)

Dr. Mike Ernest
Central Research Division
Pfizer, Inc.
Eastern Point Road
Groton, CT 06340
203/441-3836

GENERAL DYNAMICS:

Mr. Thomas Kessler
DOD Advanced Space Programs
General Dynamics - Convair Division
PO Box 80847, Mail Code 21-9530
San Diego, CA 92138
619/573-5106
619/755-4779 (home)

Mr. Gerry Huston
DOD Advanced Space Programs
General Dynamics - Convair Division
PO Box 80847, Mail Code 21-9530
San Diego, CA 92138
619/573-9783
619/487-5287 (home)

NASA ARC:

Dr. Emily Holton
Biomedical Research Division
M/S 239-14
NASA-Ames Research Center
Moffett Field, CA 94035
415/965-5471 (FTS = 448)
415/965-5247
408/246-7440 (home)

Mr. Paul Sebesta
Life Sciences Flight Experiments
Project Office
M/S 240A-3
NASA-Ames Research Center
Moffett Field, CA 94035
415/965-6455 (FTS = 448)
408/996-8335 (home)

Dr. Jerome Goldsboro, Jr.
Biosystems Division
M/S 236-5
NASA-Ames Research Center
Moffett Field, CA 94035
415/965-6703 (FTS = 448)
415/965-6390
415/921-3552 (home)

NASA-JSC:

Mr. John Jackson
Crew Station Integration Section
Mail Code FN-43
NASA-Johnson Space Center
Houston, TX 77058
713/483-3173 (FTS = 525)
713/333-4542 (home)

Mr. Neil Christie
Crew Station Integration Section
Mail Code EN-43
NASA-Johnson Space Center
Houston, TX 77058
713/483-3173 (FTS = 525)

Dr. Malcolm Smith
Mail Code SD-3
NASA-Johnson Space Center
Houston, TX 77058
713/483-5457 (FTS = 525)

Dr. Ron McNair
Mail Code CB
NASA-Johnson Space Center
Houston, TX 77058
713/483-3856 (FTS = 525)

NASA HEADQUARTERS:

Mr. Alan Ladwig
Office of Space Flight
Code ME
NASA Headquarters
Washington, DC 20546
202/453-1138
202/244-4290 (home)

Mr. Michael Bowie
Office of Space Flight
Code MC-7
NASA Headquarters
Washington, DC 20546
202/453-1139

Dr. Thora Halstead
Life Sciences Division
Code SBE-3
NASA-Headquarters
Washington, DC 20546
202/755-3114
703/356-1397 (home)

Ms. Evvie Rasmussen
Public Affairs Office for OSSA
Code E-6
NASA-Headquarters
Washington, DC 20546
202/755-3054

NASA-KSC:

Dr. William Knott
Code MD-RSB-2
NASA-Kennedy Space Center, FL 32899
305/867-3152 (FTS = 823)
305/267-1321 (home)

Mr. Jerry Moyer
BIO-3, Hanger L
NASA-Kennedy Space Center, FL 32899
305/853-3165 (FTS = 824)
305/268-0672 (home)

Mr. John Bryant
Code CS-SED-4
NASA-Kennedy Space Center, FL 32899
305/867-3044 (FTS = 823)

Others:

Mr. Jack Sweeney
Bone and Connective Tissue Research Program
Orthopaedic Hospital
2400 South Flower St.
Los Angeles, CA 90007

TABLE 1. SPF Criteria for Rats for LSFEP
Organisms Recommended for Exclusion from Rats

ORGANISM	SOURCE
BACTERIA	
Streptobacillus moniliformis	Oral
Spirillum minus	Oral
Streptococcus pneumoniae	Oral, Nasal
Streptococcus, beta hemolytic	Oral, Nasal
Bacillus piliformis	Liver
Corynebacterium kutscheri	Fecal, Oral
Salmonella sp.	Fecal
Pasteurella pneumotropica	Oral, Nasal
Leptospira sp.	Urine
Klebsiella pneumoniae	Fecal, Oral, Nasal
Campylobacter sp.	Fecal
MYCOPLASMAS	
Mycoplasma pulmonis	Blood, Nasal Aspirate
Mycoplasma arthritidis	Blood, Nasal Aspirate
VIRUSES	
Lymphocytic choriomeningitis virus	Blood
Rat parvoviruses	Blood
Rat Coronavirus	Blood
Sialodacryadenitis virus	Blood
Sendai Virus	Blood
FUNGI	
All Dermatomycoses	Skin
Ecto parasites	Skin, Hair
Endo parasites	Feces, Caecal contents

TO: Weber Team

FROM: Project Director/Scientist

SUBJECT: Biweekly report, October 31, 1983

CREW BRIEFING: Members of the Weber team met with the STS11 crew on Wednesday, Oct. 19, 1983 beginning at 8AM at JSC. All 5 members of the crew were present (crew directory is attached). Members of the Weber team included Dan Weber, Dave Larson, Tom Kessler, John Jackson, Neil Christie, Laura Staples, and Emily Holton. Also present were members of the timelining group for STS11: Willie B. Williams (Mail Code DH6, phone number 713/483-3319), Allen Burge (Mail Code DH6, phone number 713/483-4483), and Tom Vollrath (Mail Code DH4, phone number 713/483-3486). Dr. Phil Johnson (Mail Code SD-3, phone number 713/483-5457) and Ms. Theda Driscoll (Baylor College of Medicine, phone number 713/799-4769) represented JSC Life Sciences Division. John Jackson began the briefing by thanking the crew and introducing the topic. Emily Holton briefly introduced the project and the principal players. She discussed criteria for SSIP proposals and the rationale of the program. Dan Weber then discussed his project and gave an historical and current perspective. Tom Kessler discussed development of the hardware (AEM). Dave Larson discussed the science and addressed some of the conflicts that have occurred. The briefing was scheduled for 2 hours, and at 10AM, all presentations had not been completed, but most of the important information had been conveyed. The crew was most attentive and helpful.

As requested by the entire Weber team, a note of appreciation has been sent to the crew through Ron McNair.

Following the briefing, the team met to discuss the timelines (see attached). Several changes were requested; primarily, the on/off light schedule was recommended to occur at the same time each day with data-gathering to occur as closely to the same time of day as the schedule will allow. The team would like more video taping but appreciates the time constraints. The checklist for animal health/behavior was approved, but may be expanded.

Ron McNair requested healthy and arthritic rats so that he could observe the development of the arthritic process and would be familiar with the measurements prior to flight. Dave Larson provided the rats and delivered them at the briefing. Phil Johnson made arrangements to have the animals housed at the JSC animal facility and Theda Driscoll transported the rats to the animal facility after the briefing. Ron McNair has been visiting the animal facility on his own time in the evenings.

SUPPLEMENTAL SCIENCE: Just to reemphasize, supplemental science will only be done on specimens, data, or film obtained by the Weber team and approved by the team and by NASA Life Sciences division. Only members of the team will have access to the flight and control rats.

AEM HARDWARE STATUS: 1. The AIR FLOW rate in the "dirty" AEM (as at end of DSO0421) was 16.7 ft/min or 14.7 cfm. The pots controlling the fan gain will be removed to add another +2v to the system. Air flow rate will be measured again after the filter and pots have been removed.

Hopefully, the final flow rate will be close to 30 ft/min.

2. The 4 front FUSES (3/8 amp each) may be removed from the AEM since they are prone to failure inherently and are difficult to change. Also a larger fuse (2 amp) was required between the AEM and external power and was added prior to STS8. Thus, removal of the smaller fuses will decrease significantly the possibility of failure of the system.

3. An automatic on/off LIGHT SWITCH is being developed at JSC by Laura Staples/John Jackson/Neil Christie. The printed circuit board will be sent to General Dynamics and incorporated into the flight system. The manual switch will be keep as a backup system.

4. The TEMPERATURE PROBE will be changed. From a suggestion made by Bob Stewart at the crew briefing, photographic thermometers are being investigated. A larger diameter, smaller range thermister will be obtained and sealed with a gasket to the lexan top in approximately the same position as the thermister used in STS8.

5. The WATER BOTTLE is still under development. However, the delay of STS9 has impacted testing of the system. Presently John Jackson is investigating the possibility of KC135 flights at JSC and Paul Sebesta is investigating flights at ARC. The aluminum container will initially be fabricated at General Dynamics due to delays in delivery by the original vendor. This prototype will be tested on the KC135 and will be used in the ground control cage during the mission if the watering system is approved in time for STS-11.

SCIENCE STATUS: 1. A FULL-UP TEST will be done for the first 3 days that the team is at KSC to assure that no hardware change will impact animal health/ behavior and to timeline the procedures necessary to load the animals prior to launch. The ground simulation cage will be used and all modifications to the AEM will be included in that cage. The animals will be weighed before and after the test, daily monitoring of behavior will be done, and food and water (or potato) consumption will be noted and compared to normally housed rats. The AEM will be run during part of this test to assure that no charcoal is in the fans and that the system functions properly following shipment.

Perhaps we should consider soap rather than anti-fog on the lexan cover. Whatever we use should be incorporated in the full-up test to assure that the agent does not impact the rats.

2. A recent EXPERIMENT at Pfizer has shown that barrier derived (gut flora defined) Lewis rats develop arthritis as do SPF Lewis rats. Thus, if necessary the barrier derived rats can be used for flight, but the cost is staggering ($125/rat).

3. A potential method for MARKING RATS discussed at the crew briefing would be to use black dye (india ink or equivalent) on the total tail, the distal half of the tail, or not at all. In addition, both ears, one ear, or no ears would be dyed with the ink. Such markings would be necessary to distinguish animals inflight and should be used in conjunction with tatoos. These markings will be tried on rats in the full-up test to see how readily the rats can be distinguished from one another.

UPDATED TEAM DIRECTORY. The updated directory includes the name and address of Dan's teacher, Francine Salzman.

ACTION ITEM UPDATE: Be sure to peruse the action item update list and attend to those items assigned to you. Once items are completed, they will be deleted from this list.

ENCLOSURES:
1) STS11 Crew Directory
2) Kessler/Holton Presentations for Crew Briefing
3) AEM/SSIP Timelines for STS11
4) Launch Windows for STS11
5) Updated Team Directory
6) Updated Action Items

STS11 CREW DIRECTORY

COMMANDER: Vance D. Brand
Mail Code CB
NASA-Johnson Space Center
Houston, TX 77058
/13/483-2321 (FTS = 525)

PILOT: Capt. Bruce McCandless
Mail Code CB
NASA-Johnson Space Center
Houston, TX 77058
713/483-2321 (FTS = 525)

MISSION SPECIALISTS: Dr. Ronald E. McNair
Mail Code CB
NASA-Johnson Space Center
Houston, TX 77058
713/483-2321 (FTS = 525)

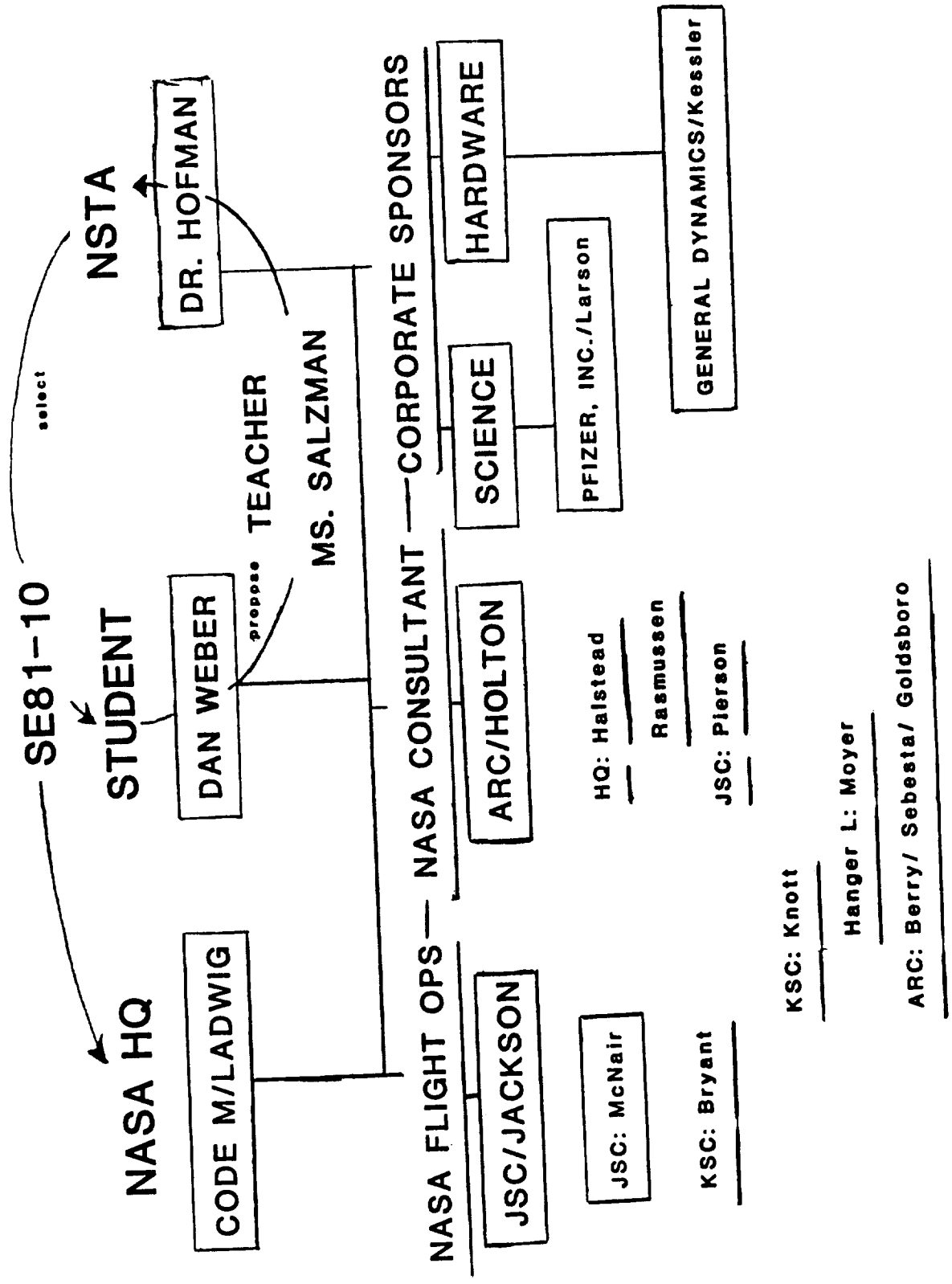
Lt. Cdr. Robert "Hoot" Gibson
Mail Code CB
NASA-Johnson Space Center
Houston, TX 77058
713/483-2321 (FTS = 525)

Lt. Col. Robert Stewart
Mail Code CB
NASA-Johnson Space Center
Houston, TX 77058
713/482-2321 (FTS = 525)

PRESENTATIONS AT CREW BRIEFING

JOHNSON SPACE CENTER

October 19, 1983


NASA HQ
SE81-10
select
NSTA
STUDENT
DR. HOFMAN
DAN WEBER
propose
TEACHER
MS. SALZMAN
CODE M/LADWIG
NASA FLIGHT OPS
NASA CONSULTANT
CORPORATE SPONSORS
JSC/JACKSON
ARC/HOLTON
SCIENCE
HARDWARE
PFIZER, INC./Larson
GENERAL DYNAMICS/Kessler
HQ: Halstead
Rasmussen
JSC: Pierson
JSC: McNair
KSC: Bryant
KSC: Knott
Hanger L: Moyer
ARC: Berry/ Sebesta/ Goldsboro

A SHORT HISTORY OF THE ANIMAL ENCLOSURE MODULE AND THE DAN WEBER SSIP EXPERIMENT

TOM KESSLER
GENERAL DYNAMICS PROJECT LEADER

19 OCTOBER 1983

CHRONOLOGY OF DAN WEBER'S
SHUTTLE STUDENT INVOLVEMENT PROJECT

1981 - Beginnings

January	-	Student's proposal received at NASA Headquarters
Feb-June	-	SSIP Evaluation and Selection Process Search for Corporate Sponsor for Weber Experiment
July	- -	Pfizer and General Dynamics agree to co-sponsor Weber Experiment Dr. E. M. Holton agrees to serve as NASA Consultant
August	-	George Drake, former life science chief, selected to head GD effort
October	-	Drake estimates GD sponsorship would cost $500K or more, cites past experience with STS Hardware Qualification
November	-	Tom Kessler from Advanced Systems selected to take fresh look at project to see if it could not be handled in a non routine manner at lower cost

ORIGINAL ANIMAL ENCLOSURE MODULE DESIGN - JULY 1981

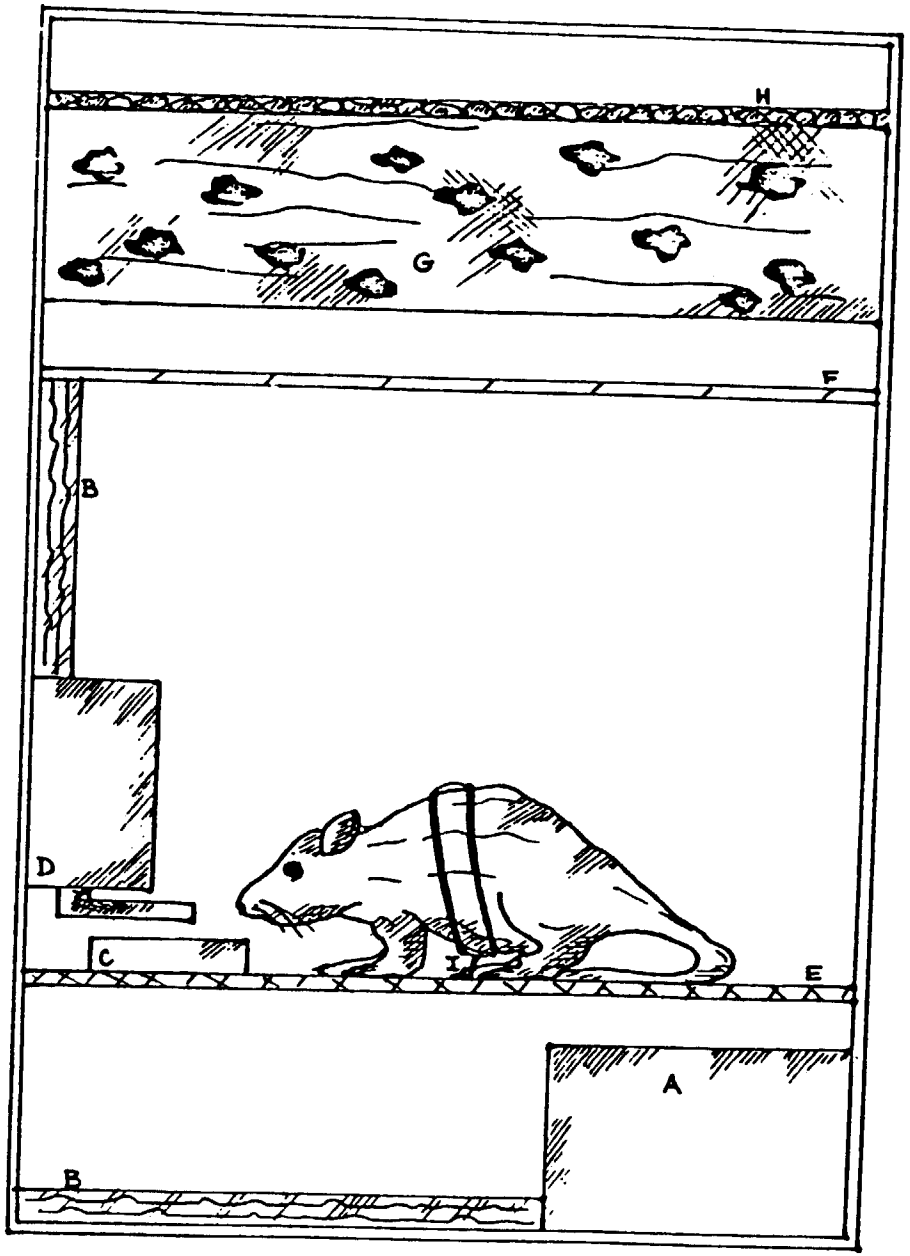


Diagram Key

A) battery powered fan

B) semi-permeable membrane

C) Ames food bar

D) pressurized water bottle

E) intricate mesh

F) wide mesh

G) cotton-charcoal waste absorber

H) bed of charcoal

I) tether for rat stability

CHRONOLOGY CONTINUED

1982 - Design and Fabrication

January	-	Preliminary design issues researched
Jan-July	-	Weber visits Pfizer Lab on a biweekly basis and works with Dr. Dave Larson conducting background research and developing experiment protocol.
February 8-9	-	GD discusses student experiment at NASA Headquarters with SSIP management and Life Sciences Branch personnel.
February 10	-	GD meets student and Pfizer counterparts at Groton, CT.
February 26	-	Hardware proposal discussed with NASA Ames Life Science Experiments experts. Much design data, names of hardware suppliers, etc for RAHF obtained; Potatoes selected for water supply.
March 4	-	Hardware proposal discussed with NASA JSC - John Jackson, Dr. Jeff Hoffman, Safety, Still Photo & Video personnel
April 20	-	Refined hardware proposal discussed with NASA KSC - Dr. Bill Knott and others at Life Science Support Facility
April 22	-	Refined hardware proposal and numerous trade study results presented to large NASA JSC audience-Dead Animal Disposal; Filter Design & Composition; Blower type and #; Basic Design Layout; Concept of Test Flight followed by Experiment Flight-STS 6 & 7
April-June	-	Design finalized and Production Drawings for Test Flight Article produced; Locker Drawer delivered to GD
June 23	-	Final Design Review at NASA Ames
July	-	Animal Enclosure Module Test Flight Article produced
	-	Dan Weber visits GD-Convair and spends 3 weeks with Dr. Holton of Ames refining data base with animal suspension tests

CHRONOLOGY CONTINUED

1982 - Testing and Refinement

August 5 - AEM delivered to Pfizer where Dr. Larson and Dan conduct 4 live animal tests with it:
- 6 Animals (Healthy/Arthritic) for 6 days; Filters Changed
- 6 Animals (Healthy/Arthritic) for 6 days; Filters not Changed
- 6 Animals (Healthy only) for 6 days; Filters not Changed
- 6 Animals (4 Dead, 2 Healthy) for 6 days

No objectionable odors were detected during any of these tests despite 3 week continued use of same filter; No other anomalous behavior detected

September 13- AEM returned to GD Convair - 24 minor changes made to hardware in light of test results

October 4 - AEM delivered to NASA JSC for testing and potential flight on STS-6 in January; Freon leaks tests performed; Vibration tests with filters loaded

November 24 - Human Use Board Meeting suggests minor hardware modification, and that cage never be opened in flight, whether animals die or not, to reduce contamination potential

December 10 - AEM returned to GD Convair - Minor modifications made, wiring rearranged, gasket material added to improve seals

CHRONOLOGY CONTINUED

1983 - Final Testing and First Flight

January 11	-	AEM delivered to JSC
January 13	-	Critical Design Review; Planning for STS DTO and STS-11 Experiment Flight
February 16	-	Safety Review at JSC; Primary Fuse Added, Safety decides to run second Dead Animal Test
March 25-April 4	-	Odor Detection Test #1; 6 Dead Rats for 10 days with fans running continuously in sealed 2 M^3 test chamber; No objectionable odors were detected at any point until AEM seal was broken; Bacteria and fungi tests on cage exterior report negative
April 15-21	-	Odor Detection Test #2; 6 Live Healthy Rats for 6 Days with fans running; No odors, off-gassing, bacteria, fungi, etc detected
May 13	-	Test Results Published by Medical Research Branch
	-	AEM DSO #0421 postponed until STS-8 in August
May-August	-	AEM placed in Bonded Storage at JSC
August 4	-	STS-8 DSO Coordination Meeting at NASA Headquarters; JSC, KSC, ARC and General Dynamics attend
August 25	-	AEM delivered to KSC; Ground preparation begins with healthy Gnotobiotic animals
August 30	-	Animals and AEM loaded into orbiter at T-12 hours
August 30-September 5	-	STS-8 Test Flight; Animals readily adapt to Zero-G, suffer no harmful effects; Potatoes all eaten 24 hours before landing; Air Flow Rate lower than expected

FINAL PREPARATIONS FOR STUDENT EXPERIMENTS

1983

SEPTEMBER 20-21	POST FLIGHT REVIEW WITH DR. BILL THORNTON; STS-11 PLANNING MEETING WITH RON McNAIR
OCTOBER 5	AEM RETURNED TO GENERAL DYNAMICS; AIR FLOW RATE TESTS, MINOR AEM MODIFICATIONS AND FABRICATION OF GROUND CONTROL CAGE AND SPRING-LOADED WATER SUPPLY SYSTEM BEGUN
OCTOBER 19	FULL STS-11 CREW BRIEFING

FUTURE

NOVEMBER 15	SPRING LOADED WATER SUPPLY & AEM DELIVERED TO AMES FOR LIVE ANIMAL TESTING
DECEMBER 1	AEM DELIVERED TO JSC BONDED STORAGE
DECEMBER 12	SPRING LOADED WATER SUPPLY DELIVERED TO JSC FOR FURTHER TESTING

1984

JANUARY 29	STS-11 LAUNCH WITH DAN WEBER STUDENT EXPERIMENT (3 YEARS AFTER ORIGINAL SSIP PROPOSAL SENT TO NASA)
MAY	STS-14 LAUNCH WITH ANDREW FRAS STUDENT EXPERIMENT (CO-SPONSORED WITH L.A. ORTHOPEDIC HOSPITAL)
	AFTER STS-14 FLIGHT, AEM WILL BE DONATED TO NASA FOR FUTURE USE BY OTHER PROFESSIONAL INVESTIGATORS

STUDENT EXPERIMENTS

TIMELINES

AEM //

1 AEM Lights On

LIGHTS - ON
✓Fan Fuse LED (four) - off

* If any LED lit, notify MCC *

Log MET ____/____:____

____/____:____

____/____:____

____/____:____

____/____:____

____/____:____

____/____:____

____/____:____

____/____:____

2 AEM Data Collection

Pull AEM from locker

NOTE

Cage A (left) has 3 arthritic rats (#1,2,3). Cage B (right) has 3 normal rats (#4,5,6). Rate condition as: B = bad, P = poor, F = fair, G = good, or E = excellent

MET ___/___:___ TEMP _____ °F

	Cage A					Cage B				
Condition	B	P	F	G	E	B	P	F	G	E
Motion										
Grooming										
Feeding										
Morale										

Comments:

Stow AEM in locker

MET ___/___:___ TEMP _____ °F

	Cage A					Cage B				
Condition	B	P	F	G	E	B	P	F	G	E
Motion										
Grooming										
Feeding										
Morale										

Comments:

Stow AEM in locker

3 AEM Lights Off

LIGHTS - OFF
✓Fan Fuse LED (four) - off

* If any LED lit, notify MCC *

Log MET ____/____:____

____/____:____

____/____:____

____/____:____

____/____:____

____/____:____

____/____:____

____/____:____

____/____:____

STUDENT EXPERIMENT (AEM) OPERATION TIMES

EVENT	APPROX MET (D/HH:MM)	DURATION (HH:MM)
LIGHTS OFF (HANGAR L)	-0/13:30	12:00 OFF
LOAD AEM IN MIDDECK	-0/12:00	
LIGHTS ON	-0/01:30	11:00 ON
LAUNCH	0/00:00	
LIGHTS OFF	0/09:30	11:00 OFF
LIGHTS ON	0/20:30	11:00 ON
DATA & LIGHTS OFF	1/07:30	11:30 OFF
LIGHTS ON	1/19:00	10:30 ON
VTR/DATA & LIGHTS OFF	2/05:30	12:00 OFF
LIGHTS ON	2/17:30	11:00 ON
DATA & LIGHTS OFF	3/04:30	13:00 OFF
LIGHTS ON	3/17:30	11:00 ON
DATA & LIGHTS OFF	4/04:30	13:00 OFF
LIGHTS ON	4/17:30	11:00 ON
VTR	5/00:10	
DATA & LIGHTS OFF	5/04:30	13:00 OFF
LIGHTS ON	5/17:30	11:00 ON
DATA & LIGHTS OFF	6/04:30	13:00 OFF
LIGHTS ON	6/17:30	11:00 ON
VTR/DATA & LIGHTS OFF	7/04:30	13:00 OFF
LIGHTS ON	7/17:30	11:00 ON
LANDING (KSC)	7/23:21	
REMOVE AEM FROM MIDDECK (LDG + 1 HR)	8/00:21	
LIGHTS OFF	8/04:30	

use this schedule Tasmoit

BARRIOS TECHNOLOGY, INC.

TRANSMITTAL MEMO

TITLE: STS-11 Launch Window

T. M. NO.: 678

TO: NASA/JOHNSON SPACE CENTER
2101 NASA ROAD 1
HOUSTON, TEXAS 77058

DATE: 15 September 1983

CONTRACT NO: NAS 9-16129

ATTN: R. Swalin/FM2

TASK ORDER NO: J3

W. P. NO: 563.2

REMARKS:

This memo contains digital and graphical STS-11 launch window data for the time period January 20, 1984 to February 29, 1984. The available launch window is shaded on the attached launch window plot (Figure 1). The opening of the launch window is based on the orbiter lighting constraint to land no earlier than sunrise minus 10 minutes for the AOA landing opportunity into EDW. The Westar earth horizon sensor constraint for the backup injection opportunity on 33A may be relaxed as required to provide a larger launch window. The closing of the window is based on the thermal constraint for a Palapa or Westar injection on 5A which could be accomplished in the event of a payload sunshield failure. Westar injection on 7A is the first prime deployment opportunity for the mission. Digital launch window data for the orbiter landing lighting constraints and the payloads thermal constraints are summarized in Table I.

A launch time of 13:00 GMT is acceptable for any launch date after January 29, 1984. Selection of a launch time that is valid for a resonable period of time without compromising mission objectives can significantly decrease data products required to support the mission in the event of a launch day change. Changing the launch time will have minor effects on the trajectory design. An evaluation of impact to the trajectory design resulting from revisions to launch time is in progress.

Prepared By: D A Kessler 480-1889
[redacted]
Sr. Task Manager

Approved By: S G Mallini
S.G. Mallini
Production Flight Design Manager

Approved By: J A Yglesias
J.A. Yglesias
Project Manager

Approved By: _____

Approved By: _____

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FD04-REV 3/82

NASA-JSC

83FM42

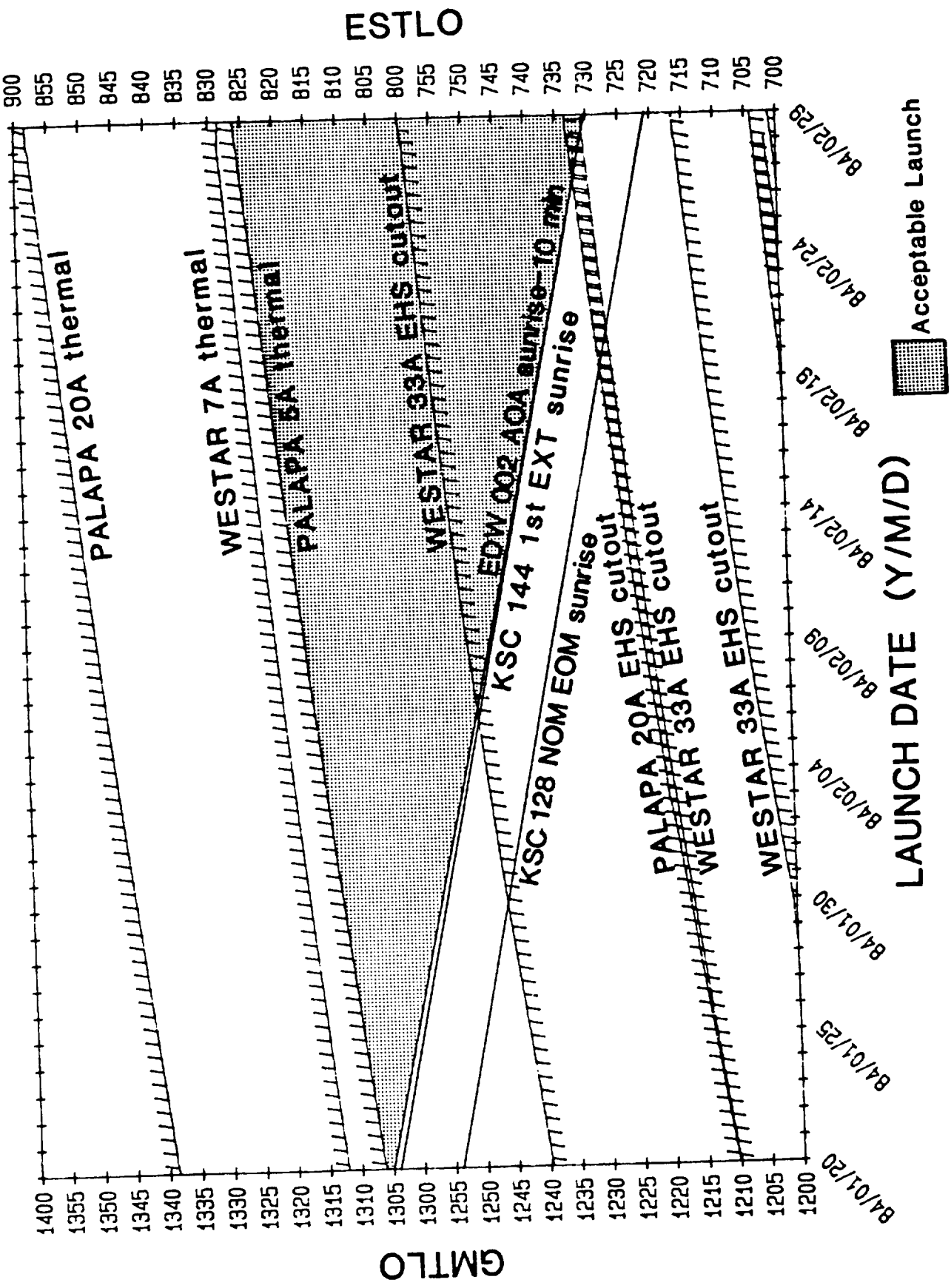

Figure 1.– STS–11 composite launch window

TABLE IA.- STS-11 DIGITAL LAUNCH WINDOW DATA
(January 20, 1984 - January 31, 1984)
GMT (HR:MIN)

DATE	AOA EDW (SUNRISE -10 MIN) OPENING	EOM KSC SUNRISE ORBIT 128 OPENING	EOM KSC SUNRISE ORBIT 144 OPENING	P-5A CLOSING	W-5A CLOSING	P-7A CLOSING	W-7A CLOSING	P-20A CLOSING	W-20A CLOSING	P-33A CLOSING	W-33A CLOSING
1/20	13:05	12:54	13:04	13:06	13:07	13:10	13:12	13:38	13:40	14:06	14:08
1/21	13:05	12:54	13:03	13:06	13:08	13:11	13:12	13:39	13:40	14:06	14:08
1/22	13:04	12:53	13:03	13:07	13:08	13:11	13:13	13:39	13:41	14:07	14:08
1/23	13:04	12:53	13:02	13:07	13:09	13:12	13:13	13:40	13:41	14:08	14:09
1/24	13:03	12:52	13:02	13:08	13:09	13:12	13:14	13:40	13:42	14:08	14:09
1/25	13:03	12:52	13:01	13:09	13:10	13:13	13:14	13:41	13:42	14:09	14:10
1/26	13:02	12:51	13:00	13:09	13:10	13:13	13:15	13:41	13:42	14:09	14:10
1/27	13:02	12:50	13:00	13:10	13:11	13:14	13:15	13:42	13:43	14:10	14:11
1/28	13:01	12:50	12:59	13:10	13:11	13:14	13:16	13:42	13:43	14:10	14:11
1/29	13:00	12:49	12:59	13:11	13:12	13:15	13:16	13:43	13:44	14:11	14:12
1/30	13:00	12:49	12:58	13:11	13:12	13:16	13:16	13:43	13:44	14:11	14:12
1/31	12:59	12:48	12:57	13:12	13:13	13:16	13:17	13:44	13:45	14:12	14:13

TABLE IB - Continued
(February 1, 1984 - February 14, 1984)
GMT (HR:MIN)

DATE	AOA EDW (SUNRISE -10 MIN) OPENING	EOM KSC SUNRISE ORBIT 128 OPENING	EOM KSC SUNRISE ORBIT 144 OPENING	P-5A CLOSING	W-5A CLOSING	P-7A CLOSING	W-7A CLOSING	P-20A CLOSING	W-20A CLOSING	P-33A CLOSING	W-33A CLOSING
2/01	12:58	12:47	12:56	13:12	13:13	13:17	13:17	13:45	13:45	14:12	14:13
2/03	12:58	12:46	12:56	13:13	13:14	13:17	13:18	13:45	13:46	14:13	14:14
2/03	12:57	12:46	12:55	13:13	13:14	13:18	13:18	13:46	13:46	14:13	14:14
2/04	12:56	12:45	12:54	13:14	13:15	13:18	13:19	13:46	13:47	14:14	14:14
2/05	12:55	12:44	12:53	13:14	13:15	13:18	13:19	13:47	13:47	14:14	14:15
2/06	12:54	12:43	12:53	13:15	13:15	13:19	13:20	13:47	13:48	14:15	14:15
2/07	12:54	12:43	12:53	13:15	13:16	13:20	13:20	13:48	13:48	14:15	14:16
2/08	12:53	12:42	12:51	13:16	13:16	13:20	13:20	13:48	13:48	14:16	14:16
2/09	12:52	12:41	12:50	13:16	13:17	13:21	13:21	13:49	13:49	14:16	14:16
2/10	12:51	12:40	12:49	13:17	13:17	13:21	13:21	13:49	13:49	14:17	14:17
2/11	12:50	12:39	12:48	13:17	13:17	13:22	13:22	13:50	13:50	14:17	14:17
2/12	12:49	12:38	12:47	13:18	13:18	13:22	13:22	13:50	13:50	14:18	14:18
2/13	12:48	12:37	12:46	13:18	13:18	13:22	13:22	13:51	13:50	14:18	14:18
2/14	12:47	12:36	12:45	13:19	13:19	13:23	13:23	13:51	13:51	14:19	14:18

TABLE IB.- Concluded
(February 15, 1984 - February 29, 1984)
GMT (HR:MIN)

DATE	AOA EDW (SUNRISE -10 MIN) OPENING	EOM KSC SUNRISE ORBIT 128 OPENING	EOM KSC SUNRISE ORBIT 144 OPENING	P-5A CLOSING	W-5A CLOSING	P-7A CLOSING	W-7A CLOSING	P-20A CLOSING	W-20A CLOSING	P-33A CLOSING	W-33A CLOSING
2/15	12:46	12:35	12:44	13:19	13:19	13:23	13:23	13:51	13:51	14:19	14:19
2/16	12:45	12:34	12:43	13:20	13:19	13:24	13:24	13:52	13:52	14:20	14:19
2/17	12:44	12:33	12:42	13:20	13:20	13:24	13:24	13:52	13:52	14:20	14:19
2/18	12:42	12:32	12:41	13:21	13:20	13:25	13:24	13:53	13:52	14:21	14:20
2/19	12:41	12:31	12:40	13:21	13:21	13:25	13:25	13:53	13:53	14:21	14:20
2/20	12:40	12:30	12:39	13:22	13:21	13:26	13:25	13:54	13:53	14:21	14:21
2/21	12:39	12:29	12:38	13:22	13:21	13:26	13:25	13:54	13:53	14:22	14:21
2/22	12:38	12:28	12:37	13:23	13:22	13:27	13:26	13:55	13:54	14:22	14:21
2/23	12:37	12:27	12:36	13:23	13:22	13:27	13:26	13:55	13:54	14:23	14:22
2/24	12:35	12:26	12:35	13:23	13:22	13:28	13:27	13:55	13:54	14:23	14:22
2/25	12:34	12:25	12:34	13:24	13:23	13:28	13:27	13:56	13:55	14:24	14:22
2/26	12:33	12:24	12:33	13:24	13:23	13:28	13:27	13:56	13:55	14:24	14:23
2/27	12:32	12:23	12:32	13:25	13:23	13:29	13:28	13:57	13:56	14:25	14:23
2/28	12:31	12:22	12:31	13:25	13:24	13:29	13:28	13:57	13:56	14:25	14:24
2/29	12:30	12:21	12:30	13:26	13:24	13:30	13:29	13:58	13:56	14:25	14:24

DIRECTORY OF TEAM MEMBERS FOR SE81-10

STUDENT:

Mr. Daniel J. Weber
950 Park Avenue
New York City, NY 10028
212/249-1020
or
709 Stewart Ave.
Ithaca, NY 14850
607/273-2447

TEACHER:

Ms. Francine Salzman
1 Thurston Drive
Livingston, NJ 07039

CORPORATE SPONSOR:

PFIZER:

Dr. David Larson
Central Research Division
Pfizer, Inc.
Eastern Point Road
Groton, CT 06340
203/441-4691 (office)
203/441-4656 (lab)
203/739-0856 (home)

Dr. Mike Ernest
Central Research Division
Pfizer, Inc.
Eastern Point Road
Groton, CT 06340
203/441-3836

GENERAL DYNAMICS:

Mr. Thomas Kessler
DOD Advanced Space Programs
General Dynamics - Convair Division
PO Box 80847, Mail Code 21-9530
San Diego, CA 92138
619/573-5106
619/755-4779 (home)

Mr. Gerry Huston
DOD Advanced Space Programs
General Dynamics - Convair Division
PO Box 80847, Mail Code 21-9530
San Diego, CA 92138
619/573-9783
619/487-5287 (home)

NASA ARC:

Dr. Emily Holton
Biomedical Research Division
M/S 239-14
NASA-Ames Research Center
Moffett Field, CA 94035
415/965-5471 (FTS = 448)
415/965-5247
408/246-7440 (home)

Mr. Paul Sebesta
Life Sciences Flight Experiments
Project Office
M/S 240A-3
NASA-Ames Research Center
Moffett Field, CA 94035
415/965-6455 (FTS = 448)
408/996-8335 (home)

Dr. Jerome Goldsboro, Jr.
Biosystems Division
M/S 236-5
NASA-Ames Research Center
Moffett Field, CA 94035
415/965-6703 (FTS = 448)
415/965-6390
415/921-3552 (home)

NASA-JSC:

Mr. John Jackson
Crew Station Integration Section
Mail Code EN-43
NASA-Johnson Space Center
Houston, TX 77058
713/483-3173 (FTS = 525)
713/333-4542 (home)

Mr. Neil Christie
Crew Station Integration Section
Mail Code EN-43
NASA-Johnson Space Center
Houston, TX 77058
713/483-3173 (FTS = 525)

Dr. Malcolm Smith
Mail Code SD-3
NASA-Johnson Space Center
Houston, TX 77058
713/483-5457 (FTS = 525)

Dr. Ron McNair
Mail Code CB
NASA-Johnson Space Center
Houston, TX 77058
713/483-3856 (FTS = 525)

NASA HEADQUARTERS:

Mr. Alan Ladwig
Office of Space Flight
Code ME
NASA Headquarters
Washington, DC 20546
202/453-1138
703/237-4195 (home)

Mr. Michael Bowie
Office of Space Flight
Code MC-7
NASA Headquarters
Washington, DC 20546
202/453-1139

Dr. Thora Halstead
Life Sciences Division
Code SBE-3
NASA-Headquarters
Washington, DC 20546
202/755-3114
703/356-1397 (home)

Ms. Evvie Rasmussen
Public Affairs Office for OSSA
Code E-6
NASA-Headquarters
Washington, DC 20546
202/755-3054

NASA-KSC:

Dr. William Knott
Code MD-RSB-2
NASA-Kennedy Space Center, FL 32899
305/867-3152 (FTS = 823)
305/267-1321 (home)

Mr. Jerry Moyer
BIO-3, Hanger L
NASA-Kennedy Space Center, FL 32899
305/853-3165 (FTS = 824)
305/268-0672 (home)

Mr. John Bryant
Code CS-SED-4
NASA-Kennedy Space Center, FL 32899
305/867-3044 (FTS = 823)

Others:

Mr. Jack Sweeney
Bone and Connective Tissue Research Program
Orthopaedic Hospital
2400 South Flower St.
Los Angeles, CA 90007

SE81-10
ACTION ITEMS

ITEM	PERSON RESPONSIBLE	DATE DONE
1. Distribution of inflight timelines for SE81-10/SIS-11	Jackson	10/19/83
2. Distribution of STS-11 crew names and NASA addresses	Jackson	10/31/83
3. Inflight check list for rat health/behavior	Larson/Weber	see timelines
4. STS-11 PAO rat downlink/yea or nay	Halstead	
5. AEM air flow measurements a. dirty b. clean	Kessler/General Dynamics	10/26/83
6. STS-8 Project Report including: Microbiology Hematology Food/Water/Rat Weights Timelines Contingency Plans Launch/landing facilities used	Smith/Holton	
7 Charles River SPF rats	Larson to get guarantee	
8 Teklad Diet Purchase	Sebesta	
9 List of pathogens NASA does not allow inflight	Holton/Smith	10/17/83
10 SIS-8 (DSO 0421) and SIS-11 (SE81-10) preflight, flight, postflight coordinated videotapes	Sebesta/Holton	
11. Check for inflight temperature recorder with remote probe	Holton	10/17/83
12. Repack AEM filters/prepare under clean conditions if possible	Kessler/Christie	
13. Make new lid for AEM	Kessler	
14. Check out antifog spray for AEM lid	Johnson	
15. Microbiology of AEM filter after repacking and before STS-11	Smith	
16 Contingency plans for nonUS landings	Jackson	

ITEM	PERSON RESPONSIBLE	DATE DONE
17. Contingency facilities for US landing sites	Sebesta	
18. SIS-11 Launch windows	Jackson	10/26/83
19. Directory of personnel at KSC, JSC, ARC, and HQ associated with SIS11 launch and recovery operations (addresses/phones) for SE81-10	Sebesta/Smith	
20. Publicity coordination policy	Halstead	10/4/83
21. Holder for transporting AEM to launch pad	Jackson	
22. Ground unit mock-up of AEM	Kessler	
23. KSC photographic support/ physicals and clearances necessary	Knott/Sebesta	
24. Experiment measurements table for supplemental science agreed/ recommended	Halstead	
25. Animal handlers physicals/ requirements and updates for team	Knott	
26. Clear Kessler to launch pad	Knott	
27. Letter to Pfizer requesting services of person qualified for orbital vein bleeding	Halstead	
28. Biweekly newsletter	Holton	ongoing; initiated 10/3/8
29. Crew Briefing Date Preflight	Jackson	10/6/83
30. Historical videotape of NASA Life Sciences past animal flights	Halstead	
31. Postflight trip to Pfizer for rats	Halstead/Knott/Sebesta (contingency landing sites)	
32. Letter to Gene Rice requesting servie of Dr. Smith for SE81-10	Holton	10/17/83
33. Questions for postflight crew debriefing	Team	

ITEM	PERSON RESPONSIBLE	DATE DONE
34A. AEM to General Dynamics for refurbishing	Jackson	10/5/83
34B. AEM to JSC for flight storage	Kessler	
35A. Build water system for AEM	Kessler/Sweeney	
35B. Flight qualify water system	Jackson	
35C. KC135 flights at JSC	Jackson	
35D. KC135 flights at ARC	Sebesta	
36. Potato consumption/food consumption/growth data from baseline studies	Weber/Larson	
37. Motel/condo reservations for team at KSC	Knott	
38. Method for marking rats preflight and during flight	Team	
39. Objectives/protocol for KC135 test of water system	Kessler	
40. Status of JSC temperature recorders	Jackson	
41 Microbiology report from preflight and postflight measurements for rats and AEM in OS00421	Knott/Moyer	
42. Effect of 2 5KHz noise for 2 hours on rats (simulated 3-axis acoustic containment furnace experiment [ACES] which will be in middeck locker on STS11)	Sebesta	
43. Fuse changeout procedure	Jackson/Christie	

TO: Weber Team

FROM: Project Manager/Scientist

SUBJECT: Biweekly report (#4), November 14, 1983

AEM HARDWARE STATUS: 1. The WATER BOTTLE is to be tested on the KC135 flight at Dryden at 0800, 12/10/83. If the General Dynamics bottle is ready, it will be tested; if not Jack Sweeney will test his prototype. The tests will be done in conjunction with postflight data collection for SL1. STS9 is presently scheduled for launch November 28, 1983, and recovery on December 7, 1983. Postflight data gathering for SL1 using the KC135 will occur over a two day period during which the water bottle will be flown on a space available basis on runs other than that scheduled above. Videotape and regular photography will be available inflight.

2. The automatic on/off LIGHT SWITCH may not be ready in time for STS11. Thus, it will not be sent to General Dynamics and incorporated into the system. If added, the PC board will be incorporated into the AEM at JSC.

3. The new TEMPERATURE PROBE is a photographic, bimetalic thermometer, 1 3/4" in diameter with a 25-125F range and +/- 0.5 degree accuracy. It will be at approximately the same place on the divider in the AEM as the old probe, but it will be surrounded by a gasket which will be in contact with the lexan top so that the top over the probe will not come in contact with moisture, urine, feces, food, etc. which tend to obscure the lexan top and, hence, reading of the dial.

4. The CARRYING CASE for transporting the AEM to the launch pad is finished and ready for the project.

5. The GROUND CONTROL CAGE and WATER BOTTLE will hopefully be finished by the end of December. They will be shipped from General Dynamics to ARC for testing and ARC will be responsible for shipping the equipment to KSC after observing rats in the cage.

SCIENCE STATUS: 1. An EXPERIMENT is in progress at Pfizer in which rats were given tetracycline on days 10 and 18 after induction of arthritis. Animals will be euthanized about day 28 and the tibias and humeri removed and sent to ARC to determine the feasility of this labeling schedule and the type and amount of bone data that might be gleaned from such an experiment. Nonarthritic rats are also being processed.

2. NO BLOOD SAMPLES will be taken from flight or control rats PREFLIGHT. Health, well-being, and humane treatment of rats are a continuous concern of this team. No invasive samples will be taken from rats in this experiment without documented data that suggests such information is meaningful and necessary. Any unnecessary handling or measurements of rats prior to flight must be avoided so that flight and control rats will not be unduly stressed during the experiment.

DATES TO REMEMBER:
1. November 28 is launch date for STS9.

2. January 29 is launch date for STS11.

3. December 6, five randomly chosen animals from the same barrier room which will provide the flight and control animals will be shipped to KSC.

December 9, preliminary health screening for pathogens will be done on nasophyrngeal swabs and fecal pellets on the above five rats.

December 12, complete health screening for pathogens recommended for exclusion from flight will be done on these animals.

December 15, preliminary report on health status of rats in that barrier room.

December 16, decision on whether SPF animals from that barrier room are sufficiently clean or whether we should use gnotobiotics.

4. January 10, rats arrive at KSC and placed on light/dark schedule to be used during flight (presently lights on at 1200EST and off at 0100EST; 13 hrs light/11 hours dark based on launch at 0730EST).

5. January 21, team arrives at KSC.

January 22, meeting to plan timelines and full-up test.

January 23, begin full-up test.

January 26, end full-up test.

January 27, finalize timelines

January 28, load animals in AEM and deliver to launch pad around 1930EST.

Most of the above dates are tentative (primarily 3-5). If you have difficulty or conflicts with the above schedule, please let me know as soon as possible. All dates are based on the premise that STS9 will go on schedule and will be successful. Any problems with STS9 may impact the launch schedule and create a slip in all the above dates.

TIMELINES: The timelines you received from Laura Staples are tentative timelines written prior to our briefings at JSC, Oct. 19. You will receive updated timelines as they become available.

LAUNCH WINDOWS: In the last newsletter, projection of launch windows for STS11 was enclosed but somehow missed being listed with the enclosures. This document will also be updated as the missions draw nearer.

ACTION ITEM UPDATE: Be sure to peruse the action item update list and attend to those items assigned to you.

ENCLOSURE: Updated Action Items

SE81-10
UPDATED ACTION ITEMS

ITEM	PERSON RESPONSIBLE	DATE DONE
1. STS-11 PAO rat downlink/yea or nay	Halstead	
2. AEM air flow measurements (clean)	Kessler/General Dynamics	
3. STS-8 Project Report	Smith/Holton	
4. Charles River SPf rats	Larson to get guarantee	
5. Teklad Diet Purchase	Sebesta	
6. STS-8 (DSO 0421) and STS-11 (SE81-10) preflight, flight, postflight coordinated videotapes	Sebesta/Holton	
7. Repack AEM filters/prepare under clean conditions if possible	Jackson/Christie	
8. Make new lid for AEM	Kessler	
9. Check out antifog spray for AEM lid	Johnson	
10. Microbiology of AEM filter after repacking and before STS-11	Smith/Pearson	
11. Contingency plans for nonUS landings	Jackson	
12. Contingency facilities for US landing sites	Sebesta	
13. Directory of personnel at KSC, JSC, ARC, and HQ associated with STS11 launch and recovery operations (addresses/phones) for SE81-10	Sebesta/Smith	
14. Ground unit mock-up of AEM	Kessler	
15. KSC photographic support/ physicals and clearances necessary	Knott/Sebesta	
16. Updated STS11 timelines (as available)	Staples/Jackson	
Updated STS11 launchwindows (as available)		

ITEM	PERSON RESPONSIBLE	DATE DONE
17. Experiment measurements table for supplemental science: agreed/ recommended	Halstead	
18. Animal handlers physicals/ requirements and updates for team	Knott	
19. Clear Kessler to launch pad	Knott	
20. Biweekly newsletter	Holton	ongoing; initiated 10/3/83
21. Historical videotape of NASA Life Sciences past animal flights	Halstead	
22. Postflight trip to Pfizer for rats	Halstead/Knott/Sebesta (contingency landing sites)	
23. Questions for postflight crew debriefing	Team	
24. AEM to JSC for flight storage	Kessler	
25A. Build water system for AEM	Kessler/Sweeney	
B. Flight qualify water system	Jackson	
C. KC135 flights at DFC (ARC South)	Jackson/Sweeney/Kessler/Moyer	
D. Objectives/protocol for KC135 test of water bottle	Jackson	
26. Potato consumption/food consumption/growth data from baseline studies	Weber/Larson	
27. Motel/condo reservations for team at KSC	Knott	
28. Status of JSC temperature recorders	Jackson	
29. Microbiology report from preflight and postflight measurements for rats and AEM in DS00421	Knott/Moyer	
30. Effect of 4.5KHz noise at 75db for 2 hours on rats (simulated 3-axis acoustic containment furnace experiment [ACES] which will be in middeck locker on STS11)	Sebesta	
30. Fuse changeout procedure	Jackson/Christie	
34. PC board for automatic light/dark cycle in AEM	Staples/Jackson	

TO: Weber Team

FROM: Project Manager/Scientist

SUBJECT: Biweekly report (#5), November 28, 1983

Columbia (SL1 or STS-9) lifted off on time at 11AM EST today. The crew is scheduled to return Wednesday, December 7.

AEM HARDWARE STATUS: 1) The WATER BOTTLE is still scheduled for testing on December 10, 1983 at 8AM PST, at Dryden. The KC135 flights will occur at 8AM and 1PM that day and each run is scheduled to last 3 hrs 20 min. The primary questions for this test are: a) does the water bottle work in parabolic flight, b) does the system leak, c) would the aluminum container contain all water if a leak developed in the plastic bags, d) what is the residual volume in the bags after complete bleed-down (ie., what is the total available water volume), and e) could air bubbles impede the flow of water if they impinged upon the lixit valve. Photographic coverage of this test should be available to document answers to all these questions. By the next newsletter, we should have a better idea of the status of the water bottle.

2) The JSC TEMPERATURE RECORDERS will be available for STS11 and will be snapped into the water container if the watering system is available and ready in time for flight.

3) The FRONT FUSE on the AEM is presently configured for 6 amps. This configuration was used to protect the shuttle from failure of the AEM since the AEM wires would fuse at 7 amp. However, with removal of the smaller fuses from the AEM, this front fuse will probably be lowered to about 4 amps to also protect the AEM electronics in case of a failure.

4) The FRONT HANDLES of the AEM have been repositioned and now come directly off the black frame. Rather than pulling on the fragile plastic front, force will be on the AEM main Frame Assembly.

5) The AEM is scheduled to be shipped from General Dynamics on Wednesday, November 30, 1983, to JSC for bonded storage.

SCIENCE STATUS: 1) An ACOUSTIC EXPERIMENT simulating the worst case noise level and frequency expected from the simulated 3-axis acoustic containment furnace experiment (ACES) which will be in a middeck locker on STS11 is being planned at ARC (see enclosed memo). The hypothesis being tested is that ACES will not adversly affect rat performance or well-being; a negative response would indicate that animals are adversely affected by ACES and further planning would be necessary while a null response would suggest that ACES will not adversely influence the rats.

2) The Public Affair Office (PAO) at NASA Headquarters is compiling a brochure on facts about NASA's use of animals in research. When available, this brochure will be distributed to all team members.

3) The results of MICROBIOLOGICAL monitoring for DSO0421 are attached. I have not included the information on the initial SPF Lewis animals which were found to have Klebsiella pneumoniae and, hence, were not

flown. If you want this additional information, please request it.

DATES TO REMEMBER:

1. December 7 is landing date for STS9.

2. January 29 is launch date for STS11.

3. December 6, five randomly chosen animals from the same barrier room which will provide the flight and control animals will be shipped to KSC.

   December 9, preliminary health screening for pathogens will be done on nasophyrngeal swabs and fecal pellets on the above rats.

   December 12, complete health screening for pathogens recommended for exclusion from flight will be done on these animals.

   December 15, preliminary report on health status of rats in that barrier room.

   December 16, decision on whether SPF animals from that barrier room are sufficiently clean or whether we should use gnotobiotics.

4. January 10, rats for this experiment placed on light/dark schedule to be used during flight (presently lights on at 1200EST and off at 0100EST; 13 hrs light/11 hours dark based on launch at 0730EST). Rats will still be at Charles River, Kingston, NY, at this time.

   January 21, Larsen team to Charles River to inoculate rats. Rats shipped to KSC and Pfizer.

   January 23, team arrives at KSC; evening meeting to plan timelines and full-up test.

   January 24, begin full-up test.

   January 27, end full-up test, finalize timelines, and clean-up.

   January 28, load animals in AEM and deliver to launch pad around 1930EST.

   January 29, launch; begin ground-based experiments and preparation of final report

January 30-February 6, conduct ground-based experiment and prepare draft of final report

   February 6, landing, postflight observations, and delivery of animals to Pfizer.

   February 7, final clean-up and departure of team from KSC.

CONDOMINIUMS: Furnished condominiums at the Sea Gull Beach Club, 4440 Ocean Beach Blvd., Cocoa Beach, FL 32931 are being reserved for the launch. The phone number is 305/783-4441. One-bedroom condos rent for

$300/wk and two-bedroom condos rent for $350/wk. The rates will increase by $25/wk unless reserved before January 1, 1984. A check for $100 is necessary to reserve your condo. Be sure to mention these rates when making your reservation. This corporation is familiar with launch problems; they will return your $100 deposit if the launch is delayed or apply your monies to the new time schedule. The minimal reservation is one week; after one week, days are prorated if the tenancy is less than a full week.

One bedroom condos have a double bed in the bedroom, a sleeper couch in the living area, a balcony with an ocean view, and are located on the second and third floors of the building (some members have already reserved rooms on the third floor). Two-bedroom condos have a double bed, bath, and private entrance in each bedroom, a sleeper couch in the living area, and are on the ground floor. All condos have a kitchen/living area supplied with cooking equipment, dishes, table, chairs, etc. Linens are supplied also. A swimming pool is located between the building and the beach. Only four 2-bedroom condos are available while about thiry-two 1-bedroom condos are available.

ACTION ITEM UPDATE: Be sure to peruse the action item update list and attend to those items assigned to you.

ENCLOSURES:
1) Acoustic Experiment Memo
2) Results from Microbiological Monitoring for STS8
3) Action Item Update

LSFEP INTRA-OFFICE INFORMATION TRANSMITTAL

IT 7-776

FROM	TO
Paul Sebesta	Distribution

DATE	SUBTASK-ACT.DOC.	☒ INFORMATION ☐ REVIEW & COMMENT ☐ APPROVAL	REFERENCE
11-14-83			

SUBJECT

SSIP: EFFECT OF STS-11 ACOUSTIC EXPERIMENT ON AEM RATS

1. According to RAT-X Ultrasound of Chicago, rats are irritated by 20 kilohertz and 50 kilohertz levels, at and above 80 db.

2. The STS-11 acoustic experiment levels are measured at 1.5 kilohertz to 4.5 Khz. without any kind of containment on an open bench, at 75db 6 inches away.

3. These acoustic levels are reached in their package on MD-1: MET 22:30 for a period of 1 hour and 30 minutes.

4. These levels will be attenuated by:
   - Acoustic experiment container
   - Acoustic experiment mid deck locker
   - AEM experiment locker
   - AEM fans
   - Shuttle background noise levels

   There are no measurements of what the actual noise in flight configuration will be.

5. I expect to run acoustic tests here at ARC using worst case conditions to identify a negative or a null response. With a null response the subject will be reported and dropped. With a negative response I will have to go to the science personnel on this project (Holton and Larson) and define the problem ,tests, and find solutions working with light /dark cycles, realistic noise levels (flight configuration),and exploring the possibility of having the AEM or the Acoustic locker moved farther apart.

CONCURRENCES

PROJECT MANAGER

TASK MANAGER

TECHNICAL MONITOR

DISTRIBUTION

☒ WE BERRY	☐ PL CHENG	☐ ED NEVILLE	☒ E. Holton 239-14
☒ RP HOGAN	☐ BP DALTON	☒ CL SCHATTE	
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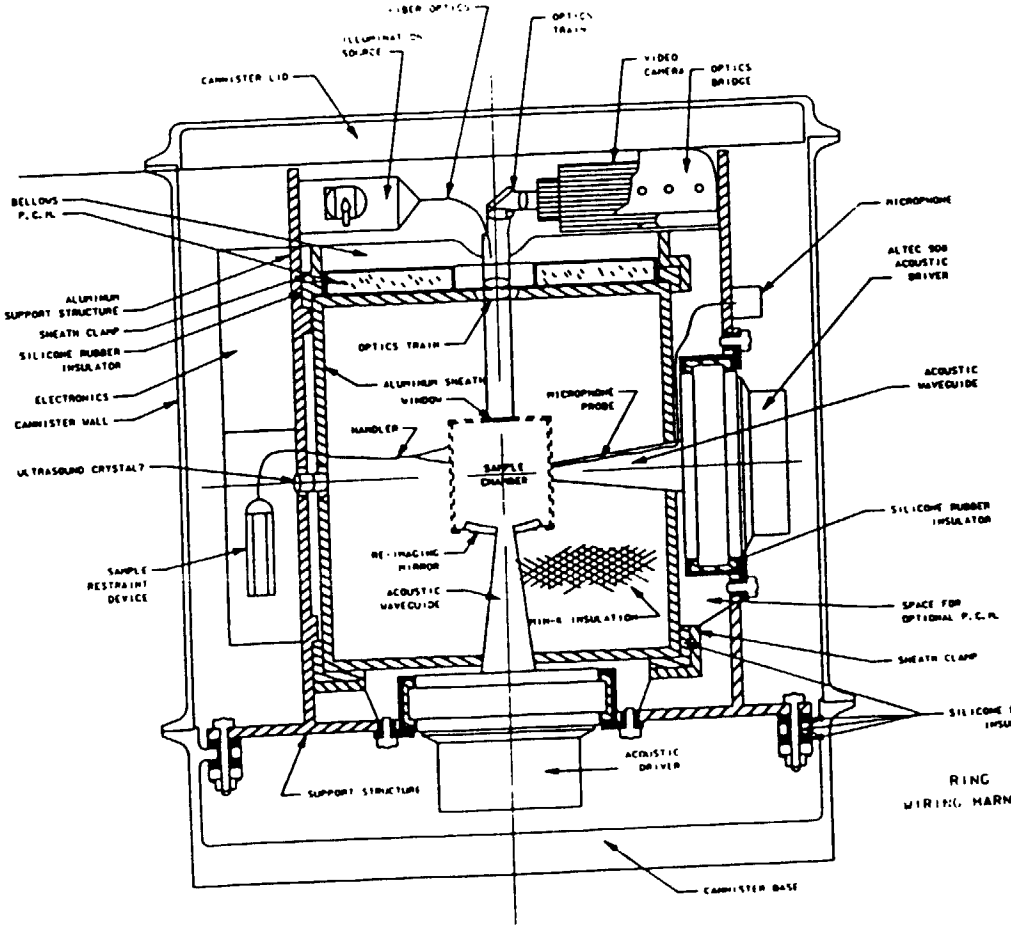
☐ OK CHEE	☐ HA LEON	☒ JW TREMOR	
	☐ EL MEREK	☐ BA WILLIAMS	

Page No. 1 of 1

ACES MIDDECK CONFIGURATION



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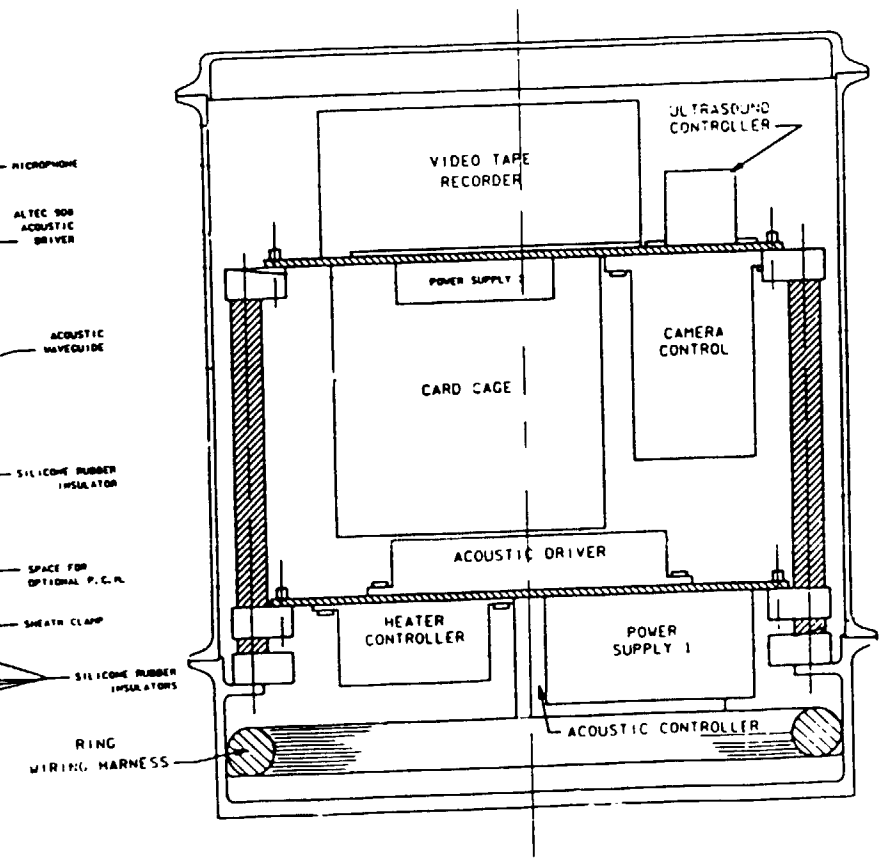

ELECTRONICS CANNISTER

National Aeronautics and
Space Administration

John F. Kennedy Space Center
Kennedy Space Center, Florida 32899

NASA

Reply to Attn of MD-ESB-C

NOV 18 1983

TO: Distribution

FROM: MD-ESB-C/Manager, Life Sciences Support Facility

SUBJECT: Results from Microbiological Monitoring for STS-8

Enclosed are several reports that summarize the results from Microbiological monitoring conducted in association with the rodents flown to test the Animal Enclosure Module on STS-8. The reports include results from tests performed in conjunction with both the Specific Pathogen Free (SPF) and Gnotobiotic animals housed in Hangar L in association with this test.

The microbiological monitoring program was designed primarily to verify that flight animals did not contain any of the pathogens listed for exclusion as per attachment #1. Additional monitoring was conducted to verify facility cleanliness and operational procedures.

The SPF barrier raised animals were received from Charles River Breeding Laboratories on July 20, 1983 in preparation for an early August launch. Due to launch delays these animals were not used for flight but were microbiologically monitored periodically to assess facility capabilities. Five live animals were randomly selected and shipped to Dr. Norman Altman's laboratory at the University of Miami for screening of all listed pathogens. Serum samples were collected and submitted to Dr. Russell Lindsey at the University of Alabama for Elisa testing for Mycoplasma. This monitoring revealed that the animals had Klebsiella pneumoniae and probably would have been excluded from flight. Reports from the Bionetics on-site laboratory and the two off-site laboratories are enclosed.

The gnotobiotic rodents were received on August 18, 1983. No necropsy evaluations and serological testing were performed on these animals because of the receipt of only 15 animals and the time constraints for launch. Results from pre and post flight bacteriological and parasitological monitoring done by the on-site Bionetics Laboratory are enclosed.

Several tests were conducted and conclusions drawn by Bionetics microbiologists in their reports that will not be a part of routine microbiological monitoring at KSC. Most were done in conjunction with the processing of the animals for STS-8 because this was the initial introduction of animals into Hangar L and these were the first animals flown in the STS program. The conclusions and recommendations of these microbiologists are included as information from persons directly involved in the STS-8 operations.

25

25th Anniversary
1958-1983

The information included in the enclosed microbiological reports will hopefully be helpful as we prepare for future flights involving animals. If you have any questions please call me at (305) 867-3152.

William Knott

William M. Knott

Distribution:
NASA/KSC/CP-SPO/W. Munsey
NASA/HDQTRS/R. Schmitz
NASA/ARC/B. Dalton
NASA/ARC/E. Holton
NASA/JSC/M. Smith
NASA/JSC/D. Pearson
Pfizer Inc./D. Larson

the bionetics corporation

Biomedical and Environmental Laboratories
Mail Code BIO-2
Kennedy Space Center, Florida 32899
Telephone (305) 853-4034
FTS 824-4034

NOVEMBER 3, 1983
BIO-2-3-442

TO: Jerry Moyer/BIO-3

FROM: Department of Clinical Microbiology

THRU: Stanley C. White, M.D./BIO-1

SUBJECT: STS-8 Animal Monitoring Program

1.0 INTRODUCTION

The Animal Enclosure Module (AEM) was flown aboard the STS-8 mission to help determine how well it would perform under operational conditions in future missions. Gnotobiotic rats were used to test the AEM's ability to contain the microbial flora found in the rats, as well as its ability to exclude the microbial flora of the crew from the rats. The use of gnotobiotic rats further reduced the risk of releasing pathogenic microorganisms into the crew quarters should the AEM fail inflight. In their pathogen free state the rats were also less likely to become ill during the flight.

A monitoring program was set up to demonstrate that the rat colony, from which the six "Astrorats" were to be selected, maintained its pathogen free state. Fecal and nasopharyngeal cultures were performed upon arrival, one week later and again just prior to flight. Periodic samples of the cages, food, water, bedding, irradiated potatoes, epoxy glue and the AEM were taken to detect the background of environmental contaminants and the adequacy of sterilization procedures in an effort to minimize their introduction into the gnotobiotic rat colony.

2.0 MATERIALS AND METHODS

Fecal pellets were submitted in 10% formalin for ova and parasitic examination and sterile saline or Port-a-cul transport media (BBL) for bacterial examination. Saline wet preparations were performed in the parasitic exams. The pellets were crushed and inoculated directly onto sheep blood agar, Columbia CNA agar with 5% sheep blood, MacConkey agar, Sabouraud dextrose agar, Campy blood agar, thioglycollate broth, GN broth and Campybroth.

Anaerobic bacteria were detected by inoculating both a blood agar and a chocolate agar plate with a portion of the fecal pellet and incubating the plates anaerobically for forty-

eight hours. All anaerobic bacteria recovered were identified utilizing the Minitek Anaerobe Set II in conjunction with The Manual of Clinical Microbiology methodologies.

Each GN broth was subcultured after twenty-four hours of incubation at 36°C onto Salmonella-Shigella and Hektoen enteric agar plates.

Every Campybroth was subcultured onto a Campy blood agar plate after incubation at 5°C for forty-eight hours. The Campy blood agar plates were incubated under microaerophillic conditions at 42°C for forty-eight hours and examined for the presence of Campylobacter.

Nasopharyngeal swabs were submitted in either Port-a-cul transport media or on culturette swabs for culturing. The swabs were directly inoculated onto sheep blood agar, chocolate agar, MacConkey agar, Columbia CNA agar with 5% sheep blood and thioglycollate broth. Specimens sent in Port-a-cul transport media were also subcultured onto a second set of blood agar and chocolate agar plates and incubated anaerobically in order to recover any anaerobic bacteria present.

Environmental samples were taken randomly from the cages, food, bedding, water, sipper tubes and later in the program from irradiated potatoes, the AEM and the epoxy glue used to secure the food bars to the AEM.

These samples were placed in 100 ml of thioglycollate broth and incubated for seven days at 36°C. During the incubation period the broth cultures were visually inspected for growth (turbidity) and routinely subcultured after seventy-two and ninety-six hours of incubation onto sheep blood agar and either Sabouraud dextrose or mold inhibitory agar plates.

Food pellets were crushed using a sterile mortar and pestle prior to culturing.

Cages were sampled for sterility by swabbing the top and sides with a sterile calcium alginate swab previously moistened with thioglycollate broth.

Bedding was placed directly into 100 ml of thioglycollate broth and incubated as previously stated.

Each water sample was passed through a .45 µM millipore filter and incubated at 35.5°C on a nutrient pad containing tryptone glucose extract broth with indicator. Two hundred and fifty milliliters out of approximately a five hundred milliliter sample were filtered and examined at twenty-four and forty-eight hour intervals for the number of colonies present.

Many standard identification schemes were employed. The BBL minitek identification systems for Enterobacteriaceae, gram negative nonfermentative bacteria and anaerobes were used. The API 20C yeast strip was utilized to identify any true yeast recovered. Bailey and Scott's Diagnostic Microbiology, 5th Edition and The Manual of Clinical Microbiology, 3rd Edition (ASM) were used as reference texts for supplemental testing and identification schemes. The schemes were used in speciating those bacteria not identified employing routine procedures including all gram positive bacteria recovered.

Saline wet preparations for ova and parasites were performed on all fecal specimens submitted.

3.0 RESULTS

The data gathered are presented in tabular form as seen in Tables 1 through 9.

All fecal examinations failed to demonstrate any medically significant parasites known to infect man.

4.0 DISCUSSIONS AND CONCLUSIONS

The initial animal monitoring sample results can be seen in Table 1. These results reflect the initial attempt to ascertain the microbial burden found on the hardware and within the food and bedding prior to its use with the gnotobiotic rats.

The initial fecal cultures of the gnotobiotic Lewis rats received on August 18th 1983 and the follow-up fecal cultures performed on August 25th contained a microaerophilic Lactobacillus species. Anaerobic bacteria were not cultured for during this initial test period.

The irradiated potato still contained many organisms as can be seen in Table 1. Even after soaking and scrubbing the potatoes with a dilute solution of sodium hypochlorite they retained much of their initial flora as seen in Table 2.

Table 2 also shows that preflight rat fecal cultures originally resulted in the recovery of only a microaerophilic Lactobacillus species and an anaerobic Bacteroides distasonis, as was expected from these gnotobiotic animals.

Other selective media designed specifically for anaerobes was not used. The standard aerobic media used will support the growth of most anaerobic bacteria under anaerobic conditions as well as the growth of the faster growing aerobes.

Thus, there may have been a tendency for the anaerobes present to be overgrown by the aerobic bacteria found in the mixed cultures. In the future, it is recommended that a variety of Schaedler's selective anaerobic media be used to resolve this question.

Food samples and water sipper tubes from the preflight cages yielded a Lactobacillus species, originating most likely from the rats themselves. In addition, two of the water sipper tubes also yielded Staphylococcus epidermidis. At this time it is felt that the Staphylococcus epidermidis recovered originated from either the sampler or some other environmental source, since the PAP Institute at the University of Miami was only able to recover a Lactobacillus species from five similar water sipper tube samples.

Random samples of the potatoes put in the preflight cages yielded a variety of organisms, including: CDC Group VE Biotype 1, Bacillus species, Group D streptococcus, not enterococcus, and Enterobacter agglomerans. Various potato samples throughout the study yielded different organisms. It is believed that this is due to the small size of the sample and the large variety of organisms inhabiting the potato. As a result all the organisms colonizing the potato may not have been recovered from each sample.

Samples taken from the AEM contained Staphylococcus epidermidis. Since these organisms are indigenous to human skin it is suspected that the AEM had not been completely sterilized during its preparation and handling.

Table 3 contains the data gathered from the postflight specimens taken at Dryden Flight Research Center shortly after the landing of STS 8. It can be seen here that a variety of bacteria were recovered. Their sources are most likely the potatoes used to provide water for the animals during flight.

No anaerobic bacteria were recovered from these postflight samples. This may be due to the large number of aerobic bacteria present in the nasopharyngeal and fecal specimens. This would greatly reduce our chances of recovering any anaerobes present.

The variety of organisms recovered from both the Port-a-cul transport media and culturette tubes were basically the same. The question as to whether the aerobic overgrowth overwhelmed the slower growing anaerobic organisms is recommended for testing using gnotobiotic animals at a future flight opportunity. Specific media for the growth of anaerobic organisms should be added to the testing program.

The postflight ground control specimens were taken at approximately the same time as those taken at the Dryden Flight Research Center after the landing of STS-8. The results are shown in Table 4. The bacteria recovered were very similar to those recovered from the postflight samples taken at DFRC, suggesting a common source such as the potato.

Tables 5,6, and 7 show the transition of the microbial burden from pre- to post-flight status. Table 5 is primarily concerned with the AEM. Table 6 lists the bacteria recovered from the experimental rodents during the three phases of the monitoring program. Table 7 lists the organisms recovered from all sources involved in the pre-flight, post-flight and ground control operations.

A summary of the organisms recovered per site can be seen in Table 8. Here we see the potato was colonized by at least twelve different microorganisms. There were only four other additional microorganisms recovered during the study. The Lactobacillus species and the Bacteroides distasonis obviously came from the gnotobiotic rats. The remaining two, a Staphylococcus aureus and a Streptococcus viridans, came from another source.

It could be hypothesized that the Streptococcus viridans came from the potato or the food bar since it was recovered from both the postflight and the control groups of animals. The food bar would seem an unlikely source because we were unable to recover any bacteria from the food bar samples taken from the AEM just prior to launch. It would appear most reasonable therefore to suspect the source to be the potato.

With this in mind then why do we only find the Streptococcus viridans in the fecal and nasopharyngeal samples? This could be explained to be due to the numbers of this bacterium being quite low prior to its ingestion by the "Astrorats". After ingestion the bacterium rapidly multiplied in the gastrointestinal tract of the rats at a much faster rate than in any other source sampled. This could give the appearance that it was only colonizing the gut of the rats.

The remaining Staphylococcus aureus remains an enigma. It was found in the postflight samples only. This suggests that it came from a source unique to the "Astrorats" such as the AEM itself. The Staphylococcus aureus was found in both the interior and exterior samples of the AEM. These results point to either an interior to exterior contamination route or vice versa.

Each batch of water given to the gnotobiotic animals was tested for sterility. The results of the tests can be seen in Table 9.

At the point in time when the potatoes were introduced into the AEM and exposed to the gnotobiotic rats the objectives of the study were compromised since at that point we were no longer able to ascertain the microbial containment and exclusionary capabilities of the AEM. When the rats were no longer gnotobiotic it became impossible to determine if any bacteria were transmitted to these animals from sources other than the interior of the AEM. Any future program would benefit from using an alternate source of water, other than the potato. Perhaps, a modified demand sipper tube and water absorbent material to control free water would prove useful.

If tighter controls are needed for future experiments using gnotobiotic rats it is suggested that the routine use of thioglycollate broth inoculations, on-site, be added to the microbiology program. A fecal specimen would be taken from each cage (or a significant number of cages) when the cages were changed. The fecal pellet would then be placed in a tube of thioglycollate broth, incubated at 36°C and observed by the animal technician each day for a period of seventy-two hours. Any rapid growing bacteria would be quickly spotted and its respective cage removed for further study by the microbiology laboratory. The present initial, midpoint, and prelaunch microbial workups would still be performed.

Overall the STS-8 animal monitoring program was very successful although some of the testing objectives were not met. The microbial data generated agreed very closely with the data obtained from the University of Miami through Norman Altman, V.M.D. and Nora Thuma's group at the PAP Institute. Further advice concerning mycoplasmology in laboratory rats provided to us by Russell Lindsay, D.V.M. and Maureen Davidson at the University of Alabama-Birmingham was very helpful. We recommend the continued use of both University's staff as consultants and reference laboratories.

Prepared by: Mary K. Smith MT(ASCP)
Mary K. Smith MT(ASCP)
Clinical Microbiologist

Reviewed by: Roger L Blair MT(ASCP)
Roger L. Blair MT(ASCP)
Dept. of Clinical Microbiology Supervisor

TABLE 1 KSC (BIONETICS) REPORT, 11/3/83

INITIAL ANIMAL MONITORING SAMPLES

	No Growth	Lactobacillus Species	Enterobacter cloacae	Klebsiella oxytoca	Serratia liquefaciens	Group D. Strep. not enterococcus	Bacillus sp.
Random Cage (8-15-83)	NG						
5 Fecal Specimens (8-18-83)		5/5					
Cage 6 (8-19-93)	NG						
Food Bar Batch 33235 (8-23-83)	NG						
Cage 6 Batch 3237A (8-25-83)	NG						
5 Used Water Sippers (8-25-83)	NG						
5 Fecal Specimens (8-25-83) 3237-D		5/5					
2 Glue Samples (8-26-83)	NG						
Potato-irradiated (8-26-83)			X	X	X	X	X

NG = No growth

X = Organisms isolated and identified

5/5 = 5 out of 5 sampled are positive for the presence of Lactobacillus

TABLE 2

CULTURED 8/29/83

PRE-FLIGHT SPECIMENS FROM LSSF

	Serratia liquefaciens	Klebsiella oxytoca	Citrobacter freundii	Enterobacter cloacae	Proteus mirabilis	CDC Group VE Biotype 1	Bacillus species	Enterococcus	Group D Strep not enterococcus	Streptococcus viridans group	Yeast-probable Geotrichum Sp.	Staphylococcus aureus	Staphylococcus epidermidis	Lactobacillus species	Enterobacter agglomerans	Bacteroides distasonis	No Growth
Potato (Right Side)									X						X		
Potato (Left Side)						X	X										
Food-Cage 1														X			
Food-Cage 2														X			
Food-Cage 3														X			
Food-Cage 4														X			
Food-Cage 5																	NG
AEM-Food (Left Side)																	NG
AEM-Food (Right Side)													X				
Water Sipper Cage 1														X			
Water Sipper Cage 2														X			
Water Sipper Cage 3													X	X			
Water Sipper Cage 4														X			
Water Sipper Cage 5													X				
AEM-Left Side													X				
AEM-Right Side													X				
AEM Module																	NG
AEM Filter														X		X	
FECAL Cage 1														X		X	
FECAL Cage 2														X		X	
FECAL Cage 3														X		X	
FECAL Cage 4														X		X	
FECAL Cage 5																	

X = Organisms isolated and identified

TABLE 3

*1 Port-a-cul transport medi

*2 Culturette medi

POST-FLIGHT SPECIMENS

(Taken at Dryden Flight Research Center) 9-6-83

	Serratia liquefaciens	Klebsiella oxytoca	Citrobacter freundii	Enterobacter cloacae	Proteus mirabilis	CDC Group VE Biotype 1	Bacillus species	Enterococcus	Group D Strep not enterococcus	Streptococcus viridans group	Yeast-probable Geotrichum Sp.	Staphylococcus aureus	Staphylococcus epidermidis					
Food *1		X						X										
Food (in sterile blood draw tube)		X		X								X						
Potato *1		X		X				X										
Potato (in sterile blood draw tube)		X		X				X					X					
Nasopharyngeal #1 *1		X	X	X				X		X								
Nasopharyngeal #2 *1		X						X		X								
Nasopharyngeal #3 *1		X	X	X				X		X								
Nasopharyngeal #4 *1		X	X	X				X		X								
Nasopharyngeal #5 *1		X	X	X				X		X								
Nasopharyngeal #6 *1		X	X	X				X		X			X					
Nasopharyngeal (Red/Red) *2		X		X				X				X						
Nasopharyngeal (Distal Red) *2		X		X				X										
Nasopharyngeal (Blue/Green) *2		X	X	X				X					X					
Nasopharyngeal (Blue/Blue) *2		X	X	X				X					X					
Nasopharyngeal (No Color Noted) *2		X		X				X										
Nasopharyngeal (No Color Noted) *2		X		X				X	X									
FECAL *1		X	X	X				X										
FECAL (in sterile blood draw tube)		X	X					X					X					
Interior of AEM #1 and #3		X		X				X										
Interior of AEM #1 & #2		X		X				X				X						
Exterior of AEM (Ext-1)				X								X						
Exterior of AEM (Ext-2)				X								X						

X = Organisms isolated and identified

TABLE 4

POSTFLIGHT GROUND CONTROL SPECIMENS

(taken at LSSF at approximately the same time as Post-flight samples from DFRC)

*1 Port-a-cul transport medi

*2 Culturette med

9-6-83

	Serratia liquefaciens	Klebsiella oxytoca	Citrobacter freundii	Enterobacter cloacae	Proteus mirabilis	CDC Group VE Biotype 1	Bacillus species	Enterococcus	Group D Strep. not enterococcus	Streptococcus viridans	Yeast-probable Geotrichum sp.	Staphylococcus aureus	Staphylococcus epidermidis	No Growth			
Cage 1 Food	X	X					X	X									
Cage 1 Potato		X	X		X		X	X			X						
Cage 4 Food						X	X	X									
Cage 4 Potato		X	X	X			X	X			X						
Nasopharyngeal Cage 4 (Green/Blue) 1*		X	X					X		X							
Nasopharyngeal Cage 4 (Red/Blue) 1*		X	X	X			X	X	X	X							
Nasopharyngeal Cage 4 (Red/Green) 1*		X	X	X			X	X	X								
Nasopharyngeal Cage 4 (Green/Blue) 2*		X	X					X		X							
Nasopharyngeal Cage 4 (Red/Blue) 2*		X	X	X				X									
Nasopharyngeal Cage 4 (Red/Green) 2*		X	X	X				X	X								
Nasopharyngeal Cage 1 (Distal Blue) 1*		X	X					X					X				
Nasopharyngeal Cage 1 (No Color) 1*		X	X					X	X								
Nasopharyngeal Cage 1 (Proximal Blue)		X	X	X				X					X				
Nasopharyngeal Cage 1 (Distal Blue) 2*		X	X	X				X									
Nasopharyngeal Cage 1 (No Color) 2*		X	X	X			X	X									
Nasopharyngeal Cage 1 (Proximal Blue) 2*		X	X	X			X	X									
FECAL-Cage 1 1*		X	X		X		X	X		X							
FECAL-Cage 1 (Sterile Saline)		X	X		X		X	X		X							
FECAL-Cage 4 1*		X	X	X			X	X	X								
FECAL-Cage 4 (Sterile Saline)		X	X	X			X	X	X								
3 Water Sippers 9-6-83														NG			
*Cage 3 Batch 3240 Food Bedding top side														NG			
Cage 3 Batch 3246 Food Bedding top side														NG			

** = used at flight time

NG = No growth

X = Organisms isolated and identified

Table 5:

AEM PRE- VS. POST-FLIGHT SUMMARY

	Staphylo-coccus aureus	Entero-coccus	Entero-bacter cloacae	Klebsiella oxytoca	Staphylo-coccus epidermidis	No Growth
Preflight:(8/29)						
AEM Food (Left Side)						NG
AEM Food (Right Side)						NG
AEM Left Side					X	
AEM Right Side					X	
AEM module					X	
AEM filter						NG
Postflight:(9/6)						
Interior of AEM (B1)		X	X	X		
Interior of AEM (B3)		X	X	X		
Exterior of AEM(Ext-1)	X		X			
Exterior of AEM(Ext-2)	X		X			
Interior of AEM (#1)	X	X	X	X		
Interior of AEM (#2)	X	X	X	X		

X = organisms isolated and identified

NG = No growth

Table 6: KSC BIONETICS REPORT, 11/3/83

RODENT PRE- VS POST-FLIGHT MICROBIAL SUMMARY

	Preflight organisms recovered from rats (8/29)	Postflight organisms recovered from rats (9/6)	Postflight Ground Control organisms recovered from rats (9/6)
Serratia liquefaciens			
Klebsiella oxytoca		X	X
Citrobacter freundii		X	X
Enterobacter cloacae		X	X
Proteus mirabilis			X
CDC Group VE-Biotype 1			
Enterobacter agglomerans			
Bacillus species			X
Lactobacillus	X		
Enterococcus		X	X
Group D streptococcus not enterococcus		X	X
Streptococcus viridans		X	X
Yeast-Probable Geotrichum species			
Staphylococcus aureus		X	
Staphylococcus epidermidis		X	X
Bacteroides distasonis	X		

X = Organisms isolated and identified

Table 7: KSC (BIONETICS) REPORTS, 11/3/83

COMPREHENSIVE PRE- VS POST-FLIGHT MICROBIAL SUMMARY

	Preflight organisms recovered (8/29)	Postflight organisms recovered (9/6)	Postflight Ground Control organisms recovered (9/6)
Serratia liquefaciens			X
Klebsiella oxytoca		X	X
Citrobacter freundii		X	X
Enterobacter cloacae		X	X
Proteus mirabilis			X
CDC Group VE-Biotype 1	X		X
Enterobacter agglomerans	X		
Bacillus species	X		X
Lactobacillus	X		
Enterococcus		X	X
Group D streptococcus not enterococcus	X	X	X
Streptococcus viridans		X	X
Yeast-Probable Geotrichum species			X
Staphylococcus aureus		X	
Staphylococcus epidermidis	X	X	X
Bacteroides distasonis	X		

X = Organisms isolated and identified

Table 8: KSC (BIONETICS) REPORT, 11/3/83

SUMMARY OF ORGANISMS RECOVERED PER SAMPLE SITE

	Water Sipper Tubes	Potato	Food	Naso-pharyn-geal	Fecal	AEM
Serratia liquefaciens		X	X			
Klebsiella oxytoca		X	X	X	X	X
Citrobacter freundii		X		X	X	
Enterobacter cloacae		X	X	X	X	X
Proteus mirabilis		X			X	
CDC Group VE-Biotype 1		X	X			
Enterobacter agglomerans		X				
Bacillus species		X	X	X	X	
Lactobacillus	X		X		X	
Enterococcus		X	X	X	X	X
Group D streptoccocus not enterococcus		X		X	X	
Streptococcus viridans				X	X	
Yeast-Probable Geotrichum species		X				
Staphylococcus aureus			X	X		X
Staphylococcus epidermidis	X	X		X	X	X
Bacteroides distasonis					X	

X = Organisms isolated and identified

Table 9:

LSSF

Sterile Water Sample Summary

Date	Amount Sample No.	Total Count Filtered	CFU/ml
8/9/83	1	250 ml	<1CFU
8/16/83	1	250 ml	<1CFU
8/19/83	1	250 ml	<1CFU
	2	250 ml	<1CFU
8/23/83	1	250 ml	<1CFU
8/25/83	1	250 ml	<1CFU
8/29/83	1	100 ml	<1CFU
9/6/83	1	250 ml	<1CFU
9/14/83	1	250 ml	<1CFU

CFU = Colony forming units

University of Miami
Miami, Florida 33101

DEPARTMENT OF PATHOLOGY
P.O. Box 016960
Division of Comparative Pathology, School of Medicine (R-46)

September 6, 1983

Mr. Jerry Moyer
Bionetics Corporation
Kennedy Space Center
Florida 32899

Dear Jerry:

Enclosed are the results of the culture and parasitological examinations for the Lewis rats from the Charles River Breeding Laboratories isolators.

They contain no pathogenic organisms or parasites.

Sincerely yours,

N. Altman

Norman H. Altman, V.M.D.
Professor and Director
Division of Comparative Pathology

NHA:bs

cc: Mrs. Nora Thuma

THE PAP INSTITUTE

1155 N.W. 14th St., Miami, Florida • Telephone (305) 324-5572 • Mailing Address: Box 016188, Miami, FL 33101

We received from the Bionetics Corporation on August 31, 1982 in the morning, via Federal Express, the following items:

1. Five red-topped tubes containing approximately 5 - 6 fecal pellets each.

2. Five red-topped tubes containing pieces of food pellets.

3. Five moistened swabs from sipper tubes.

Each of the above groups of items were labeled 1 through 5, representing cages Numbers 1 through 5.

All items arrived intact in a styrofoam box with ice packs.

Microbiology culturing was performed on all 15 samples. In addition, parasitology was performed on the 5 fecal samples.

The results are attached.

FINAL PCRI MICROBIOLOGY SUMMARY

INVESTIGATOR: Kennedy Space Center/Bionetics Corp ANIMAL NUMBERS: See below DATE: 9/2/83

SPECIES/STRAIN: Lewis Rats from Charles River Lab, LOCATION: Isolator GROUP NUMBER: KSC-2

Wilmington

ANIMAL NUMBER	Lacto-bacillus Sp.	Fecal #1	Fecal #2	Fecal #3	Fecal #4	Fecal #5	Slipper Tube (ST) #1	ST #2	ST #3	ST #4	ST #5	Food #1	Food #2	Food #3	Food #4	Food #5			
		+	+	+	+	+	+	+	+	-	-	+	+	+	-	+			

PCRI PARASITOLOGY REPORT

INVESTIGATOR PCRI Kennedy Space Center/ Bionetics Corp. GROUP NO. KSC-2 ROOM NO. _____ DATE August 31, 1983

ANIMAL NUMBERS See below SPECIES Lewis Rats

ANIMAL NUMBER	ECTO-PARASITES		(SCOTCH-TAPE) PINWORM		SALINE PREPS - FECAL DIRECT				ZINC SULFATE -FECAL FLOATATION				SALINE PREPS DUODENAL				OTHER	
Fecal 1						-				-								
Fecal 2						-				-								
Fecal 3						-				-								
Fecal 4						-				-								
Fecal 5						-				-								

SUMMARY OF FINDINGS:

SE81-10
UPDATED ACTION ITEMS

ITEM	PERSON RESPONSIBLE	DATE DONE
1. STS-11 PAO rat downlink/yea or nay	Halstead/Rasmussen	
2. AEM air flow measurements (clean)	Kessler/General Dynamics	
3. STS-8 Project Report	Smith/Holton	
4. Letter from Charles River regarding SPF status and light/dark cycle	Larson	
5. Teklad Diet Purchase	Sebesta	
6. STS-8 (DSO 0421) and STS-11 (SE81-10) preflight, flight, postflight coordinated videotapes	Sebesta/Holton	
7. Repack AEM filters/prepare under clean conditions if possible	Jackson/Christie	11/15/83
8. Make new lid for AEM	Kessler	
9. Check out antifog spray for AEM lid	Johnson	
10. Microbiology of AEM filter after repacking and before STS-11	Smith/Pearson	
11. Contingency plans for nonUS landings	Jackson	
12. Contingency facilities for US landing sites	Sebesta	
13. Directory of personnel at KSC, JSC, ARC, and HQ associated with STS11 launch and recovery operations (addresses/phones) for SE81-10	Sebesta/Smith	
14. Ground unit mock-up of AEM	Kessler	
15. KSC photographic support/ physicals and clearances necessary	Knott/Sebesta	
16. Updated STS11 timelines (as available) and updated launch windows (as available)	Staples/Jackson	

ITEM	PERSON RESPONSIBLE	DATE DONE
17. Experiment measurements table for supplemental science; agreed/ recommended	Halstead	
18. Animal handlers physicals/ requirements and updates for team	Knott	
19. Clear Kessler to launch pad	Knott	
20. Historical videotape of NASA Life Sciences past animal flights	Halstead/Rasmussen	
21. Postflight trip to Pfizer for rats	Halstead/Knott/Sebesta (contingency landing sites)	
22. Questions for postflight crew debriefing	Team	
23. AEM to JSC for flight storage	Kessler	
24A. Build water system for AEM B. Flight qualify water system C. KC135 flights at DFC (ARC South) D. Objectives/protocol for KC135 test of water bottle	Kessler/Sweeney Jackson Jackson/Sweeney/Kessler/Moyer Jackson/Sweeney/Kessler	
25. Potato consumption/food consumption/growth data from baseline studies	Weber/Larson	
26. Status of JSC temperature recorders	Jackson	11/25/83
27. Microbiology report from preflight and postflight measurements for rats and AEM in DS00421	Knott/Moyer	11/18/83
28. Effect of 4.5KHz noise at 75db for 2 hours on rats (simulated 3-axis acoustic containment furnace experiment [ACES] which will be in middeck locker on STS11)	Sebesta	
29. Fuse changeout procedure	Jackson/Christie	
30. PC board for automatic light/dark cycle in AEM	Staples/Jackson	

TO: Weber Team

FROM: Project Manager/Scientist

SUBJECT: Biweekly report (#6), December 12, 1983

Last Friday, a project status review for the Weber SSIP was given to NASA Headquarters Life Sciences Flight Programs personnel at Ames Research Center (ARC). Most of the attachments to this report were handed out at that meeting. This report will refer to and discuss those handouts starting with the OUTLINE. The first item on the outline is the MILESTONE SCHEDULE. Please note that the launch is presently scheduled for January 30, 1984, and will land on either February 7 or 8. Although the milestone schedule notes that the launch and landing are both to occur at KSC, the brake problem on the Shuttle may necessitate a landing at Dryden. We should know whether the primary landing site will switch to Dryden before the next newsletter. If the landing site does change, then the contingency planning we were doing becomes essential—particularly plans such as the site of the ground-based experiment (KSC or Pfizer), the best means of getting the ground controls from KSC and the flight rats from Dryden to Pfizer, and where the team should be during the flight.

AEM HARDWARE STATUS: The next item on the outline and milestone schedule is hardware. The first set of attachments addresses the hardware. This portion of the presentation was prepared and presented by Paul Sebesta. The AEM was shipped to JSC from General Dynamics on 11/30/83 and was received at JSC the following morning; it was in transit less than 24 hours!

1) AIR FLOW measurements in the clean AEM suggest that air flow in the AEM with a clean filter is not different than the flow in an AEM with a dirty filter (e.g., after STS-8 mission). Removing the voltage regulator for the fans added 2V to the system and increased the air flow to 16-18cfm from 14.7cfm. Any attempt to increase flow further will necessitate decreasing the depth of the fiberglass/charcoal filter; such an attempt will NOT be made for STS-11. The electrostatic filters are only of secondary importance in impeding air flow. Although the system is overdesigned and the fiberglass/charcoal filter can probably be decreased in depth by 20-30% without odors escaping from the AEM and hence producing potential hazards to the spacecraft environment, such alterations will necessitate validation tests similar to those performed prior to STS-8; sufficient time to repeat the validation tests does not exist prior to STS-11.

2) The placement of the manual TEMPERATURE PROBE was altered during refurbishing. Since the probe slightly extended into the cage, the temperature probe was moved back to the originial position after receipt of the AEM at JSC The CONTINUOUS TEMPERATURE RECORDER (designed for the Cosmos experiments) may be included in the AEM and, if so, will be placed either in the extra space outside the rat cage or in the water bottle (if it is flight ready). Since this recorder is not water tight, it will be sealed around the lid and placed in a plastic bag as a precaution against the water bags leaking if flown in the water container. Water in the temperature recorder would not be a fire hazard, but would probably

destry the integrity of the recorder.

3) New GASKETS were also added to the refurbished AEM. Although a gasket was added to the bottom to seal the AEM, flight qualifications required that the bottom be sealed with RTV-11. The RTV-11 was added after the unit arrived at JSC.

4) Other AEM MODIFICATIONS have been discussed in previous biweekly reports.

5) The WATER BOTTLE was successfully tested on the KC135, Sunday, December 11. Tom Kessler, Jack Sweeney, Jerry Moyer, Dr. Robert Clark, the onboard photographer, and the pilot (Gordon Fulllerton) are to be thanked for these tests. Pictures show that a) the water bottle does not leak, b) the flow rate is sufficiently slow so that all the water in the bags could not dump on the filter simultaneously, and c) air bubbles are not a valid concern. The bottle operated very smoothly in nearweightlessness. The weight of the container before flight was 6.71lbs (3.04kg) and after bleeding the system during parabolic flight was 4.11lbs (1.84kg) giving a useable water volume of 2.61b (1.2kg or about 1200ml). The bags appeared totally compressed so that any residual water would have been only in the lines to the water bags; the container still has additional space and larger bags can be used to deliver a larger quantity of water. Parabolas began at 0700 with all participants (except Tom Kessler) onboard. The only modification to the system was suggested by Jerry Moyer. A cup is being added to the water bottle under the lixit valve to serve as a reservoir to attract any water not lapped up by the rat since the water tended to come out in globules of about one ml. The cup will also keep the rat from unintentially activating the lixit valve. The GROUND CONTROL CAGE and WATER BOTTLE are due at ARC on Wednesday, December 15 for testing with rats prior to sending the bottle to JSC for further flight qualification tests. Unless the launch slips, the water bottle will probably not have time to be flight qualified for STS-11. Thus, potatoes are being planned as the water source and information on potatoes and food are found in this set of attachments.

SCIENCE STATUS: The next section in the outline and milestone schedule deals with science and the animals. 1) Tuesday, December 6, rats were shipped to KSC from Charles Rivers in Kingston, NY. The ANIMALS are being SCREENED to assure that they have none of the pathogens recommended for exclusion from flight. If the SPF rats have any of these pathogens, then gnotobiotics (like those rats flown on STS-8) will be used at KSC for the ground-based and flight experiments. This decision will be made Friday, December 16. The next sheet in the attachments gives a quick summary of the pathogens found in the SPF rats which were NOT flown on STS-8. KSC analyzed fecal pellets and throat swabs while U. of Miami analyzed tissues. The first number is the number of animals with that pathogen of the five rats tested; N/A means not applicable or not done. The only pathogen recommended for exclusion from flight which was found was Klebsiella pneumoniae and it was only in the gut and not in the throat/ nasopharynx. The question was asked whether a pathogen found in only one site (which did not necessarily mean that the animal had active disease) was a sufficient basis for exclusion of the animals. The present NASA decision is not to fly any rats with any pathogens recommended for exclusion. The next attachment addressed potential problems

associated with use of GNOTOBIOTICS. Gnotobiotics are at least an order of magnitude more expensive than SPF, much more data is available on SPF rats, Pfizer has a standing order for SPF animals, and gnotobiotics could also become contaminated with pathogens prior to flight since many pathogens are transmitted by human animal handlers. The gnotobiotics used on STS-8 were very healthy and have a very active immune system. PRELIMINARY studies at Pfizer demonstrate that gnotobiotics do develop arthritis as do SPF animals.

2) As specified on the MILESTONE SCHEDULE, arthritis will be induced at Kingston, NY, and all animals immediately shipped to KSC. Shipment should not interfere with the disease process; animals prepared similarly and shipped to ARC developed the disease. Additional controls will be sent along for continguency purposes--if the launch slips, control rats can be inoculated at KSC with Freund's complete adjuvant every 7 days to provide the necessary arthritic animals for the experiment. Animals should be shipped and housed in groups of 3 and they should be weight and age matched for each group. The individual rat markings will be those suggested previously in the biweekly report.

4) The RODENT HEALTH CHECK LIST (see attachment) has been slightly modified from those forms used for STS-8. Copies of these forms will be made and placed in a 3-ring notebook; each animal will have a designated section in the notebook and data will be kept on each animal for the duration of the experiment.

5) The next attachment is the updated MEASUREMENTS LIST for this experiment. Please CHECK over these measurements VERY CAREFULLY. Unless a measurement is listed on this chart, IT WILL NOT BE DONE! NASA Headquarters Life Sciences Division has decided not to support any supplemental studies on SSIPs, since such studies might potentially impact students' goals.

6) The next set (3 pages) of attachments deals with OPERATION TIMES. Laura Staples, Willie Williams and the time-lining crew have done an excellent job of minimizing shifts in the light:dark cycle for the rats during flight. Rats will be loaded in the AEM and onto the shuttle during their active time (lights out). Launch will occur just about the beginning of the sleep cycle. However, interruption of this sleep cycle will probably cause less stress than loading the animals during their sleep cycle and launching them shortly thereafter. Also, rats tend to be most active during the lights-on cycle just prior to lights off; to collect data at this time necessitates launching during lights on. The shaded portions in the second sheet indicate lights on. The last sheet is an example of the documentation that will be kept in the onboard log book; similar sheets will be used for the ground control experiment. We have requested NOTIFICATION if the light cycle is changed by more than 1 hour during flight so that we can alter the ground control schedule similarly.

7) The next items on the outline and milestone schedule are FOOD AND POTATOES. Teklad diet has been ordered by KSC; this diet will be autoclaved and used for the ground control experiment. Sterile food bars will be obtained from ARC. Sterile food bars will be used only for the flight rats since very few food bars are available due to the demand of

SL3, since autoclaved teklad pellets tend to crumble and since glueing the pellets to the AEM would be an almost impossible task due to the number of pellets necessary for this mission. However, the food bars are made from this Teklad diet and many studies done at ARC show that animals do not respond differently on food bars or on Teklad diet.

Although the water bottle is preferred, the bottle is not flight qualified. Thus, we are presently planning to use potatoes. Potatoes will be procured in early January and tests done to assure that at least 70% of the weight of these potatoes is water. Although the microbiology report from STS-8 (enclosed with the last biweekly report) correctly suggested that the potatoes contained multiple bacteria which made microbiological monitoring of rats difficult, none of the bacteria found on the potatoes are on the NASA list of pathogens recommended for exclusion from flight. Prior to the mission, several potatoes from the batch obtained for this experiment will be sent to KSC for microbiological analysis For this analysis, the potatoes will be scrubbed with a chlorox solution and rinsed in sterile water. The entire potato will be minced and a portion of the minced potato analysed for pathogens.

POTENTIAL PROBLEMS: The potential problems listed on the outline have been discussed previously except for the availability of Hanger L at KSC. Hanger L availability will diminish dramatically as SL3 and SL4 approach. Animals use in the AEM may be impossible during this time unless other facilities are available.

DATES TO REMEMBER: (Please note changes from last report)

1) January 30: launch date for STS-11.

2) December 16: decision on whether SPF animals or gnotobiotics rats should be used for this experiment.

3) January 10: experiment rats placed on light:dark (0400:1500EST) cycle at Charles Rivers.

January 23: Larsen team to Charles Rivers to inoculate rats.
Rats and Weber team arrive at KSC

January 24: Plan full-up test and timelines; tie-up loose ends

January 25: Begin full-up test

January 28: End full-up test, finalize timelines, clean-up

January 29: Load animals in AEM and deliver to launch pad around 2000EST;
Load controls in ground control cage; begin ground-based experiment

January 30: Launch

January 30-February 7/8: Conduct ground-based experiment and prepare draft of final report.

February 7/8: Landing, postflight observations, delivery of rats to Pfizer

February 8/9: Final clean-up and departure of team from KSC

CREW TRAINING: On December 6, Ron McNair was briefed by Neil Christie on potential problems with the middeck locker and accessing the AEM during flight. The session was in the high fidelity shuttle mock-up with the AEM. VTR camera placement and AEM access were discussed. Ron McNair will obtain as much information as possible for our project.

MOTELS: For team members or their families not staying at least one week, the following motels at Cocoa Beach are recommended: Crossway Inn, Ocean Landing, Holiday Inn, Executive Best Western.

PASS REQUESTS: All requests for passes to the launch or landing for team members or their families should be sent to Mr. Michael Bowie. His name and phone number are on the team list.

ACTION ITEM UPDATE: Be sure to peruse the action item update list and attend to those items assigned to you.

ENCLOSURES:
1) Outline for presentation to NASA Headquarters Life Sciences Flight Projects personnel
2) Milestone Schedule
3) Sebesta Hardware Presentation
4) SPF Pathogen Summary for STS-8
5) Factors for consideration: SPF vs Gnotobiotics
6) Modified Rodent Health Check List
7) Updated Measurements List
8) Operation Times/Measruements Inflight
9) Updated Action Items
10) Directory of Team Members of SE81-10

WEBER SSIP: THE EFFECTS OF WEIGHTLESSNESS ON ARTHRITIS (SE81-10)

STATUS FOR FLIGHT ON STS-11
December 9, 1983

I. MILESTONE SCHEDULE

II. HARDWARE
- A. AEM/MODS
  1. FUSES
  2. HANDLES
  3. TEMPERATURE PROBE(S)
  4. NEW LID
  5. OTHER
- B. WATER BOTTLE STATUS/HOPES
- C. FOOD/POTATO STATUS

III. ANIMALS
- A. HEALTH STATUS--LESSONS FROM STS-8; SPF vs GNOTOBIOTICS (EXCLUSION'S LIST EXCLUSIONS)
- B. HOUSED IN GROUPS OF 3
- C. SUGGESTED MARKINGS: TATTOO AND DYE (EARS/TAILS)
- D. HEALTH CHECK LIST
- E. MEASUREMENTS FOR SE81-10
  1. PREFLIGHT
  2. INFLIGHT
  3. POSTFLIGHT
- F. FOOD: PELLETS/FOOD BARS
- G. WATER vs POTATOES (MICROBIOLOGY FROM STS-8)

IV. POTENTIAL PROBLEMS
- A. ACES EXPERIMENT
- B. AMOUNT OF FOOD/POTATOES REQUIRED
- C. ANIMAL AVAILABILITY IF GNOTOBIOTICS NECESSARY
- D. SMUDGING OF LEXAN LID
- E. AVAILABILITY OF HANGER L

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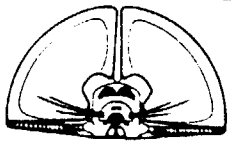

NAME/ORG.: P. SEBESTA/LBE	TITLE: AEM HARDWARE HISTORY	DATE: 12/7/83

SEPTEMBER 1983 TO JANUARY 1984

- STS-8 LANDING AND RECOVERY OF AEM AT DRYDEN ARC
- SHIPPED TO JSC/DR. M. SMITH'S LAB FOR INSPECTION SEPTEMBER 1983 JSC
- SHIPPED TO GEN. DYN. AT SAN DIEGO FOR REFURBISHMENT/TEST OCTOBER
  - 14.7 CFM POST FLIGHT (DESIGNED TO 20CFM)
    16.7 F/M
- REFURBISH AND MODIFICATION NOV. 1983
  - HANDLE ANCHORING MOVED TO LOCKER MAIN FRAME GEN. DYN.
  - RHEOSTATS REMOVED FROM FAN MOTORS GEN. DYN.
  - AEM SYSTEM PUT ON A 4 AMP FUSE GEN. DYN.
  - TEMP. PROBE SMALLER RANGE BIGGER NUMBERS GEN. DYN.
    TIGHT SEAL TO LID
  - CLEAN FILTERS INSTALLED/FLOW TEST GEN. DYN.
    17 TO 18 CFM (19 TO 20 F/M)
- AEM SHIPPED TO JSC (JOHN JACKSON)
- REFURBISH AND MODIFICATION DECEMBER, 1983
  - FOUR FUSES TO FANS REMOVED, AEM ON ONE 4 AMP FUSE JSC
  - TEMP. PROBE REMOVED AND REINSTALLED JSC
  - NEW GASKET FOR LID INSTALLED JSC
  - LID POLISHED, SPRAYED FOR ANTIFOG AND TAPED SHUT JSC

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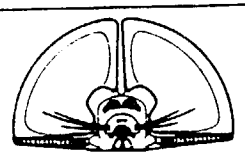

NAME/ORG.: P. SEBESTA/LBE	TITLE: AEM HARDWARE HISTORY	DATE: 12/7/83

(CON'T)

- AEM AUTOMATIC LIGHT CYCLE FABRICATION IN PROCESS (STS-17,19?) JSC
- CHARCOAL REPACK AND QUAL TEST, FUNCTIONAL TEST — DECEMBER 15, JSC
- JSC PREPACK — DECEMBER 29, JSC
- CREW WALKTHROUGH — JANUARY 4& 5 JSC
- AEM SHIPPED TO KSC RECEIVED AT O AND C — JAN 6. 1984 KSC
- AEM DELIVERED TO HANGAR L AND ASSEMBLED LAUNCH PREP TEAM L-8 DAYS

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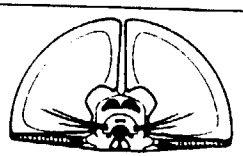

NAME/ORG.:	TITLE:	DATE:
P. SEBESTA/LBE	AEM TEMPERATURE RECORDER	12/7/83

- ORIGINAL COSMOS DESIGN
- PRESENTLY ON BOARD STS-9
- USE OF STS-11 POSSIBILITIES
  - COULD BE LOCATED ON BACK OF AEM IN FORMER SLIDE HOLDER
  - COULD BE LOCATED IN THE PROPOSED WATER BOTTLE SYSTEM
- TEMPERATURE RECORDER IS HIGHLY DESIREABLE BUT NOT CRIRTICAL

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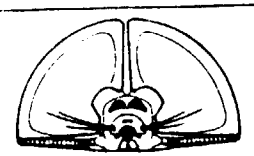

NAME/ORG.: P. SEBESTA/LBE	TITLE: AEM FOOD AND WATER SYSTEM	DATE: 12/7/83

- LOADED FOR 10 DAYS = MAXIMUM CAPACITY FOR 6 ANIMALS
- FOOD
  - FOOD BARS GLUED TO CAGE WALL
  - FDA AND NASA SAFETY APPROVED 3-X GRAY EPOXY
  - 600 GRAMS FOOD EACH SIDE
    ALLOWING 20 GRAMS PER DAY PER ANIMAL = 15% OVER NEEDS OF GROUND FEEDING BEHAVIOR AND 100% OVER KNOWN FLIGHT FEEDING BEHAVIOR
- WATER
  - WATER SATURATED POTATOES WIRED TO WIRE GRID (WALL)
  - 1700 GRAMS POTATOE EACH SIDE
    ALLOWING 40 GRAMS OF WATER PER ANIMAL PER DAY BASED ON POTAOES BEING 70% WATER = 10% OVER KNOWN GROUND WATERING BEHAVIOR

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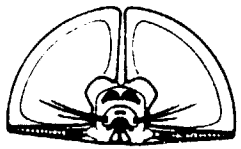


NAME/ORG.: P. SEBESTA	TITLE: AEM WATER BOTTLE STATUS	DATE: 12/7/83

- GEN. DYN. DESIGNED DOUBLE WATER BOTTLE FOR AEM — NOVEMBER, 1983
- BOTTLE FABRICATION FINISHED — NOVEMBER, 1983
- BOTTLE FUNCTIONAL TESTS — STS-9 LANDING + 3 DAYS
- PARABOLIC FLIGHTS WITH STS-9 CREW
  JERRY MOYER (KSC BIONETICS)
  JACK SWEENY (UCLA FRAS SSIP)
- JSC MANAGEMENT NOT CONSIDERING WATER BOTTLE FOR STS-11 (UNPROVEN)
- LBE RECOMMENDS USE OF WATER BOTTLE AFTER PROVEN FUNCTIONAL FLIGHT TESTS WITH NO DISCOMFORT OR DANGER TO ANIMALS USING POTATOES AS BACK UP

STS-8 MICROBIOLOGY SUMMARY
SPF RATS

	KSC	U. MIAMI	PAP INSTITUTE	U. ALABAMA BIRMINGHAM
	(Feces)	(Gut)		
INTESTINAL FLORA; GRAM NEGATIVE:				
Staph. aureus	2/5	3/5		
Staph. epidermidis	3/5	N/A		
Strep. faecalis	N/A	5/5		
Strep. viridans	2/5	N/A		
Bacillus sp.	N/A	4/5		
Lactobacillus sp.	N/A	5/5		
INTESTINAL FLORA; GRAM NEGATIVE:				
E. coli	5/5	5/5		
Proteus mirabilis	4/5	3/5		
Camphylobacter	N/A	0/5		
Klebsiella pneumoniae	3/5	5/5		
Enterobacter cloacae	2/5	N/A		
Hafnai alvei	3/5	N/A		
NASOPHARYNX:	(Throat)	(Nasopharynx)		
Staph. aureus	2/5	N/A		
Staph. epidemidis	3/5	N/A		
Alpha Strep, NOT S. pneumoniae nor Group D	N/A	3/5		
Group D Strep, NOT enterococcus	4/5	4/5		
Strep. faecalis	N/A	2/5		
Strep. viridans	3/5	N/A		
E. coli	4/5	N/A		
Proteus mirabilis	2/5	1/5		
Mycoplasma	N/A	0/5		0/5(ELIZA)
SKIN:				
Dermatophytes		0/5		
PARASITOLOGY	NEG			
VIROLOGY			NEG	
ORGAN MICROSCOPY			NEG	

FACTORS FOR RAT SELECTION: SPF vs GNOTOBIOTICS

1) EXPENSE ($/rat & care)
2) AVAILABLE DATA BANK
3) AVAILABILITY OF ANIMALS
4) POSSIBILITY OF PATHOGENS

RODENT HEALTH CHECK LIST

1. HAIR COAT
____a) normal
____b) dermatitis
____c) pruritis
____d) reddening
____e) hair loss
____f) scaliness
____g) other: _____

_____

2. RESPIRATORY SYSTEM
____a) normal
____b) labored breathing
____c) coughing
____d) sneezing
____e) chattering
____f) nasal discharge
____g) pawing of nose
____h) other: _____

_____

3. LOCOMOTION
____b) head tilted
____c) circling
____d) convulsions
____e) paralysis
____f) muscle weakness;
location: _____

_____

____g) other: _____

_____

4. ARTHRITIS
____a) none
____b) swollen joints;
location: _____

_____

____c) stiff gait
____d) lameness
____e) other: _____

_____

5. LYMPH NODES
____a) normal
____b) enlarged; location:

_____

6. GROWTH
____a) normal
____b) stunted
____c) abnormal pattern
(describe on back of sheet)
____d) excessive
____e) other: _____

_____

7. WEIGHT: _____gms
____a) normal
____b) greater than expected
____c) less than expected

8. EYES
____a) normal
____b) conjunctivitis
____c) encrusted eyelids
____d) reddened eyelids
____e) ocular discharge
____f) bulging eyes
____g) other: _____

_____

9. URINE
____a) normal
____b) hematuria
____c) hemoglobinuria
____d) other: _____

_____

10. DIARRHEA
____a) normal
____b) soiled anal area
____c) soiled hair coat
____d) other: _____

_____

11. ANEMIA
____a) none
____b) weakness
____c) pale mucous membranes
____d) other:

_____

_____

RAT NUMBER: _____

GROUP: _____

CHECK PERFORMED BY: _____ DATE: _____
(signature)

MEASUREMENTS FOR WEBER SSIP
(12/06/83)

PERIOD:	PREFLIGHT	INFLIGHT	POSTFLIGHT
SITE:	KENNEDY SPACE CENTER (KSC)	SPACE	KSC (landing day only)/PFIZER
PI/NASA/ SPONSOR:	WEBER/Holton, Jackson, Knott/ Kessler, Larson	WEBER/McNair	WEBER/Holton, Knott (KSC only)/ Kessler (KSC only), Larson

DATE	MET (days)	LIGHT:DARK CYCLE (11:13/0400:1500EST)	GROSS OBSERVATIONS	VETERINARY EXAM	VIDEO	MICROBIOLOGY (Health Status)	POTATO (Water)/ FOOD WEIGHT	BODY WEIGHT	PAW VOLUME
10 JAN	-20	X							
11	-19	X							
12	-18	X							
13	-17	X							
14	-16	X							
15	-15	X							
16	-14	X							
17	-13	X							
18	-12	X							
19	-11	X							
20	-10	X							
21	- 9	X							
22	- 8	X							
23	- 7	ARTHRITIS INDUCED: RATS/TEAM TO KSC							
		X	X	X		X		X	X
		(Measurements at both Kingston and KSC)							
24	-6	X	X					X	
25	-5	X	X				X	X	
26	-4	X	X	X	X		X	X	X
27	-3	X	X				X	X	
28	-2	X	X				X	X	
29	-1	X	X	X	X	X	X	X	X

DATE	MET (days)	LIGHT:DARK CYCLE (as per flight)	GROSS OBSERVATIONS	BEHAVIOR (VTR)
30 JAN	+0	X		
31	+1	X	X	
1 FEB	+2	X	X	X
2	+3	X	X	
3	+4	X	X	
4	+5	X	X	
5	+6	X	X	
6	+7	X	X	X
7/8	+8/9	X	X	

DATE	MET (days)	LIGHT:DARK CYCLE (11:13/0130:1230EST)	GROSS OBSERVATIONS	VETERINARY EXAM	VIDEO	MICROBIOLOGY (Health Status)	POTATO (Water)/ FOOD WEIGHT	BEHAVIOR	BODY WEIGHT	PAW VOLUME	X-RAY	BLEED	
7/8 FEB	+8/9	X	X	X	X	X	X		X	X		X	(KSC)
7/8	+8/9	X	X	X		X			X	X	X		(Pfizer)
9	+10	X	X				X	X				X	
10	+11	X	X				X	X					
11	+12	X	X				X	X					
12	+13	X	X					X	X	X			
13	+14	X	X					X					
14	+15	X	X					X					
15	+16	X	X	X			X	X	X	X	X	X	
16	+17	X	X					X					
17	+18	X	X					X					
18	+19	X	X					X					
19	+20	X						X	X	X			
20	+21	X	X					X					
21	+22	X	X					X					
22	+23	X	X	X			X	X	X	X	X	X	
23	+24	X	X					X					
24	+25	X	X					X					
25	+26	X	X					X					
26	+27	X	X					X	X	X			
27	+28	X	X					X					
28	+29	X	X	X			X	X	X	X	X	X	

Kingston, NY branch of Charles Rivers, Inc. will be the source of Lewis rats for this project.

1 AEM Lights On

LIGHTS - ON
✓Fan Fuse LED (four) - off

* If any LED lit, notify MCC *

Log MET ____/____:____

____/____:____

____/____:____

____/____:____

____/____:____

____/____:____

____/____:____

____/____:____

____/____:____

3 AEM Lights Off

LIGHTS - OFF
✓Fan Fuse LED (four) - off

* If any LED lit, notify MCC *

Log MET ____/____:____

____/____:____

____/____:____

____/____:____

____/____:____

____/____:____

____/____:____

____/____:____

____/____:____

2 AEM Data Collection

Pull AEM from locker

NOTE

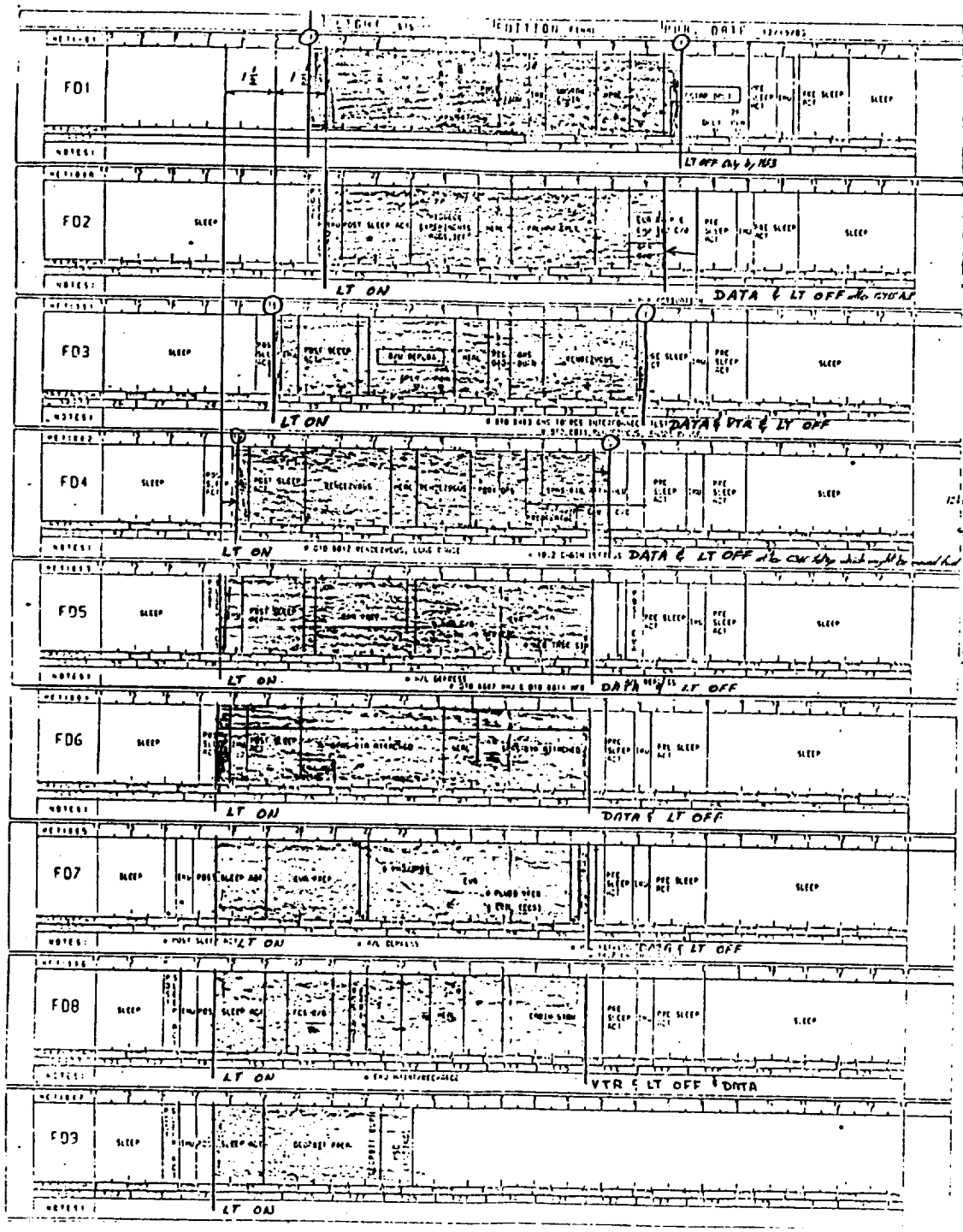
Cage A (left) has 3 arthritic rats (#1,2,3). Cage B (right) has 3 normal rats (#4,5,6). Rate condition as: B = bad, P = poor, F = fair, G = good, or E = excellent

MET ____/____:____ TEMP ____ °F

	Cage A					Cage B				
Condition	B	P	F	G	E	B	P	F	G	E
Motion										
Grooming										
Feeding										
Morale										

Comments:

Stow AEM in locker



WEBER AEM OPERATION TIMES
(Assumes Launch at 0800 EST)

EVENT	APPROX MET (Date/Day/EST)	DURATION	AFTER/DURING
LIGHTS OFF (HANGER L)	-0/17:00 (Jan 29/Sun/1500)	13hrs OFF	
LOAD AEM IN MIDDECK	-0/12:00 (Jan 30/Mon/2000)		
LIGHTS ON	-0/04:00 (Jan 30/Mon/0400)	11hrs ON	
LAUNCH	0/00:00 (Jan 30/Mon/0800)		
LIGHTS OFF	0/07:00 (Jan 30/Mon/1500)	13.5hrs OFF	Westar Deploy
LIGHTS ON	0/20:30 (Jan 31/Tues/0430)	10hrs ON	Postsleep
DATA & LIGHTS OFF	1/06:30 (Jan 31/Tues/1430)	12.5hrs OFF	EVA prep&SPAS C/O
LIGHTS ON	1/19:00 (Feb 1/Wed/0300)	11hrs ON	Postsleep
DATA/VTR & LIGHTS OFF	2/06:00 (Feb 1/Wed/1400)	12hrs OFF	Rendezvous/Presleep
LIGHTS ON	2/18:00 (Feb 2/Thurs/0200)	11hrs ON	Postsleep/IMU
DATA & LIGHTS OFF	3/05:00 (Feb 2/Thurs/1300)	12.5hrs OFF	SPAS&EMU C/O
LIGHTS ON	3/17:30 (Feb 3/Fri/0130)	11hrs ON	Postsleep/IMU
DATA & LIGHTS OFF	4/04:30 (Feb 3/Fri/1230)	13hrs OFF	EVA
LIGHTS ON	4/17:30 (Feb 4/Sat/0130)	11hrs ON	Postsleep
DATA & LIGHTS OFF	5/04:30 (Feb 4/Sat/1230)	13hrs OFF	SPAS
LIGHTS ON	5/17:30 (Feb 5/Sun/0130)	11hrs ON	IMU/Postsleep
DATA & LIGHTS OFF	6/04:30 (Feb 5/Sun/1230)	13hrs OFF	PostEVA
LIGHTS ON	6/17:30 (Feb 6/Mon/0130)	11hrs ON	Postsleep
DATA/VTR & LIGHTS OFF	7/04:30 (Feb 6/Mon/1230)	13hrs OFF	Cabin Stow
LIGHTS ON	7/17:30 (Feb 7/Tues/0130)	11hrs ON	Postsleep
LANDING	7/23:21 (Feb 7/Tues/0721) or		
DATA & LIGHTS OFF	8/04:00 (Feb 7/Tues/1200)	13.5hrs OFF	Cabin Stow
LIGHTS ON	8/17:30 (Feb 8/Wed/0130)	11hrs ON	Postsleep
LANDING	8/23:00 (Feb 8/Wed/0700)		
REMOVE AEM AND RETURN TO HANGER L	8/00:21 or 9/00:00 (Feb 7/Tues/0821 or Feb 8/Wed/0800)		

SE81-10
UPDATED ACTION ITEMS

ITEM	PERSON RESPONSIBLE	DATE DONE
1. Coordination of PAOs for NASA and corporate sponsors for Weber SSIP	Rasmussen	
2. Historical videotape of NASA Life Sciences past animal flights	Halstead/Rasmussen	
3. AEM air flow measurements (clean)	Kessler/General Dynamics	11/29/83
4. AEM to JSC for flight storage	Kessler	11/30/83
5. Ground unit mock-up of AEM	Kessler	12/07/83
6A. Build water system for AEM	Kessler/Sweeney	12/03/83
B. Flight qualify water system	Jackson	
C. KC135 flights at DFC (ARC South)	Sweeney/Kessler/Moyer	12/11/83
D. Objectives/protocol for KC135 test of water bottle	Jackson/Sweeney/Kessler	12/11/82
7. Check out antifog spray for AEM lid	Jackson	
8. Contingency plans for nonUS landings	Jackson	
9. Repack AEM filters/prepare under clean conditions if possible	Jackson/Christie	
10. Fuse changeout procedure	Jackson/Christie	
11. Updated STS11 timelines (as available) and updated launch windows (as available)	Staples/Jackson	
12. PC board for automatic light/dark cycle in AEM	Staples/Jackson	
13. Postflight trip to Pfizer for rats from KSC	Jacksonn/Knott	
14. Teklad Diet Ordered	Knott	
Teklad Diet Received		12/01/83

ITEM	PERSON RESPONSIBLE	DATE DONE
15. Animal handlers physicals/ requirements and updates for team Clear all team member for KSC and animal handling (if necessary)	Knott	
16. Clear Kessler to launch pad	Knott	
17. KSC photographic support/ physicals and clearances necessary	Knott/Sebesta	
18. Contingency facilities for US landing sites	Sebesta	
19. Postflight trip to Pfizer for rats from landing sites other than KSC	Sebesta	
20. Effect of 4.5KHz noise at 75db for 2 hours on rats (simulated 3-axis acoustic containment furnace experiment [ACES] which will be in middeck locker on STS11)	Sebesta	
21. Procurement of glue for food bars	Sebesta	
22. STS-8 (DSO 0421) and STS-11 (SE81-10) preflight, flight, postflight coordinated videotapes	Sebesta/Holton	
23. Directory of personnel at KSC, JSC, ARC, and HQ associated with STS11 launch and recovery operations (addresses/phones) for SE81-10	Sebesta/Smith	
24. STS-8 Project Report	Smith/Holton	
25. Microbiology of AEM filter after repacking and before STS-11	Smith/Pearson	
26. Letter from Charles River regarding SPF status and light/dark cycle	Larson	
27. Potato consumption/food consumption/growth data from baseline studies	Weber/Larson	
28. Requirements for Support at KSC for SSIP during STS-11	Holton/Knott	
29. Questions for postflight crew debriefing	Team	

DIRECTORY OF TEAM MEMBERS FOR SE81-10

STUDENT:

Mr. Daniel J. Weber
950 Park Avenue
New York City, NY 10028
212/249-1020
or
709 Stewart Ave.
Ithaca, NY 14850
607/273-2447

TEACHER:

Ms. Francine Salzman
1 Thurston Drive
Livingston, NJ 07039

CORPORATE SPONSOR:

PFIZER:

Dr. David Larson
Central Research Division
Pfizer, Inc.
Eastern Point Road
Groton, CT 06340
203/441-4691 (office)
203/441-4656 (lab)
203/739-0856 (home)

Dr. Mike Ernest
Central Research Division
Pfizer, Inc.
Eastern Point Road
Groton, CT 06340
203/441-3836

GENERAL DYNAMICS:

Mr. Thomas Kessler
DOD Advanced Space Programs
General Dynamics - Convair Division
PO Box 80847, Mail Code 21-9530
San Diego, CA 92138
619/573-5106
619/755-4779 (home)

Mr. Gerry Huston
DOD Advanced Space Programs
General Dynamics - Convair Division
PO Box 80847, Mail Code 21-9530
San Diego, CA 92138
619/573-9783
619/487-5287 (home)

NASA ARC:

Dr. Emily Holton
Biomedical Research Division
M/S 239-14
NASA-Ames Research Center
Moffett Field, CA 94035
415/965-5471 (FTS = 448)
415/965-5247
408/246-7440 (home)

Mr. Paul Sebesta
Life Sciences Flight Experiments
Project Office
M/S 240A-3
NASA-Ames Research Center
Moffett Field, CA 94035
415/965-6455 (FTS = 448)
408/996-8335 (home)

Dr. Jerome Goldsboro, Jr.
Biosystems Division
M/S 236-5
NASA-Ames Research Center
Moffett Field, CA 94035
415/965-6703 (FTS = 448)
415/965-6390
415/921-3552 (home)

NASA-JSC:

Mr. John Jackson
Crew Station Integration Section
Mail Code EN-43
NASA-Johnson Space Center
Houston, TX 77058
713/483-3173 (FTS = 525)
713/333-4542 (home)

Mr. Neil Christie
Crew Station Integration Section
Mail Code EN-43
NASA-Johnson Space Center
Houston, TX 77058
713/483-3173 (FTS = 525)

Dr. Malcolm Smith
Mail Code SD-3
NASA-Johnson Space Center
Houston, TX 77058
713/483-5457 (FTS = 525)

Dr. Ron McNair
Mail Code CB
NASA-Johnson Space Center
Houston, TX 77058
713/483-3856 (FTS = 525)

NASA HEADQUARTERS:

Mr. Alan Ladwig
Office of Space Flight
Code ME
NASA Headquarters
Washington, DC 20546
202/453-1138
703/237-4195 (home)

Mr. Michael Bowie
Office of Space Flight
Code MC-7
NASA Headquarters
Washington, DC 20546
202/755-2350

Dr. Thora Halstead
Life Sciences Division
Code SBE-3
NASA-Headquarters
Washington, DC 20546
202/453-1525
703/356-1397 (home)

Ms. Evvie Rasmussen
Public Affairs Office for OSSA
Code E-6
NASA-Headquarters
Washington, DC 20546
202/755-3054

NASA-KSC:

Dr. William Knott
Code MD-RSB-2
NASA-Kennedy Space Center, FL 32899
305/867-3152 (FTS = 823)
305/267-1321 (home)

Mr. Jerry Moyer
BIO-3, Hanger L
NASA-Kennedy Space Center, FL 32899
305/853-3165 (FTS = 824)
305/268-0672 (home)

Mr. John Bryant
Code CS-SED-4
NASA-Kennedy Space Center, FL 32899
305/867-3044 (FTS = 823)

Others:

Mr. Jack Sweeney
Bone and Connective Tissue Research Program
Orthopaedic Hospital
2400 South Flower St.
Los Angeles, CA 90007
213/742-1396
714/989-2347 (home)

TO: Weber Team

FROM: Project Manager/Scientist

SUBJECT: Biweekly report (#7), December 17, 1983

AEM HARDWARE STATUS: The AEM GROUND CONTROL CAGE and WATER BOTTLE arrived at ARC late Wednesday afternoon, December 14. Rats were put in the cage on Thursday and left overnight. Three animals were placed on each side of the AEM and three controls were kept in a colony cage. One water bag in the water bottle leaked and completely saturated the underlying absorbant cardboard by Friday morning, but no large puddle of water was obvious on the table under the AEM or on the floor. A total volume of 1595ml was put into the two water bags and a volume of about 860 ml remained Friday morning. Examination of the water bags showed that the bag on side B was completely empty, but the bag on side A was essentially full. Since the controls drank 120ml water overnight, probably somewhere around 620ml spilled if one assumes that the animals in the ground control cage consumed about the same amount as the controls (i.e., a total of 240ml). The volume spilled may have been less since the temperature in the cage was almost 38C (100F) Friday morning and the animals may have consumed more water. The temperature in the cage was almost 20 degrees higher than the temperature in the animal room because the cage had been placed directly on the cardboard which inhibited air flow through the cage. Once the unit was placed on a plastic frame to allow air flow under the bottom of the cage, the temperature dropped quickly to about 29C (84F). Friday morning the animals and the water bottle were removed from the ground control cage. Although only one water bag had a leak, both bags were replaced and reloaded. This time the total volume of the bags was 1267ml. The water consumed by the controls between Friday afternoon and Saturday afternoon was 116ml. At this rate, the water supply should last about 11 days for rats of this size. These studies will continue through Wednesday, December 21, and at that time we should have a better estimate of the amount of water consumed over a 5 day period by animals weighing about 250gm. Side A of the ground control cage weighed an average of 248$\pm$2.5gm (S.D.), the rats on side B weighed 244$\pm$4.9gm, and the controls weighed 256$\pm$2.8gm Thursday afternoon (3 rats/group). By Friday morning, the rats on side A (the dry side) had lost an average of 8gm suggesting that they had not completely adapted to the cage while the rats on the side with the leaky bag gained about 2gm and the controls gained about 3gm. These data also suggest that the rats in the ground control cage probably did not consume more water than the controls housed in the colony cage and may even have consumed less water. By Saturday afternoon, the rats on side A weighed 235$\pm$12.1gm, those on side B weighed 229$\pm$5.7 gm, and the control weighed 262$\pm$6.1gm. On Friday, the rats in the AEM control cage had been returned to colony cages while the water bags were replaced and these animals were weighed just prior to returning them to the AEM. Further data are necessary to define whether the animals are adapting to the cage. These studies will continue until Wednesday unless the animals continue to lose weight.

The ground control cage and water bottle are very impressive. Although the group was dubious that three 250gm rats would be comfortable in each side of the ground control cage, the cage appears adequate once the

animals are installed. The animals also climbed the sides and across the top of the cage using the wire mesh. The dimensions of the cage appear more than adequate to support three 250gm rats per side.

The major problem with the water bottle was the degree of difficulty in getting the bottle in and out of the cage due to the position and number of small screws. This problem was discussed with Tom Kessler who was at ARC Friday, December 16.

Present plans include SHIPPING the WATER BOTTLE to JSC on Thursday, December 21. Unless more data are required using the rats, we will adhere to this schedule.

The manual TEMPERATURE PROBE in the ground control cage is located in the same position as the probe in the AEM. The probe is easy to read and is more accurate than the original temperature probe.

SCIENCE STATUS: On Friday, December 16, the team had a telephone conference at 4PM EST to discuss the results of the microbiological examination of the Charles Rivers SPF and gnotobiotic Lewis rats.

Members of the team at the telecon included: Dan Weber in Ithaca; Dr. David Larsen at Pfizer; Bill Munsey, Bill Knott, and Nancy Hannigan at KSC; Bob Schmitz and Evvie Rasmussen at NASA Headquarters; John Jackson, Neil Christie, and Dwayne Pearson at JSC; and Emily Holton, Tom Kessler, Paul Sebesta, Bill Berry, and Pearl Chang at ARC.

The gnotobiotic rats had received Shaedler's modified cocktail with 12 defined intestinal bacteria. KSC received 6 SPF and 2 gnotobiotic Lewis rats on December 6. Microbiology was done on throat swabs and fecal pellets to determine whether these rats had any pathogens recommended for exclusion from flight by NASA. The gnotobiotics had no pathogens that were of concern for flight. However, the SPF rats did have some questionable pathogens. six of 6 rats had Klebsiella pneumonia in the feces and 3/6 were positive for this organism in the throat swab. Three of 6 SPF rats also had a beta-Streptococcus, probably Group A, in the throat culture. In addition, 6/6 had Staph. aureus in the fecal samples and 4/6 had this organism in throat cultures. Neither type of rat had any viral organisms. The analysis for mycoplasma has not been completed. The team is indebted to the crew at KSC for the timely data.

Although the SPF animals are reasonably clean, they do contain organisms recommended for exclusion and the decision was made to use the gnotobiotic rats. Dr. Larson will check with Charles Rivers on Monday, December 19 as to the availability of these animals. At least 24 rats should be available; 9 rats would be inoculated with Freund's adjuvant and 15 rats would be shipped to KSC as controls. If the launch is delayed 7 days, then 9 of the control rats would be inoculated with the adjuvant at KSC. The absolute minimal number of rats which could be used in this experiment is 12: 3 flight arthritic, 3 flight nonarthritics, 3 ground arthritics, and 3 ground nonarthritics.

Because of this decision, any launch delay could create a major problem. A lead time of approximately 2 months is necessary to assure a proper number of gnotobiotic animals.

CONTINGENCY PLANS: We are planning a contingency landing at Dryden and would appreciate inputs from any member of the team who has not been contacted regarding requirements in California if the shuttle does land here. We should know by the first of the year whether the primary landing site has changed.

TO: Weber Team

FROM: Project Manager/Scientist

SUBJECT: Biweekly report (#8), January 3, 1984

LAUNCH DATE: The launch may be delayed a few more days bringing us to a launch date comparable to the date originally scheduled for our departure from the Cape (around February 6). We will arrive at the Cape one week prior to launch. If you have already made reservations, please remember to CHANGE YOUR RESERVATIONS at your motel/condominium. The official launch date is Feb.3, but a delay of several days may still occur.

AEM HARDWARE STATUS: The AEM GROUND CONTROL CAGE and WATER BOTTLE were shipped to JSC on Thursday, December 22, 1983. The 5-day study with this system at ARC used mature, female, Wistar-derived rats and suggested that the rats needed to be trained to the lixit valves prior to experimentation. The experiment used 6 rats (3 per side) in the AEM and 3 group-housed controls. The controls maintained their body mass while the animals in the AEM lost an average of about 16 grams during the experiment; the majority of the weight loss occured in the first 3 days. The animals in the AEM consumed only half as much water as the controls; unfortunately the water bottle in the AEM was only weighed at the beginning and end of the experiment, due to the difficulty of removing and replacing the watering system in the ground control unit.

The water bottle will processed for flight, but at some point further testing with rats will be necessary to determine the length of time required to train naive animals to the lixit valves in the water system in the ground control cage, and to assure that animals will rapidly adapt to the AEM and water system. If further details about this study are of interest to any team member, then actual data may be obtained by calling my laboratory at ARC and asking for the data from experiment RBII:48.

During this study, an interesting observation was made regarding the TEMPERATURE PROBE. The temperature was noted to be between 31-33C (88-92F) in the AEM while the ambient temperature in the animal room was consistently 22C (72F). Although initially an air flow problem was blamed, it was noted that the rats were routinely resting against the probe and that when they moved, the temperature decreased. So, the probe was probably recording the rats' body temperature rather than the ambient temperature in the cage. Thus, we have recommended shielding the probe in the ground control cage. The probe is very sensitive and very easy to read.

SCIENCE STATUS: Shortly after our telecon, Charles Rivers determined that sterility had been broken in part of their breeder colony for gnotobiotic rats. Dave Larson is constantly in touch with Charles Rivers and will have numbers of available animals for weekly inoculation dates starting January 27 (assuming launch slips of one week for each time period) through March 2 for the next newsletter. When these numbers are available, we'll have a better idea about the possibility of contingency planning with available rats.

ON ORBIT ALERT: Apparently the AEM will be POWERED DOWN twice ON ORBIT for about 30 sec. each time. The power interruption is necessitated since the AEM shares a power outlet with the ACES experiment. Since the cabling for the ACES is stowed during launch, the cables must be attached before the experiment can be activated. Because of shuttle regulations, the equipment sharing the outlet must be powered down both when the cabling is attached to and disconnected from the ACES experiment. Power on will be verified following each power down of the AEM.

Dan Weber and Dave Larson are preparing short verbal descriptions of the items to be measured inflight. The table of measurements was included in report #6, but has been extended to include paw swelling and movement of both joints and body of the animals.

CONTINGENCY PLANS: Contingencies for shuttle landings at Dryden and nonUS landings have been submitted to John Bryant from Paul Sebesta; a copy is enclosed for your perusal.

ACTION ITEMS: Please check the action items and try to finish as quickly as possible those assigned to you. If you have ideas for action items assigned to others please contact them immediately. If you take any action that impacts efforts assigned another, be sure to inform that individual.

Shipment of rats from KSC to Pfizer is presently assigned to Jackson/Knott. Please contemplate potential shipping arrangements for the animals and inform Jackson/Knott if you have any ideas.

TEAM NEWS: Dan Weber will be getting 4 units of college credit from Cornell for a special project which will include his work on the SSIP. He wants to do additional analysis of samples at the Cornell Veterinary School with his advisor, Dr. Lennart Krook.

ENCLOSURES:
1) Updated Action Items
2) Letter to John Bryant from Paul Sebesta re: contingencies

SE81-10
UPDATED ACTION ITEMS

ITEM	PERSON RESPONSIBLE	DATE DONE
1. Coordination of PAOs for NASA and corporate sponsors for Weber SSIP	Rasmussen	
2. Historical videotape of NASA Life Sciences past animal flights	Halstead/Rasmussen	
3. Flight qualify water system	Jackson/Holton	
4. Check out antifog spray for AEM lid	Jackson	
5. Repack AEM filters/prepare under clean conditions if possible	Jackson/Christie	
6. Fuse changeout procedure	Jackson/Christie	
7. Updated STS11 timelines (as available) and updated launch windows (as available)	Staples/Jackson	
8. PC board for automatic light/dark cycle in AEM	Staples/Jackson	
9. Postflight trip to Pfizer for rats from KSC	Jackson/Knott	
10. Teklad Diet Received	Knott	01/05/84
11. Animal handlers physicals/ requirements and updates for team Clear all team member for KSC and animal handling (if necessary)	Knott	
12. Clear Kessler to launch pad	Knott	
13. KSC photographic support/ physicals and clearances necessary	Knott/Sebesta	
14. Contingency facilities for US and nonUS landing sites	Sebesta	12/22/83
15. Postflight trip to Pfizer for rats from landing sites other than KSC	Sebesta	
16. Effect of 4.5KHz noise at 75db for 2 hours on rats (simulated 3-axis acoustic containment furnace experiment [ACES] which will be in middeck locker on STS11)	Sebesta	

ITEM	PERSON RESPONSIBLE	DATE DONE
17. STS-8 (DSO 0421) and STS-11 (SE81-10) preflight, flight, postflight coordinated videotapes	Sebesta/Holton	
18. Directory of personnel at KSC, JSC, ARC, and HQ associated with STS11 launch and recovery operations (addresses/phones) for SE81-10	Sebesta/Smith	
19. STS-8 Project Report	Smith/Holton	
20. Microbiology of AEM filter after repacking and before STS-11	Smith/Pearson	
21. Number of gnotobiotic rats available for inoculation on Jan. 26, Feb.2, Feb. 9, Feb. 16, Feb. 23, or March 1 from Charles Rivers	Larson	
22. Potato consumption/food consumption/growth data from baseline studies	Weber/Larson	
23. Requirements for Support at KSC for SSIP during STS-11	Holton/Knott	
24. Questions for postflight crew debriefing	Team	

E. Halloon, 239-14

LBE:240A-3

December 22, 1983

Mr. John Bryant
NASA Kennedy Space Center
Code CS-SED-4
Florida 32899

Dear Mr. Bryant:

This letter is written in response to your request through Bill Patton and John Jackson and regards recovery contingencies for the Weber SSIP to be flown on STS-11.

This is the student project that carries arthritic and normal rats in the mid-deck locker AEM (Animal Enclosure Module).

Contingencies are addressed in three categories: (1) Early Landing at Dryden, (2) Full Mission with Dryden Landing, and (3) Out of Continent Landing.

Any activity associated with landing and recovery at Dryden is assumed to use facilities as discussed with Bill Patton or a reasonable facsimilie thereof.

1.0 Basic Dryden Facility

The basic facilities needed are:

(1.1) clear air flow bench (STS-8 recovery quality or better) with 8 sq. ft. work bench space.

(1.2) a work area dedicated to the AEM disassembly that is separate from other people and activity that is approximately 10' x 10' and has in it one lab cart 2' x 3' and bench space of 2' x 6'.

(1.3) Suggested arrangement follows:

(1.4) This area needs 110 A.C., four outlets

(1.5) (two duplex outlets).

Lighting should be bright enough for normal reading activity.

(1.6) The area should be free of noise, vibration and strong odors (i.e., being parked next to a diesel power generator would destroy the experiment).

(1.7) We need two incandescent goose neck desk lamps as incubation sources. With those lamps the SSIP can tolerate a 70° trailer for recovery operations. Without the lamps we would require an 80-85° room.

(1.8) Two chairs without wheels are needed (not folding).

(2.0) Early Dryden Landing

(2.1) Contingency team from ARC arrives via ARC aircraft ASAP with kit

Team:
Dr. Chris Schatte
Dr. Joseph Sharp
Ms. Pearl Cheng
Mr. Marty Curry
Ms. Barbara Hunter

(2.2) Contingency team receives animals and returns to ARC after:

a - checking animal well-being

b - transfer from AEM to SPF cages

(2.3) Animals housed in ARC vivarium until P. I. arrives or animals sent to P.I.

(3.0) Full Mission with Dryden Landing

(3.1) Representative of recovery team does walk thru of Dryden facilities two weeks before STS-11 launch.

(3.2) Weber SSIP recovery team flies to Dryden from ARC on NASA aircraft 6 hours before touchdown.

(3.3) SSIP recovery facilities finalized four hours before recovery

(3.4) Team Members:
Paul Sebesta, ARC
Dr. Emily Holton, ARC
Dr. Jerome Goldsboro, ARC
Dr. Al Morland, KSC (Bionetics)
Ms. Nancy Hannigan, KSC (Bionetics)
Marty Curry, ARC
Danny Weber, P. I.
Dr. Dave Larson Pfizer
Tom Kessler, Gen. Dyn.
Gerry Huston, Gen. Dyn.
Theda Driscol, Baylor/JSC

In addition, there is a good possibility that General Dynamics will send some upper level management to the recovery area. General Dynamics has built the AEM without remuneration from NASA.

(3.4.1) Science coordinator and P. I. fly with ground control rats to Dryden. Animals are housed in 10'x10' work area where flight animals are received.

(3.5) AEM received from STS team. (R+60 min)

- microbiological swabs taken
- animals inspected by vets
- weights, blood and microflora data taken
- animals transferred to SPF cages

(3.6) SSIP Team returns to ARC and all animals begin trip to Groton, Connecticut. (R+3 hours)

(3.7) SSIP recovery clear of Dryden facilities by R+5 hours.

(3.8) AEM returned for refurbishment. Exact route TBD.

(4.0) Out of Continent Landing

(4.1) AEM/SSIP team stands by at KSC and/or Dryden for telecon support (24 hours).

(4.2) Dr. Jerry Goldsboro on standby to travel to contingency area with recovery kit.

(4.3) After out of continent landing and crew safety is taken care of, the following steps could be taken:

4.3.1 Remove AEM from mid deck locker to general conditions of 72^{0}+ or - 3^{0}F and 50% R.H. + or - 10% R.H.

4.3.2 Insure that animals have adequate ventilation and sterile drinking water.

4.3.2.1 Ventilation can be done by powering up fans from any 28 volt D.C. (10 amp). Definitely no more than 30 volts DC and no less than 20 volts for continuous running. Fans are protected by one 4 amp fuze located on AEM front panel.

4.3.2.2 Water for animal drinking can be sterilized by boiling, autoclaving (pressure cooker), microwave, or chemical treatment. Water bottles or dishes must be sterilized in a like manner.

4.3.2.3 Food can be used from within the AEM walls. If that food is consummed they can be fed sterilized rat, dog or cat chow pellets. Sterilization can be by (1) alcohol (70%) spray and dry (2) heat flash of 600°F for 90 seconds (3) autoclave on dry cycle at 250°F, 20 psi for 15 - 20 minutes (4) standard kitchen microwave for 5 min.

4.3.2.4 Animals can be transferred to standard pet animal cages if the AEM is considered unsafe or impractical. The cages and bedding should be sterilized. The lids with access to room air should be covered with the same kind of material used for paper surgical masks. The purpose is to restrict "germs" (bacteria and viruses) from infecting the animals.

(4.4) In the event an animal is suffering for any reason from accident or disease, they may be euthanized. This can be done humanely by overdosing with any of the following:

- ether
- CO_2
- Halothane
- pentabarbitol
- phenabarbitol
- surital
- sodium thiopenital
- .5ml buthanasia

Rodent bodies should preferably be quick frozen and shipped in dry ice to the Animal Care Facility at NASA/ARC, Attention: Dr. J. Goldsboro. Otherwise, the animals should be handled in either of two ways:

a. injection and pickled in formaldehyde and shipped to ARC

b. cremated and disposed

(4.5) Live animal returns to USA could be accomplished by military, NASA or commercial aircraft as long as animals enjoy the same cabin atmosphere as humans. Ideally, the animals will be escorted by Dr. J. Goldsboro, D.V.M. from NASA/ARC (Col. U.S. Army).

(4.6) Further contingencies can be handled through the Life Sciences staff familiar with the Weber SSIP. Order of priority for calling:

Paul Sebesta, NASA-ARC, 415-965-6455 or 6228
KSC, 305-853-3165 (FTS 253)

Dr. Emily Holton, NASA-ARC, 415-965-5471 or 6228
KSC, 305-853-3165 (FTS 253)

Dr. Jerome Goldsboro. NASA-ARC, 415-965-5471 or 6228
KSC, 305-853-3165 (FTS 253)

Paul D. Sebesta

bcc:

H. Klein, 200-7
J. Sharp, 200-7
E. Holton, 239-14
J. Goldsboro, 236-5
J. Ferandin, 240A-3
C. Schatte, 240A-3
M. Curry, 203-6
P. Cheng, 240A-3
B. Hunter,
J. Tremor, 240A-3
F. Drinkwater, 211-17
M. Landis, 211-17

WEB

PDS:pm 12-22-83/6455

TO: Weber Team

FROM: Project Manager/Scientist

SUBJECT: Biweekly report (#9), January 16, 1984

THE CHALLENGER IS ON THE PAD! On Thursday, January 12, the Challenger made its journey from the Vehicle Assembly Building to the launch pad. The roll out was about 2 days behind schedule. The Flight Readiness Review is scheduled for Tuesday, January 17; at this review, we will learn whether the flight is still on schedule for February 3.

HARDWARE STATUS: The BENCH REVIEW for STS-11 was conducted at JSC on Tuesday, Jan. 10 at 1PM. At this review, all available flight hardware/equipment from the middeck lockers is displayed on benches in a clean area and the flight crew is walked through and inspects the contents of each locker. The STS-11 crew asked many questions and spent much time familiarizing themselves with the flight hardware. Neil Christie, who was at the review to answer questions about the AEM, was impressed with the interest and thoroughness of the entire crew. Neil demonstrated and discussed the hardware as well as the potential problem of sliding the AEM into and out of the locker.

SCIENCE STATUS: The team was asked to decide what the crew should do IF the LIGHTS in the AEM FAILED TO TURN OFF. The choices were: 1) disconnect the power or 2) leave the lights on. Our decision was to leave the lights on. Although leaving lights on might interfer with the rats' circadian rhythms, we felt that interrupting the animals' periodicity might be preferable to lack of air flow. Also, disconnecting the power source would require powering down other experiments attached to the same power outlet each time the AEM was disconnected and/or reconnected and the effect of daily interruption of the power supply on AEM performance has never been bench tested.

ACES ACOUSTICAL TEST was performed at ARC Monday morning, January 9. The experiment protocol involved placing the rats in plastic cages in a wooden acoutical test box. The rats were allowed about 10 minutes to adapt before the test began. The low fequency noise lasted 30 minutes, and about two minutes later the high frequency study began and continued for 90 minutes. The test used four speakers all on the front of the test box. Two microphones placed next to the rat cage recorded the frequency and noise level from the speakers. The enclosed graphs are from microphone two which recorded slightly higher than microphone one; each graph is the average of 20 recordings (approximately one sec each). The low frequency run was approximately 1,500 Hz, 47.30 db; the high frequency run was about 5,480 Hz, 78.31 db. Other readings on the graph reflect background noise. The animals showed no response to the noise. The high frequency noise is very irritating to humans, but the rats slept through most of the test. When the high frequency noise began, two of the three rats awoke and looked around, then went back to sleep. This test suggests that the ACES experiment will not stress the rats.

The NUMBER OF GNOTOBIOTIC RATS available for a February 3 launch is 18. Six animals will be inoculated with adjuvant, six animals will be backups to be inoculated if the launch slips, and six animals will serve as

normal control rats.

POTATO TESTING. Potatoes procured were from the October harvest. They were carefully cleaned, placed in dilute (1:32) chlorox, and rinsed in sterile water. A sealed package of potatoes was shipped from ARC and received at KSC for preliminary microbiology tests. Some potatoes are being stored in sterile water to determine whether such storage increases/maintains water content. Per cent water content of the potatoes should be known by the next newsletter; after 6 days at 30C (86F), potatoes that were quartered had only lost 40% of their initial weight.

All rats will be put on potatoes during the full-up test prior to launch. The animals will also be given sterile drinking water during this time to assure that they are hydrated prior to launch.

UPDATED ACTION ITEMS: Most items not directly related to the STS-11 flight have been omitted. Please continue to check this list and to conclude your action items. If you note any omissions of items that should be on the list, please contact me.

TEAM ALERT: 1) If you must have ACCESS TO RATS at any time at the Cape be sure that you have contacted Dr. William Knott at the Cape (see team directory for address or phone number) and have complied with the KSC directive for animal handlers. The animal handler's badge is good for one year so those people associated with STS-8 do not have to renew their badge.

2) If you need PASSES to the launch or recovery site or to get to Hanger L (the animal facility at KSC) for yourself or your family/friends, make sure that you send the names to Michael Bowie. Michael has been tasked with the action to obtain these passes.

3) Check the enclosed TEAM DIRECTORY and please notify me if your address or phone number is incorrect.

4) Our "HEADQUARTERS" at KSC will be in Hanger L. Please contact me whenever you arrive so that we will know when team members are available in the area. I will be at Hanger L (853-3165) or at the Sea Gull Beach Club condominium (783-4441). I want to have a,LIST OF contact TELEPHONE NUMBERS for the team while we are at KSC. We also plan to have a TEAM PICTURE taken, time and place to be announced.

5) We are starting a SCRAPBOOK for this project, so clip out any articles you find and bring them along. At the end of the project, Dan Weber will be given custody of the scrapbook.

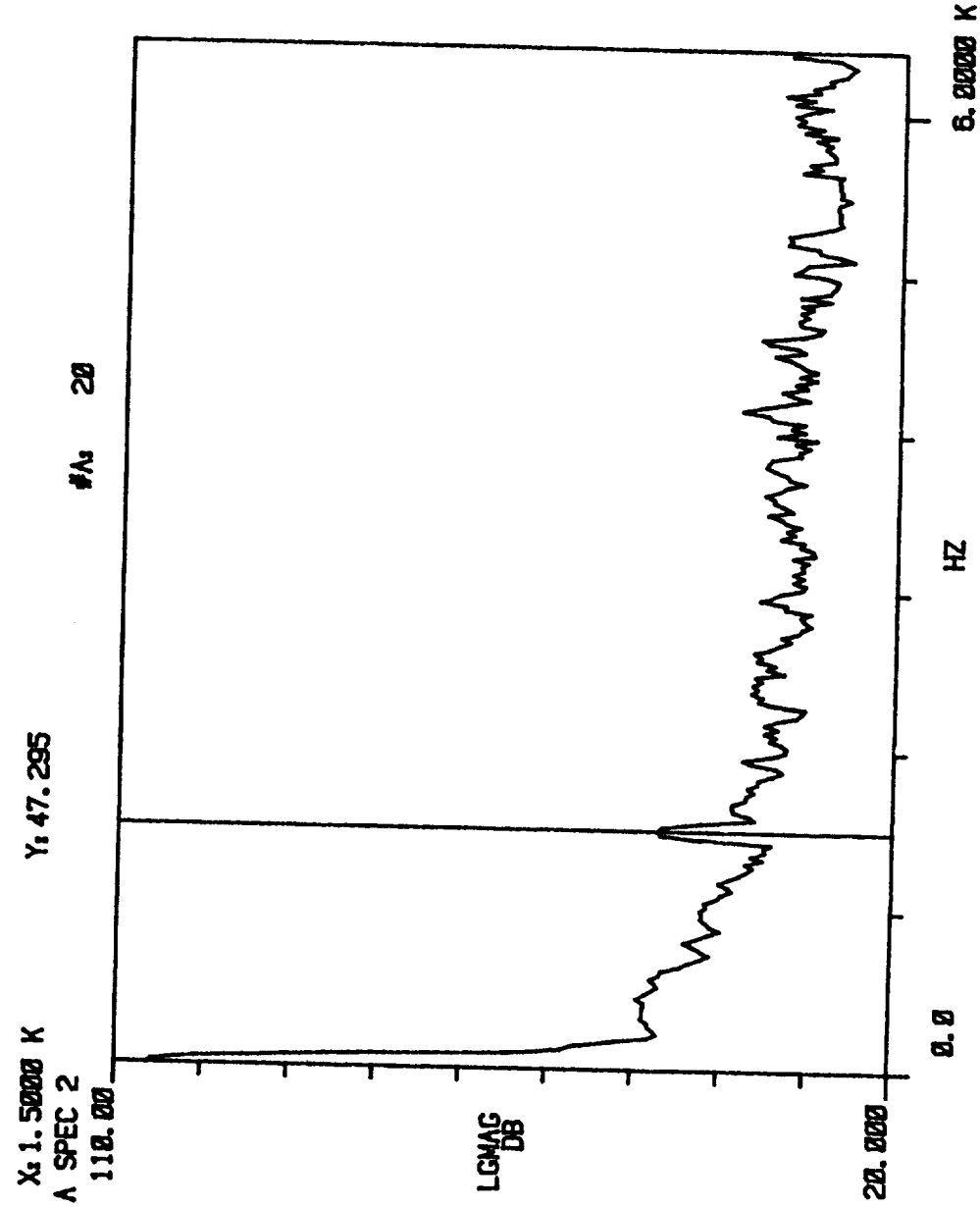
HANGER L UPDATE: 1) Three BEEPERS have been obtained for critical personnel so they can be reached, if necessary, when they are not at the hanger. Thus, launch personnel will be able to contact us at any time problems arise and we will not need personnel at Hanger L 24 hours a day.

2) Hopefully the paging system will be functional and a closed circuit monitor may be in place in the conference room. If so, we can see/hear the press conference, count down, etc. in the hanger.

ENCLOSURES:
1) ACES test graphs
2) Updated action items
3) Updated team directory

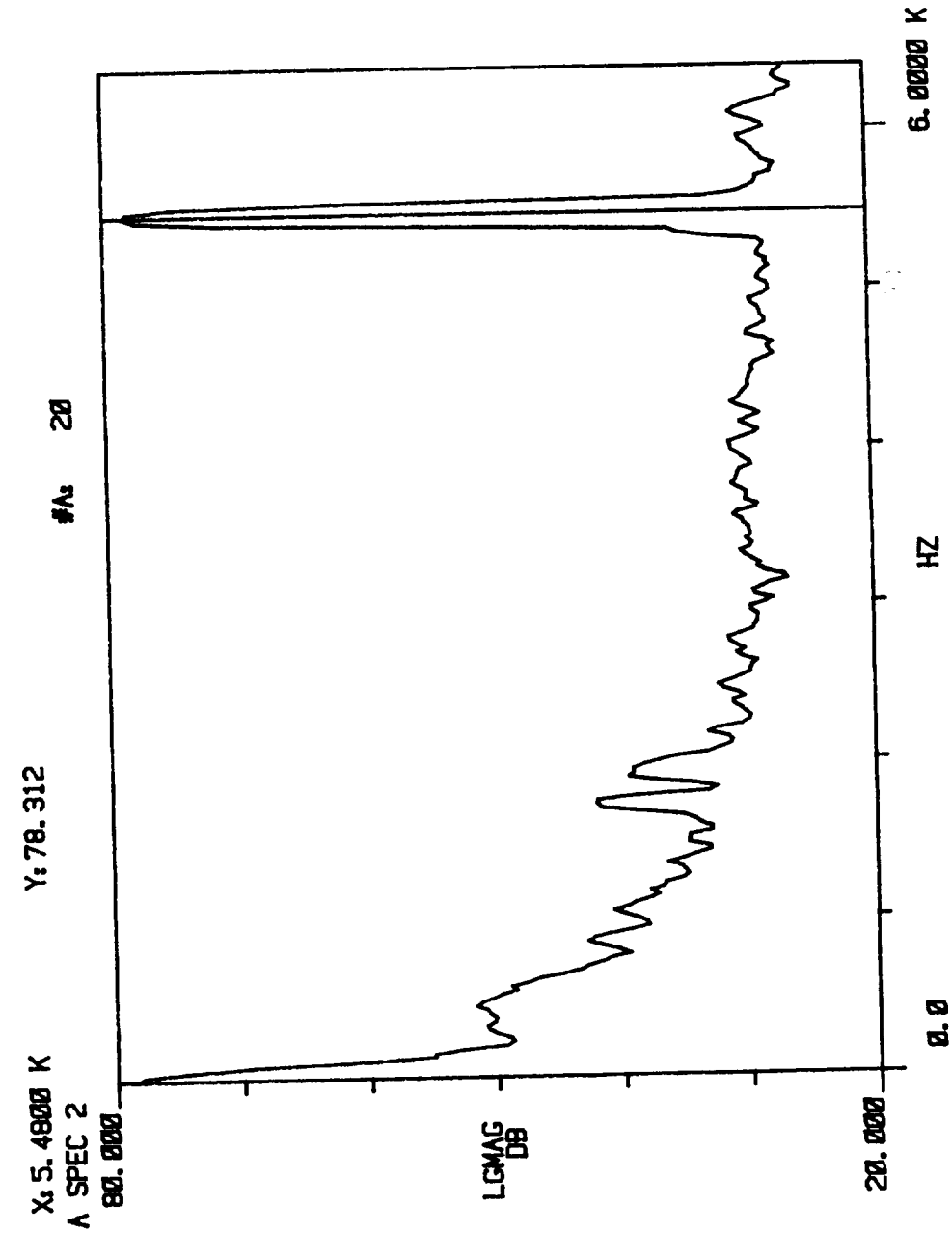
ACES NOISE--LOW FREQUENCY TEST

SPEAKER 2



ACES NOISE--HIGH FREQUENCY TEST

SPEAKER 2



SE81-10
UPDATED ACTION ITEMS

ITEM	PERSON RESPONSIBLE	DATE DONE
1. Coordination of PAOs for NASA and corporate sponsors for Weber SSIP	Rasmussen	ongoing
2. Historical videotape of NASA Life Sciences past animal flights	Halstead/Rasmussen	
3. Passes for team to launch/ landing sites	Bowie	
4. Procure antifog spray for AEM lid for full-up test	Jackson	
5. Repack AEM filters/prepare under clean conditions if possible	Jackson/Christie	
6. Fuse changeout procedure	Jackson/Christie	1/11/84
7. Updated STS11 timelines (as available) and updated launch windows (as available)	Staples/Jackson	
8. Postflight trip to Pfizer for rats from KSC	Jackson/Knott	
9. Animal handlers physicals/ requirements and updates for team. Clear all team member for KSC and animal handling (if necessary)	Knott	
10. Clear Kessler to launch pad	Knott	
11. KSC photographic support/ physicals and clearances necessary	Knott/Sebesta	
12. Postflight trip to Pfizer for rats from landing sites other than KSC	Sebesta	
13. Effect of 4.5KHz noise at 75db for 2 hours on rats (simulated 3-axis acoustic containment furnace experiment [ACES] which will be in middeck locker on STS11)	Sebesta	1/9/84
14. STS-8 (DSO 0421) and STS-11 (SE81-10) preflight, flight, postflight coordinated videotapes	Sebesta/Holton	

ITEM	PERSON RESPONSIBLE	DATE DONE
15. Directory of personnel at KSC, JSC, ARC, and HQ associated with STS11 launch and recovery operations (addresses/phones) for SE81-10	Sebesta/Knott/Jackson/Ladwig	
16. Microbiology of AEM filter after repacking and before STS-11	Smith/Pearson	
17. Number of gnotobiotic rats available for inoculation on Jan. 26, Feb.2, Feb. 9, Feb. 16, Feb. 23, or March 1 from Charles Rivers	Larson	
18. Potato consumption/food consumption/growth data from baseline studies	Weber/Larson	
19. Brief description of inflight measurements	Weber/Larson	1/12/84
20. A. Procure potatoes B. Determine water content	Holton	1/9/84
21. Initial microbiology on potatoes	Knott/Moyer	
22. Requirements for Support at KSC for SSIP during STS-11	Holton/Knott	1/10/84
23. Questions for postflight crew debriefing	Team	

DIRECTORY OF TEAM MEMBERS FOR SE81-10

STUDENT:

Mr. Daniel J. Weber
950 Park Avenue
New York City, NY 10028
212/249-1020
or
709 Stewart Ave.
Ithaca, NY 14850
607/273-2447

TEACHER:

Ms. Francine Salzman
1 Thurston Drive
Livingston, NJ 07039

CORPORATE SPONSOR:

PFIZER:

Dr. David Larson
Central Research Division
Pfizer, Inc.
Eastern Point Road
Groton, CT 06340
203/441-4691 (office)
203/441-4656 (lab)
203/739-0856 (home)

Dr. Mike Ernest
Central Research Division
Pfizer, Inc.
Eastern Point Road
Groton, CT 06340
203/441-3836

GENERAL DYNAMICS:

Mr. Thomas Kessler
DOD Advanced Space Programs
General Dynamics - Convair Division
PO Box 80847, Mail Code 21-9530
San Diego, CA 92138
619/573-5106
619/755-4779 (home)

Mr. Gerry Huston
DOD Advanced Space Programs
General Dynamics - Convair Division
PO Box 80847, Mail Code 21-9530
San Diego, CA 92138
619/573-9783
619/487-5287 (home)

NASA ARC:

Dr. Emily Holton
Biomedical Research Division
M/S 239-14
NASA-Ames Research Center
Moffett Field, CA 94035
415/965-5471 (FTS = 448)
415/965-5247
408/246-7440 (home)

Mr. Paul Sebesta
Life Sciences Flight Experiments
Project Office
M/S 240A-3
NASA-Ames Research Center
Moffett Field, CA 94035
415/965-6455 (FTS = 448)
408/996-8335 (home)

Dr. Jerome Goldsboro, Jr.
Biosystems Division
M/S 236-5
NASA-Ames Research Center
Moffett Field, CA 94035
415/965-6703 (FTS = 448)
415/965-6390
415/921-3552 (home)

NASA-JSC:

Mr. John Jackson
Crew Station Integration Section
Mail Code EN-43
NASA-Johnson Space Center
Houston, TX 77058
713/483-3173 (FTS = 525)
713/333-4542 (home)

Mr. Neil Christie
Crew Station Integration Section
Mail Code EN-43
NASA-Johnson Space Center
Houston, TX 77058
713/483-3173 (FTS = 525)

Dr. Malcolm Smith
Mail Code SD-3
NASA-Johnson Space Center
Houston, TX 77058
713/483-5457 (FTS = 525)

Dr. Ron McNair
Mail Code CB
NASA-Johnson Space Center
Houston, TX 77058
713/483-3856 (FTS = 525)

NASA HEADQUARTERS:

Mr. Alan Ladwig
Office of Space Flight
Code ME
NASA Headquarters
Washington, DC 20546
202/453-1138
703/237-4195 (home)

Mr. Michael Bowie
Office of Space Flight
Code MCS
NASA Headquarters
Washington, DC 20546
202/755-2350

Dr. Thora Halstead
Life Sciences Division
Code SBE-3
NASA-Headquarters
Washington, DC 20546
202/453-1525
703/356-1397 (home)

Ms. Evvie Rasmussen
Public Affairs Office for OSSA
Code E-6
NASA-Headquarters
Washington, DC 20546
202/453-1716

NASA-KSC:

Dr. William Knott
Code MD-RSB-2
NASA-Kennedy Space Center, FL 32899
305/867-3152 (FTS = 823)
305/267-1321 (home)

Mr. Jerry Moyer
BIO-3, Hanger L
NASA-Kennedy Space Center, FL 32899
305/854-3165 (FTS = 253)
305/268-0672 (home)

Mr. John Bryant
Code CS-SED-4
NASA-Kennedy Space Center, FL 32899
305/867-3044 (FTS = 823)

Others:

Mr. Jack Sweeney
Bone and Connective Tissue Research Program
Orthopaedic Hospital
2400 South Flower St.
Los Angeles, CA 90007
213/742-1396
714/989-2347 (home)

TO: Weber Team

FROM: Project Manager/Scientist

SUBJECT: Biweekly report (#10), January 23, 1984

LAUNCH is scheduled for Friday, Feb. 3, 1984. On Thursday, Jan. 26, the APUs will be test-fired. This test is the last possible problem prior to launch. Unless unexpected problems occur during this test, we will have launch as scheduled.

HARDWARE STATUS: The AEM and ground control unit are at KSC. The units will be moved to Hanger L for the full-up test.

SCIENCE STATUS: The POTATO test revealed that the potatoes are 78% water. Quartered potatoes maintained in an oven at 29.5C (85F) slowly lost water; the first day about 16% of the original weight (water) was lost, by the second day the weight was down about 25%, on day 3 about 31%, and by day 6 the potato quarters were 44% of their original weight. An additional factor to compensate for water loss needs to be incorporated into the calculated amount of potatoes that the rats will require for a 8/9 day mission plus a 2.5-day contingency hold. The initial microbiology on the potatoes revealed that the initial one hour soak in a 1:32 dilution of chlorox did not destroy the entire microbiological flora. An additional soak and a six hour UV exposure has been done and should eliminate the remaining flora.

The gnotobiotic rats will be inoculated as per protocol at KSC. Inoculating the animals at KSC will allow earlier shipping from Charles Rivers colony in Wilmington, MA as well as better contingency planning.

UPDATED ACTION ITEMS: Please conclude your action items if you haven't done so. Any remaining items will be discussed at the first team meeting at KSC, Saturday morning, Jan.28.

TENTATIVE TIMELINES: Please peruse the timelines enclosed and make sure that all necessary items are properly scheduled.

WEBER TEAM DIRECTORY FOR KSC: Please check the list and make sure that the information for yourself and your family/team is correct.

SCRAPBOOK UPDATE: Don't forget articles for the scrapbook. The January issue of HEALTH had an article on Dan, the SSIP, and the experiment.

CONTINGENCY PLANS: Since this will be the first landing of the shuttle at KSC and since the weather at KSC is often unpredictable, we will have a back-up recovery team at Dryden flight center during the landing. The back-up team will be composed of:

Dr. Joseph C. Sharp, team leader
Paul Sebesta, hardware
Dr. David Moore, veterinarian
Barbara Hunter, AHT
Marty Curry or Eric James, photographer

The team is having a familiarization trip to Dryden on Wed., Jan. 25 to work out logistics and to assure that the necessary facilities are

available in Trailer 25. The group has been trained in the procedures and measurements that are required immediately after flight. The team, with the exception of Paul Sebesta, will also be on standby for a Shuttle abort once around.

The RATS will be ACCOMPANIED back to Pfizer by a veterinarian and an animal handler technician (AHT). If the landing is at KSC, Dr. Larson will be accompanied by Dr. Jerry Goldsboro and Ms. Nancy Hannagan and if the landing occurs at Dryden, the transport team will include Dr. David Moore and Ms. Barbara Hunter.

This issue of the newsletter will be the last PREFLIGHT edition.

ENCLOSURES:
1) Updated Action Items
2) Tentative Timelines
3) Weber Team Directory for KSC

SE81-10
UPDATED ACTION ITEMS

ITEM	PERSON RESPONSIBLE	DATE DONE
1. Coordination of PAOs for NASA and corporate sponsors for Weber SSIP	Rasmussen	ongoing
2. Historical videotape of NASA Life Sciences past animal flights	Halstead/Rasmussen	
3. Procure antifog spray for AEM lid for full-up test	Jackson	
4. Repack AEM filters/prepare under clean conditions if possible	Jackson/Christie	1/17/84
5. Postflight trip to Pfizer for rats from KSC	Jackson/Knott/Goldsboro	
6. Clear Kessler to launch pad	Knott	
7. KSC photographic support/ physicals and clearances necessary	Knott/Sebesta	
8. Postflight trip to Pfizer for rats from landing sites other than KSC	Sebesta	
9. STS-8 (DSO 0421) and STS-11 (SE81-10) preflight, flight, postflight coordinated videotapes	Sebesta/Holton	
10. Directory of personnel at KSC, JSC, ARC, and HQ associated with STS11 launch and recovery operations (addresses/phones) for SE81-10	Sebesta/Knott/Jackson/Ladwig	
11. Microbiology of AEM filter after repacking and before STS-11	Smith/Pearson	1/17/84
12. Potato consumption/food consumption/growth data from baseline studies	Weber/Larson	
13. A. Procure potatoes B. Determine water content	Holton	1/9/84 1/23/84
14. Initial microbiology on potatoes	Knott/Moyer	1/18/84
15. Questions for postflight crew debriefing	Team	

TENTATIVE

TIMELINES FOR WEBER SSIP FOR STS-11

ALL TIMES ASSUME A FEBRUARY 3, 1984 LAUNCH DATE

Thursday, Jan. 26: Rats arrive at KSC; placed on L/D cycle for flight

F-7 (Friday, Jan. 27): Arrival of team members at KSC/Inoculation of rats

F-6 (Saturday, Jan. 28):	0900	Meeting of team to finalize agenda, procedures, supplies, and assign teams Prepare potatoes as necessary
	1300	Familiarization with sterile/clean facilities and set up equipment to begin full-up test
(Team I)	1330	Power up and check AEM
(Team II)	1330	Weigh out proper amount of food/potatoes Load food/potatoes into test cages
(Team III)	1330	Perform rodent health check, then mark all rats with ink
(Team I)	1400	Take microbiological samples of AEM
(Team II)	1400	Take microbiological samples of rats
(Team III)	1400	Take microbiological samples of food/ potatoes/test cages
	1430	Load rats into cages
	1500	Lights out; START TEST
(Team I)	1500	Power down AEM
	1600	Clean up and leave area
F-5 through L-3:	1300	Meeting of team to review progress
	1430	Observe rats/take data
	1500	Lights out/leave area
F-2 (Wednesday, Feb. 1):	0800	End Full-up test
(Team II)		Perform rodent health check Take microbiological samples of rats (feces, nasophyryngeal)/food/potatoes/ test cages Clean-up/return rats to colony cages
(Team I/III)		Wipe-down (sterilize) AEM interior cage Weigh food bars and glue to AEM interior cage
	1300	Meeting of team to review data and review time-lines for launch loading

F-1 (Thursday, Feb.2):		1000	Final prelaunch meeting of team
	(Team III)	1400	Perform rodent health check
			Take microbiological samples of rats
		1500	LIGHTS OUT in animal rooms
	(Team I)	1630	Wipe-down (sterilize) AEM
			Power up and check AEM
			Take microbiological samples of AEM
	(Team II)	1630	Install potatoes in AEM flight cage/ ground test cages
			Weigh, place food in ground test cages
			Take microbiological samples of cages
	(Team III)	1830	Load rats in flight test cage
	(Team II)	1830	Load rats in ground test cages
	(Team II/III)	1900	Install flight test cage in AEM
		1930	AEM ready to be taken to launch pad
F-0 (Friday, Feb. 3):		0400	LIGHTS ON in AEM/animal room
		0800	LAUNCH (F)(Window = 0800-0815)
		1500	LIGHTS OFF (ground/flight)
			OUTLINE FINAL REPORT
F+1 (Saturday, Feb. 4):		0430	LIGHTS ON in AEM/animal room
			BEGIN PREPARATION OF FINAL REPORT
		1430	Inflight/ground data take
			LIGHTS OFF (ground/flight)
F+2 (Sunday, Feb 5.):		0300	LIGHTS ON (ground/flight)
		1400	Inflight/ground data take
			LIGHTS OFF (ground/flight)
			CONTINUE PREPARATION OF FINAL REPORT
F+3 (Monday, Feb. 6):		0200	LIGHTS ON (ground/flight)
		1300	Inflight/ground data take
			LIGHTS OFF (ground/flight)
			CONTINUE PREPARATION OF FINAL REPORT
F+4 (Tuesday, Feb. 7):		0130	LIGHTS ON (ground/flight)
		1230	Inflight/ground data take
			LIGHTS OFF (ground/flight)
			CONTINUE PREPARATION OF FINAL REPORT
F+5 (Wednesday, Feb.8):		0130	LIGHTS ON (ground/flight)
		1230	Inflight/ground data take
			LIGHTS OFF (ground/flight)
			CONTINUE PREPARATION OF FINAL REPORT
F+6 (Thursday, Feb. 9):		0130	LIGHTS ON (ground/flight)
		1230	Inflight/ground data take
			LIGHTS OFF (ground/flight)
			CONTINUE PREPARATION OF FINAL REPORT
F+7 (Friday, Feb. 10):		0130	LIGHTS ON (ground/flight)
		1230	Inflight/ground data take
			LIGHTS OFF (ground/flight)
			CONTINUE PREPARATION OF FINAL REPORT
F+8 (Saturday, Feb. 11):		0130	LIGHTS ON (ground/flight)
			LANDING (L)
		L+1hr	AEM to Hanger L

L+1hr

Perform the following on flight unit:

1) Take microbiological samples inside and outside of flight unit
2) Perform rodent health check (all rats)
3) Measure paw size
4) Take microbiological samples of all rats
5) Take microbiological samples of feces
6) Weigh remaining food/potatoes and take microbiological samples

Perform the above measurements on the ground control unit/rats

Perform the above measurement on the back-up animals

Place all animals in clearly marked transport cages and transport the rats to Pfizer, Inc.

TO: Weber Team

FROM: Project Manager/Scientist

SUBJECT: FINAL NASA REPORT, May 1, 1984

SUPERLATIVES TO THE WEBER TEAM! My sincere appreciation for the outstanding job and concern of everyone on the team. Data collected immediately postflight suggest that gravity does not contribute to the development of arthritis in this experimental setting, but the hardware performed nominally and many significant findings evolved throughout the project. The Weber SSIP was extremely successful; both scientific and educational aspects of the SSIP were fulfilled.

This report is the last of our newsletters and marks the dissolution of the official NASA Weber team. However, many of us will continue to be involved with Dan and the corporate sponsors in preparing the final report to NASA/NSTA which Dan will distribute to all team members. The final NASA team report deals with the project up to that point at which the animals were turned over to the corporate sponsor and the hardware was shipped back to bonded stores at JSC.

SIGNIFICANT FINDINGS/EXCITING FACTS: 1. Dr. Ron McNair did not notice any swelling of the left hindpaw of the arthritic flight rats when they were examined prior to reentry (see his inflight notes and postflight comments, Attachment A).

2. The use of gnotobiotic rats may have adversely affected the outcome of the data. Apparently gnotobiotics have a delayed onset of the systemic portion of the disease process; ground control animals inoculated with adjuvant did not show significant swelling in the left hind paw until 14 days postinoculation (Figure 3) rather than the 10 day period usually found for SPF Lewis rats--this 4 day differential may have been a major contributor to the arthritic flight response. The data base for this project was established with SPF, not gnotobiotic, rats. Thus, establishing a data base with gnotobiotics is critical for proper design of future experiments if SPF rats are unacceptable for flight.

3. Even raw potatoes which have been carefully scrubbed and cleaned can contain Klebsiella pneumonia (see KSC rodent microbiological report, Attachment B).

4. Flight rats may eat more food and drink more water than ground controls suggesting that ground based experiments may underestimate the food and water necessary for flight experiments. Although flight animals ate more food and gained more weight than ground controls, body mass gain in flight rats in terms of g/kcal was virtually identical to ground controls in STS-41B (see Body Mass Gain and Nutrient Intake Study, Attachment C).

5. Potatoes may be an inadequate water source for arthritic rats. Perhaps the pain of grasping and chewing was enough to decrease both food and water intake in arthritic rats. Alterations in nutritional status may adversely alter immune responsiveness. Arthritic animals preferred water to potatoes during the preflight period and consumed less potato and more water than normal controls (Table 1). Postflight, the arthritic

WEBER TEAM DIRECTORY FOR KSC

NAME/ORGANIZATION (alphabetical)	ACCESS SITES DESIRED KSC (Hanger L) AHE = Animal Handler's Exam	LAUNCH	LAND	ARRIVAL/ DEPARTURE DATE		RESIDENCE AT KSC
BOWIE, MICHAEL/ NASA HQ	X	X	X	2/01	2/05	Howard Johnson's Orlando (351-3333)
GOLDSBORO, JERRY/ NASA ARC	X (AHE)	X	X	1/27	2/11	Sea Gull Beach Club Cocoa Beach
HOLTON, EMILY/ NASA ARC	X (AHE)	X	X	1/27	2/11	Sea Gull Beach Club Cocoa Beach
Karen Holton (daughter)	X	X	X	2/02	2/11	"
JACKSON, JOHN/ NASA JSC	X (AHE)	X		1/30	1/04	Sea Gull Beach Club Cocoa Beach
KESSLER, TOM/ General Dynamics	X (AHE)	X	X	1/31	2/11	Sea Gull Beach Club Cocoa Beach
LADWIG, ALAN/ NASA HQ						
LARSON, DAVE/ Pfizer, Inc.	X (AHE)	X	X	1/26	2/11	Sea Gull Beach Club Cocoa Beach
Jerry Antognli (technician)	X (AHE)	X		1/26	2/05	"
Karen Caise (technician)	X	X		2/01	2/06	Flisher Residence 209 Wineco Dr. Indian Harbor
Mark Caise (husband)	X	X		2/01	2/06	
RASMUSSEN, EVVIE/ NASA HQ	X	X	X	1/31	2/11	Econolodge, Cocoa Beach (784-2550)
SALZMAN, FRANCINE/ Hunter College High School	X	X (CAR	X PASS)	2/02	2/12	Sea Gull Beach Club Cocoa Beach
Philip Salzman (husband)	X	X	X	2/02	2/12	"
Bradley Salzman (son)	X	X	X	2/02	2/12	"
Rhonda Salzman (daughter)	X	X	X	2/02	2/12	"
SEBESTA, PAUL/ NASA ARC	X (AHE)	X	X	1/30	2/05	Sea Gull Beach Club Cocoa Beach
Anna Sebesta (mother)	X	X		2/03	2/03	
Jody Atwood (sister)	X	X		2/03	2/03	
Pearl Cheng/ARC	X	X		1/27	2/07	Cape Royal Towers Cocoa Beach
WEBER, DAN/Cornell	X (AHE)	X	X	1/30	2/11	Sea Gull Beach Club Cocoa Beach
Judy/Dan Weber (parents)	X	X		2/02	2/04	"
Debra/Alfred Eichler (grandparents)	X	X		2/02	2/04	"
Ethel Wetnroth (aunt)	X	X		2/02	2/04	"

flight animals consumed more water than any other group (see details in NASA Operations). Also, potatoes were never used as a water source in experiments using the rat model which mimics certain aspects of space-flight; these experiments suggested that unloading the rear limbs of rats inoculated with adjuvant inhibited development of the systemic disease. Preflight experiments showing that arthritic animals on potatoes gain weight similarly to arthritic animals on water will be detailed in the Weber final report.

6. The Animal Enclosure Module (AEM) performed successfully. This mid-deck unit was originally built and tested for this project. NASA Head-quarters Life Sciences Division is presently considering upgrading the unit for continuing use by approved Life Sciences investigators and has issued a request for proposals which may include use of this unit for research on the shuttle.

7. An internationally known academic rheumatologist who will be making a general presentation at the 9th International Congress of Physical Medi-cine and Rehabilitation has requested information on the Weber experiment and may briefly mention this project during his presentation.

8. The March 30, 1984, issue of Science magazine contains an article detailing the finding of a small virus resembling parvovirus in synovial tissue of a patient with severe rheumatoid arthritis. Immunoassays using polyclonal antibodies against this virus detect probable virus in syno-vial cells from different rheumatoid arthritis patients, but not persons with osteoarthritis. The findings suggest, but do not establish, that a virus may be involved in the etiology of rheumatoid arthritis.

LESSONS LEARNED/RECOMMENDATIONS FOR FUTURE EXPERIMENTS: 1. See 2 above. Data base should be established using exact type of animal to be flown, e.g. gnotobiotic vs SPF. The cost of establishing a data base with gno-tobiotics may be extremely expensive (cost of animals are about $120 each plus cost for sterile housing whereas SPF animals are about $6 each) and contamination of gnotobiotics with pathogens presently recommended for exclusion from flight is a serious problem due to the pervasiveness of some of these pathogens in air, food, water, and human animal handlers.

Literature searches on gnotobiotics or germ-free animals should be done if such animals are essential for research on the shuttle. A postflight literature search at ARC turned up an article by Pearson et al (Proc. Soc. Exper. Biol. Med. 112: 91-93, 1963) that documented development of arthritis in germ-free animals and showed that time of onset was delayed slightly in the germ-free rats as compared with regular animals (18.7 days vs 13.2 days); Dan Weber noted that this information is not found in the summary but is in the text.

2. Necessity to obtain preflight food/water consumption to estimate minimal flight quantities needed. Although flight animals ate more than ground controls during the flight period, they ate only slightly more than they consumed during the preflight period; the ground controls ate less during the flight period than during the preflight period suggesting that the ground controls had greater difficulty adapting to the handling and/or caging than did the flight animals.

3. Necessity to protect all on/off switches on flight hardware. During this flight, the fans were unintentionally turned off for a short interval perhaps by a misdirected toe. A similar episode occurred with the plant growth unit on SL1.

4. Necessity for timelines, teamwork, and checklists. Unlike normal laboratory experiments which seldom have time constraints, flight experiments require timelines, teamwork, and checklists to assure that the experiment is ready to load in the shuttle on schedule. Multiple teams were necessary for this experiment: animal health, animal loading, potato cleaning, potato loading, food installation, etc. Teams and timelines for the flight experiment are enclosed (Attachment D).

5. Necessity to perform and document all measurements on animals and hardware for the entire experiment. The preflight experiment on gnotobiotics was not detailed nor was the mil-spec interface plug for the animal enclosure module (AEM) fit tested before flight. Had the preflight gnotobiotic experiment been detailed, alterations in time of disease onset may have been noted and the inoculation times rescheduled. Because a spring was missing from the mil- spec plug, it could not be locked into place in the shuttle; the plug which attached the AEM to shuttle power was not fit-tested prior to installation of the AEM in the shuttle middeck even though the item had supposedly been inspected after receipt at JSC, but the defect was internal, not external.

6. Defined responsibilities for each team member/NASA center/corporate sponsor to avoid redundancy and misunderstandings.

7. Defined NASA paper flow--particularly who receives and/or initiates contingency plans.

8. Scheduling problems for mid-deck locker space. Oversubscription for mid-deck locker space is obvious and slips in experiments may require a minimal 6 month delay in rescheduling.

9. Public affairs/SSIP program plan agreeable to student, teacher, corporate sponsor(s), NSTA, and NASA. Names of pertinent persons from all these catagories should be constantly appraised of progress of each experiment, and communication flow to/from all parties should always be professional and consistant with program goals.

10. THE STUDENT'S BEST INTEREST SHOULD ALWAYS COME FIRST!

AEM HARDWARE STATUS: The hardware performed nominally for this mission. NASA now has flight-tested hardware for middeck locker experiments. If you are interested in the future of the AEM, keep in touch with Tom Kessler at General Dynamics, Pearl Cheng at ARC, or Tom Perry at NASA Headquarters. John Jackson and Neil Christie at JSC will be involved with all modifications necessary for the Andrew Fras SSIP. Information on the design/fabrication/ testing of the AEM along with changes after STS-8 will be detailed in the Weber final report.

SCIENCE STATUS: Enclosed are tables of data obtained at KSC from both STS-8 (AEM hardware test) and STS-41B (Tables 1-6; odd tables from 41B, even tables from 8). The tables detail food/water consumption and

changes in body mass. Figures 1-3 include changes in body mass and paw volume from only STS-41B. Discussion of the data will be included in the Weber final report; that discussion will also include all preflight experiments and the postflight data obtained both at Pfizer and Cornell.

NASA OPERATIONS: The final team structure is enclosed (Figure 4). This list is composed of the major participants. Many other persons were involved in this visibile project. Along with the team structure, the updated directory of team members is enclosed (Attachment E).

Starting October 3, 1984, biweekly newsletters were distributed to all team members. The intent of the newsletter was to keep everyone abreast of progress in the project and to avoid redundancy and misunderstandings. Since the Weber SSIP was NASAs first rat experiment on the shuttle, documentation of all actions was essential.

Three beepers were obtained at KSC for this project so that persons leaving Hanger L could be contacted if necessary. Also, the Cocoa Beach condominium had no telephones in the rooms, so beepers were essential for contacting personnel at the condos.

The team assignments/timelines for loading, unloading, and measurements during the flight period were put together by the KSC Hanger L team and are enclosed (Attachment D) as a model for future experiments using the AEM.

A copy of the rodent health check list which was compiled for this experiment is enclosed (Attachment F). The originals of the forms filled out during the Weber flight project are in Hanger L archives.

Paul Sebesta did most of the contingency planning and a copy of the plan for landing operations is enclosed (Attachment G). Contingency planning is essential for any animals experiment to assure that the animals will be humanely cared for whereever the shuttle lands.

Loading operations took place within the animal facilities at Hanger L at KSC. The total package (AEM, food, potatoes, middeck locker) weighed 68.5lbs which is almost the maximal allowable weight for middeck lockers (70lbs). The AEM was loaded approximately 14hrs prelaunch. The defective plug was noticed when interfacing the unit with the shuttle. Final decision to launch the unit as is was made by JSC mission control. The launch was on schedule at about 0800 EST. The majority of the Weber team viewed the launch from the VIP site. After 8 days in orbit, the Shuttle landed on schedule at KSC on 2/11/84 at 0716 EST and the AEM arrived at Hanger L at 0845 EST. Rats were processed in the large portable clean room in the hanger bay. Using this facility, animals could be unloaded and processed in sterile conditions by the Weber team without interference from the multiple non-gowned observers who viewed the procedures through the large windows of the clean room.

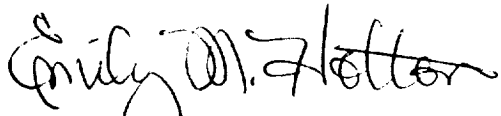
Arthritic flight animals appeared to be very dehydrated postflight and consumed more water (35ml) than normal flight animals (15ml), arthritic ground control groups (10ml for flight controls and 20ml for backup arthritics), or normal ground control groups (25ml for both) during the short time they were in Hanger L. Processing was very orderly with

veterinarians performing animal health checks and taking microbiology samples first, with Dan Weber serving as official recorder, with Nancy Hannagan and Dave Larson weighing animals and measuring paw circumference, with Sarah Williams labeling microbiology samples and assisting the vets, and with Jerry Moyer and Emily Holton assisting whereever needed. Videotaping of each group of rats was accomplished by photographing the animals in colony cages. Ground controls were obviously more active than flight animals; flight animals were essentially lethargic whereas ground control animals required constant attention to keep them in their cages, from which the tops were removed, during filming. Rats were placed in transport cages which were divided into 2 sections with arthritics in one section and normals in the other. Flight animals were in one cage, flight ground controls in a second cage, and back-up rats in the third cage. Rats accompanied by Dan Weber, Nancy Hannagan, and Drs. Goldsboro and Larsen left KSC en route to Melbourne airport at approximately 11:30 AM EST. The facilities and personnel at Hanger L were outstanding.

SLIDES/PHOTOGRAPH: Enclosed is a list which explains each slide that was sent to team members. For the team picture, names are identified on the back of the photograph.

ACKNOWLEDGEMENTS: So many people contributed so much time and effort to this project that trying to name all would make this report too long. Major thanks go to the corporate sponsors for their interest and time. Their dedication to and their understanding of the value of combining expertises to further the careers of the outstanding youth of today is commendable. Within NASA , a tremendous debt of gratitude is owed to General Abrahamson whose foresight and vision made this project possible; to Alan Ladwig who made sure that General Abrahamson kept his vision and foresight; to John Jackson and Neil Christie who handled the flight operations both at JSC and KSC and worked so hard to make this project a success; to Dr. Ron McNair for his interest and enthusiasm and excellent job preflight, inflight, and postflight; to Dr. Bill Knott and the Hanger L crew (particularly Jerry Moyer, Nancy Hannagan, Sarah Williams, and Maggie Manning who spent multiple hours with us and were so caring about the team and the animals); to our conscientious veterinarians—Drs. Al Moreland and Jerry Goldsboro; to Evvie Rasmussen who did her best in dealing with a most difficult project; to Bill Berry who offered travel funds and support; to Ken Souza for his excellent advice; to members of my lab for keeping the lab progressing during my absences, and finally to Paul Sebesta whose compassion for people and details and whose gentle but firm guidance was essential. And finally thanks to Dan Weber for being such an outstanding youth.

To all who contributed to the Weber project--our lasting gratitude.



Emily M. Holton, Ph.D.
Research Scientist
Biomedical Research Division

ENCLOSURES:

Table legends and 6 tables
Figure legends and 4 figures
Attachment A. Dr. Ron McNair Inflight and Postflight Briefing Information
Attachment B. STS-41B Rodent Microbiological Report from KSC
Attachment C. Body Mass Gain and Nutrient Intake Study
Attachment D. STS-41B AEM Support Team Assignments and Timelines
Attachment E. Directory of Team Members for SE81-10
Attachment F. Rodent Health Check List
Attachment G. STS-41B AEM/SSIP Experiment Support Plans for Landing
Attachment H. Weber SSIP Slides and Group Photograph (Only the legends are included in this report)

LEGENDS FOR TABLES

Table 1. Food and potato and/or water consumption by rats during the Weber flight project (STS-41B). Data for both preflight and postflight periods are included. All data are expressed per group of 3 rats; numbers in parentheses are total consumption for the experimental period whereas numbers not in parentheses are consumption in g or ml/day. Potatoes were placed in colony cages along with sterile water for a 3 day period prior to the day of loading the animals for launch; during the flight period, animals only had potatoes as a water source. Idaho potatoes were used for flight and ground controls but Washington potatoes were used for backup rats; Ames food bars (Teklad diet L-356) were used during the flight period for flight and ground controls, during other periods and for backup controls pelleted L-356 was used. Ground controls were placed in a ground-simulation cage which was identical in configuration to the AEM interior but did not contain any electrical systems. Backup controls were kept in colony cages; only these animals were handled during the flight period and every other day paw volumes, weights, and videotaping for 30 minutes were taken.

Table 2. Food and potato and/or water consumption by rats during the AEM hardward test (STS-8). Data for both preflight and postflight periods are included. All data are expressed as per legend for table 1. Potatoes (from Washington) were used only during the flight period in both groups; sterile water was given to all animals preflight and postflight. Controls were kept on water until launch whereas the flight animals were put on potatoes when they were placed in the AEM about 12 hours before launch. Feeding was as above (Table 1). Ground controls were kept in colony cages and were not handled during the flight period. All rats, except the KSC controls, ran out of potatoes before the end of the flight period.

Table 3. Body mass data from rats of the Weber flight project. Weight is in grams. Rats were weighed just prior to loading in the flight or ground unit. Weights were taken about 1300EST preflight and 0930EST postflight.

Table 4. Body mass data from rats immediately preflight and postflight during the AEM hardware test. Weight is in grams. Animals were weighed about 1200EST preflight and about 0500EST postflight.

Table 5. Preflight body mass data for the Weber flight project. Weight is in grams.

Table 6. Preflight body mass data for the AEM hardware test animals. Mass is in grams.

TABLE 1. FOOD AND POTATO/WATER CONSUMPTION PRE/INFLIGHT FOR STS-41B

POTATO CONSUMPTION (g/day/3 rats)
NOTE: potatoes are about 70% water

	FLIGHT RATS	GROUND CONTROLS	BACKUP CONTROLS
ARTHRITIC			
PREFLIGHT WATER (ml water/3days)	85 (255)	90 (271)	85 (256)
PREFLIGHT POTATO (g/3days)	35 (105)	30 (91)	37 (112)
FLIGHT (g IN/g OUT in 8.5 days)	84 (1792/1081.3) ID potatoes	70 (1421/829) ID potatoes	59 (1603/1101.4) WA potatoes
NORMAL			
PREFLIGHT WATER (ml water/3days)	57 (170)	50 (150)	68 (205)
PREFLIGHT POTATO (g/3days)	104 (312)	116 (349)	100 (300)
FLIGHT (g IN/g OUT in 8.5 days)	249 (2291/170.5)	145 (1669.6/439.6)	174 (1762.7/282.3)

FOOD CONSUMPTION (g/day/3 rats)

	FLIGHT RATS	GROUND CONTROLS	BACKUP CONTROLS
ARTHRITIC			
PREFLIGHT (g/3 days)	36 (109.3)	35 (105.8)	29 (86.3)
FLIGHT (g IN/g OUT in 8.5 days)	25 (810.7/601) Food bars	20 (364.7/192) Food bars	12 (261.5/157.3) Teklad L356
NORMAL			
PREFLIGHT (g/3days)	47 (139.8)	48 (143.1)	48 (143.9)
FLIGHT (g IN/g OUT in 8.5 days)	63 (806.7/275)	34 (476/183.2)	30 (428.1/173.3)

TABLE 2. FOOD AND POTATO/WATER CONSUMPTION PRE/INFLIGHT FOR STS-8

POTATO CONSUMPTION (g/day/3 rats)
NOTE: potatoes are about 70% water

	FLIGHT RATS	GROUND CONTROLS	NOTES:
STS-8 SIDE A			1. CONTROL RATS=ARC
PREFLIGHT (ml water/11days)	104 (1146)	85 (938)	2. Preflight = WATER
FLIGHT (g IN/g OUT in 6.5 days)	180+ (1260/90) WA potatoes	193+(+7.7ml water) (1231/76g+50 ml water) WA potatoes	3. Flight on potatoes 12hr prelaunch; controls on potatoes AT launch
			4. OUT potatoes dry scraps
STS-8 SIDE B			1. CONTROL RATS=KSC
PREFLIGHT (ml water/11days)	87 (958)	91 (996)	2. Preflight = WATER
FLIGHT (g IN/g OUT in 6.5 days)	179+ (1231/69)	177+(+7.7ml water) (1251/192+50ml water)	3. Flight on potatoes 12hr prelaunch; controls on potatoes AT launch
			4. OUT flight potatoes dry

FOOD CONSUMPTION (g/day/3 rats)

	FLIGHT RATS	GROUND CONTROLS	NOTES:
STS-8 SIDE A			1. CONTROL RATS=ARC
PREFLIGHT (g/11days)	56 (618)	46 (512)	2. ARC rats ran out of food during flight period
FLIGHT in 6.5 days)	29* Food bars	31+* Food bars	3. Rats without water will not eat food
STS-8 SIDE B			1. CONTROL RATS = KSC
PREFLIGHT (g/11days)	47 (518)	51 (512)	
FLIGHT (g IN/g OUT in 6.5 days)	25* (419/254) Food bars	39 (252) Food bars/L 356 added	

*These animals ran out of potatoes and, thus, food consumption is underestimated; the exact time required to eat all potatoes is unknown. Inflight films suggest that some potatoes were still available on day 4.

TABLE 3. BODY MASS DATA FROM STS-41B

GROUP	DATE	DATE	CHANGE IN MASS
FLIGHT:	2/2/84	2/11/84	
ARTHRITIC 1	232	203	-29
2	236	205	-31
3	240	204	-36
Mean +/- S.D.	204 +/- 1	236 +/- 4	-32 +/- 3.6
NORMAL 1	282	312	+30
2	290	322	+32
3	288	330	+42
Mean +/- S.D.	287 +/- 4.2	321 +/- 9	+35 +/- 6.4
GROUND CONTROLS:			
ARTHRITIC 1	254	226	-28*
2	265	212	-53
3	243	209	-39
Mean +/- S.D.	254 +/- 11	216 +/- 9	-40 +/- 12.5
Without A1:	254 +/- 15.6	211 +/- 2.1	-46 +/- 9.9
*A1 did not develop the systemic disease			
NORMAL 1	296	321	+25
2	271	294	+23
3	270	285	+15
Mean +/- S.D.	279 +/- 14.7	300 +/- 18.7	+21 +/- 5.3
BACKUP RATS:			
ARTHRITIC 1	283	246	-37
2	214	190	-24
3	206	187	-19
Mean +/- S.D.	234 +/- 42.3	208 +/- 33.2	-27 +/- 9.3
NORMAL 1	341	351	+10
2	238	261	+23
3	218	245	+27
Mean +/- S.D.	266 +/- 66	286 +/- 57.1	+20 +/- 8.9

20.5 ± 6.57

TABLE 4. BODY MASS DATA FROM STS-8

GROUP		DATE	DATE	CHANGE IN MASS
FLIGHT:		8/29/83	9/5/83	
SIDE A	1	288	288	-0
	2	297	286	-11
	3	293	273	-20
Mean +/- S.D.		293 +/- 4.5	282 +/- 8.1	-10 +/- 10
SIDE B	1	243	242	-1
	2	219	222	+3
	3	221	229	+8
Mean +/- S.D.		228 +/- 13.3	231 +/- 10.1	+3 +/- 4.5
GROUND CONTROLS:				
KSC	1	254	263	+9
	2	300	330	+30
	3	258	285	+27
Mean +/- S.D.		264 +/- 33.4	293 +/- 34.2	+22 +/- 11.4
ARC	1	300	300	+0
	2	282	286	+4
	3	293	296	+3
Mean +/- S.D.		292 +/- 9.1	294 +/- 7.2	+2 +/- 2.1

NOTE: Animals in all groups except KSC controls ran out of potatoes.

TABLE 5. PREFLIGHT BODY MASS DATA FROM STS-41B

GROUP		DATE	DATE	DATE
FLIGHT:		1/26/84	1/28/84	1/30/84
ARTHRITIC	1	225	236	237
	2	238	247	243
	3	233	243	241
Mean +/- S.D.		232 +/- 6.6	242 +/- 5.6	240 +/- 3.1
NORMAL	1	251	267	272
	2	237	267	278
	3	232	266	273
Mean +/- S.D.		240 +/- 9.8	267 +/- 0.6	274 +/- 3.2
GROUND CONTROLS:				
ARTHRITIC	1	245	256	253
	2	240	263	261
	3	228	240	243
Mean +/- S.D.		238 +/- 8.7	253 +/- 11.8	252 +/- 9.0
Without A1:		234 +/- 8.4	252 +/- 16.3	252 +/- 12.7
*A1 did not develop the systemic disease				
NORMAL	1	240	270	289
	2	235	250	262
	3	225	246	262
Mean +/- S.D.		233 +/- 7.6	255 +/- 12.8	271 +/- 15.6
BACKUP RATS:				
ARTHRITIC	1	268	286	284
	2	207	220	219
	3	196	206	206
Mean +/- S.D.		224 +/- 38.8	237 +/- 42.7	236 +/- 41.8
NORMAL	1	305	320	335
	2	188	213	228
	3	173	195	201
Mean +/- S.D.		222 +/- 72.3	243 +/- 67.6	255 +/- 70.9

TABLE 6. PREFLIGHT BODY MASS DATA FROM STS-8

GROUP		DATE	DATE	DATE
FLIGHT:		8/18/84	8/25/84	8/29/84
SIDE A	1	239	278	288
	2	244	285	297
	3	244	282	293
Mean +/- S.D.		242 +/- 2.9	282 +/- 3.5	293 +/- 4.5
SIDE B	1	183	234	243
	2	153	201	219
	3	154	201	221
Mean +/- S.D.		163 +/- 17.0	212 +/- 19.1	228 +/- 13.3
GROUND CONTROLS:				
KSC	1	173	218	234
	2	256	290	300
	3	196	237	258
Mean +/- S.D.		208 +/- 42.9	248 +/- 37.3	264 +/- 33.4
ARC	1	264	291	300
	2	233	271	282
	3	239	286	293
Mean +/- S.D.		245 +/- 16.4	283 +/- 10.4	292 +/- 9.1

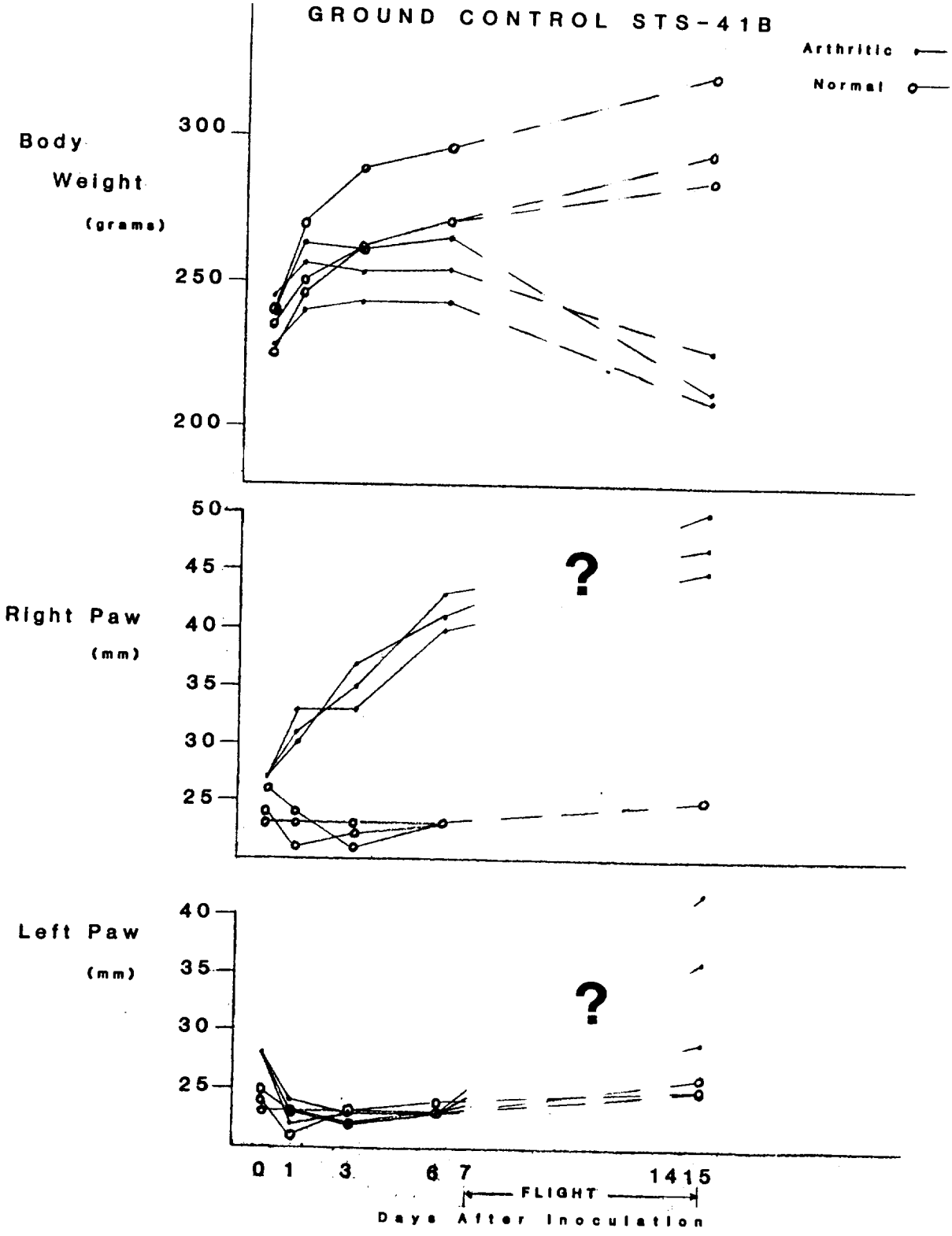
LEGENDS FOR FIGURES

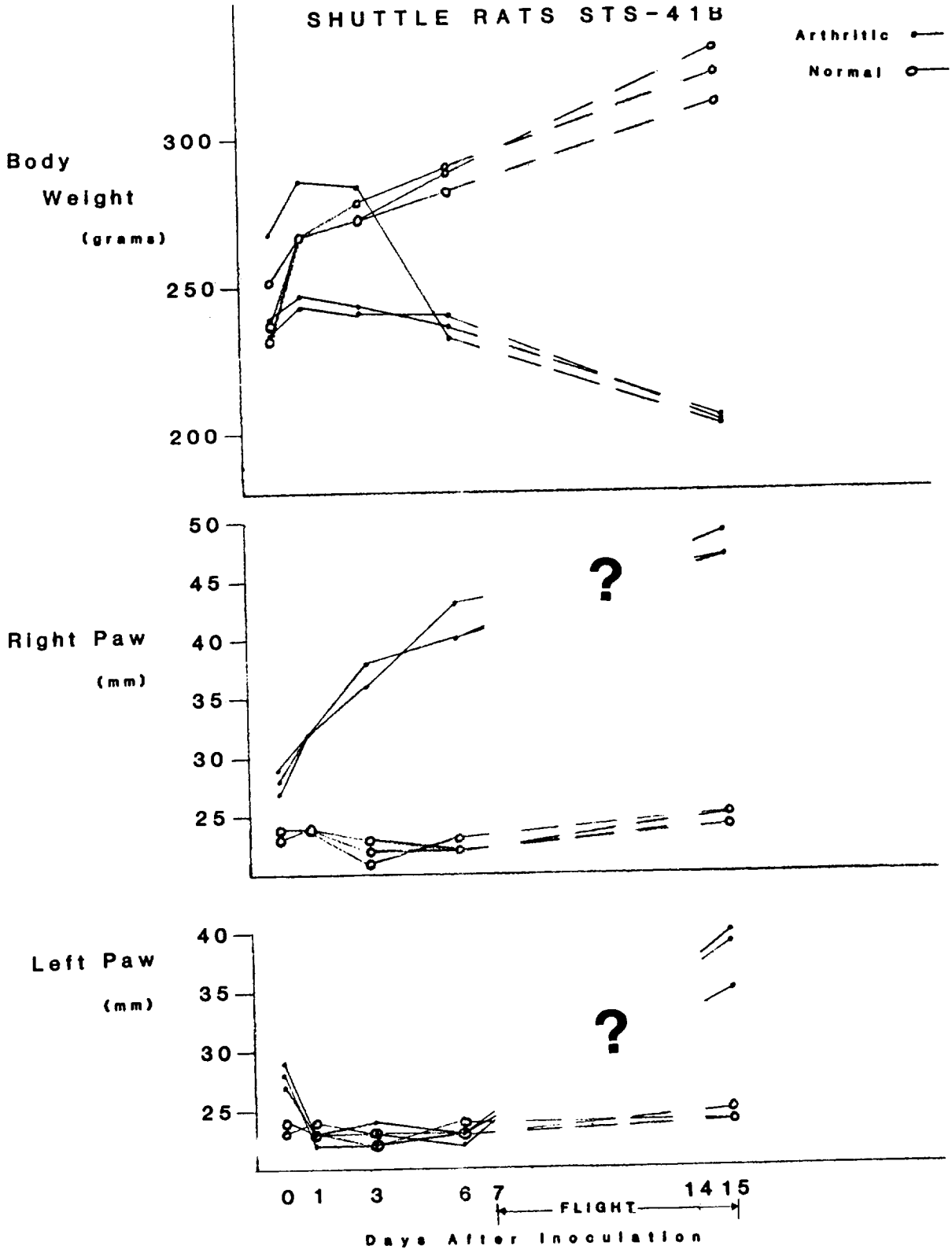
Figure 1. Body weight and paw volumes for flight animals. Rats were inoculated with complete Freund's adjuvant, 0.1ml, subplantar, 7 days before flight. Paw volumes are actually paw circumference measured to the nearest mm with a cloth metric tape; the top of the tape was placed at the ankle joint. Arthritic animals are closed circles while normal controls are open circles. Question marks in the paw volumes during the flight period indicate that the slope of the line from the preflight to the postflight period is not a straight line (see Figure 3) in the arthritic animals.

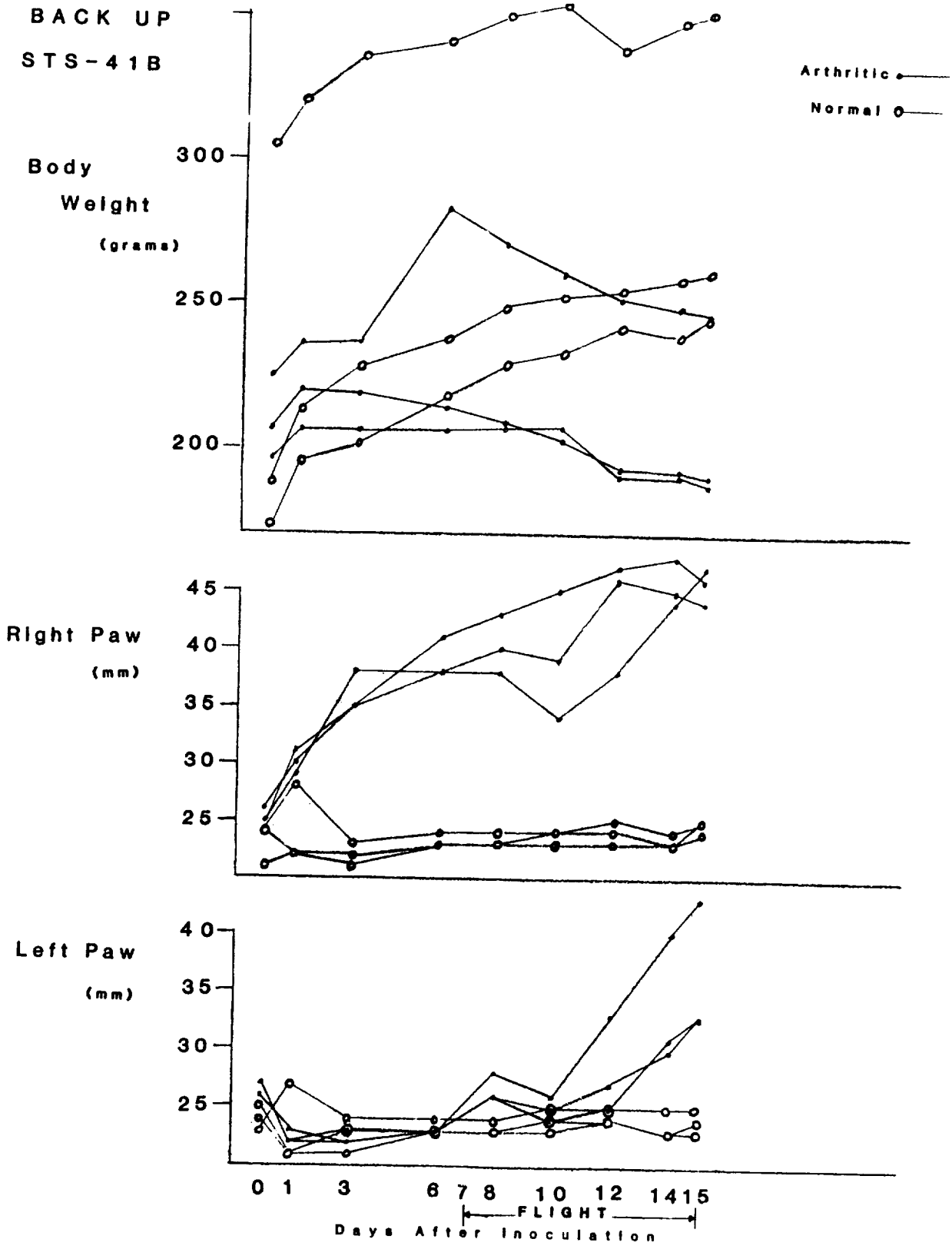
Figure 2. Body weight and paw volumes for ground control animals. See legend to figure 1 for details. Note that all arthritic animals lost weight and showed swelling of the right paw, but one rat did not show noticeable swelling in the left paw at the end of the flight period indicating a delayed onset of the systemic disease in this animal.

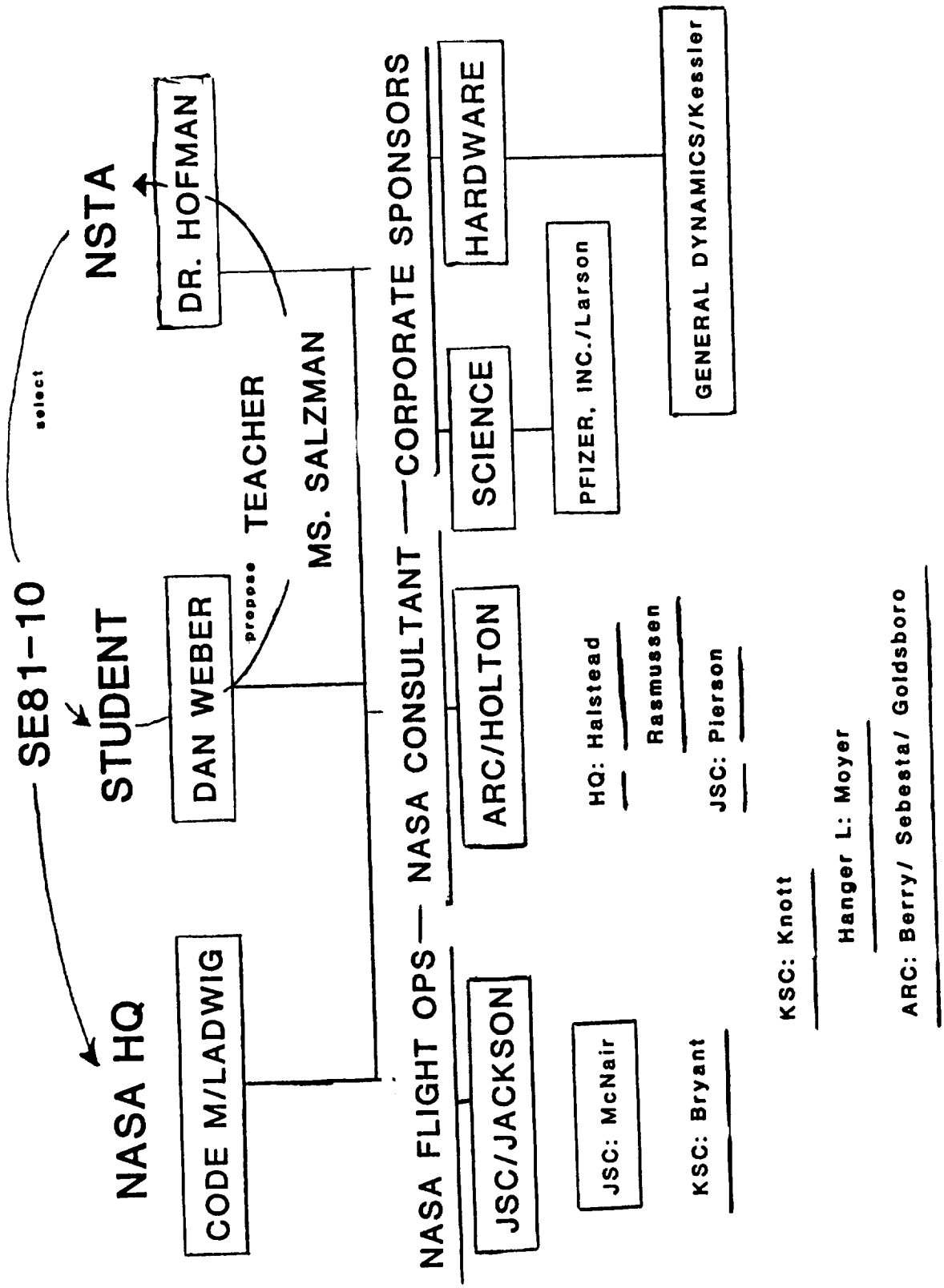
Figure 3. Body weight and paw volumes for contingency (backup) animals. See legend to figure 1 for details. Note that the left paw circumference in 2 of 3 arthritic animals was not noticeably increased until the day before the flight period ended.

Figure 4. Team structure for Weber SSIP. This figure delineates the major components of the SSIP--the student/teacher, NSTA, NASA, and the coorporate sponsors. The student under the guidance of a teacher submits a project to NASA/NSTA and NSTA arranges for the final judging. Once a project wins the national competition, corporate sponsors are located by NASA. A project usually has one corporate sponsor. This project required complex hardware development as well as science sponsorship so two corporate sponsors were solicited. SE81 stands for student experiment selected in 1981 and the number 10 tells that Weber was alphabetically the last of the 10 winner selected in 1981.


GROUND CONTROL STS-41B
Arthritic
Normal
Body Weight (grams)
300
250
200
Right Paw (mm)
50
45
40
35
30
25
?
Left Paw (mm)
40
35
30
25
?
0 1 3 6 7 14 15
FLIGHT
Days After Inoculation


SHUTTLE RATS STS-41B
Arthritic
Normal
Body Weight (grams)
300
250
200
Right Paw (mm)
50
45
40
35
30
25
?
Left Paw (mm)
40
35
30
25
?
0 1 3 6 7 14 15
FLIGHT
Days After Inoculation


BACK UP
STS-41B
Arthritic
Normal
Body Weight (grams)
300
250
200
Right Paw (mm)
45
40
35
30
25
Left Paw (mm)
40
35
30
25
0 1 3 6 7 8 10 12 14 15
FLIGHT
Days After Inoculation


NSTA
DR. HOFMAN
SE81-10
STUDENT
DAN WEBER
TEACHER
MS. SALZMAN
NASA HQ
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NASA FLIGHT OPS
NASA CONSULTANT
CORPORATE SPONSORS
HARDWARE
SCIENCE
PFIZER, INC./Larson
GENERAL DYNAMICS/Kessler
ARC/HOLTON
JSC/JACKSON
HQ: Halstead
Rasmussen
JSC: Pierson
JSC: McNair
KSC: Bryant
KSC: Knott
Hanger L: Moyer
ARC: Berry/ Sebesta/ Goldsboro

ATTACHMENT A

DR. RON MCNAIR INFLIGHT AND POSTFLIGHT BRIEFING INFORMATION

41-B Crew Debriefing
Questions to Ron McNair

1. Question: How did the AEM perform?
   Answer: Fine no problems.

2. Question: Did you have any problems getting the AEM out of the locker?
   Answer: No. None at all.

3. Question: Did the power cable problem cause any difficulty?
   Answer: No that was OK.

4. Question: When did you first look at the animals?
   Answer: Just after Orbital insertion.

5. Question: Were the animals frantically upset?
   Answer: No. They seemed a little disoriented just like us getting used to zero-g.

6. Question: Did you notice any paw swelling and when?
   Answer: Some paw swelling, but nothing like what I had observed on the JSC test animals.

7. Question: Were the arthritic animal eating potatoes?
   Answer: Yes, it seemed the both arthritic and healthy animals were eating the same amount of potatoes.

COMMENTS

- During the video taping session we discovered the fans had been accidentally turned off.

Question: How long do you think the fans had been off?
Answer: About 2 to 3 hours.

Question: What was the maximum temperature of the cage at that time?
Answer: 86°F

- The times given for video taping were not when the animals were active. I jiggled the cage to stir up some activity.

- The ACES didn't make as much noise as was predicted - No problem there at all (68 db)

GAS | STU EXP | SPAS-01 ATT EXP | SPAS-01 DET EXP | SPAS-01 DEACT | SPAS-01 DET PRO | SPAS-01 BACKUP | SPAS-01 DET DATA

AEM

1 AEM Lights On

NOTE
At first Lights On, verify MO52J DC Utility Pwr MNA is ON and secured with tape

LIGHTS - ON
✓Fans running

* If fans not running, notify MCC *

Log MET 0 /21 : 10
1 /18 : 59
2 /17 : 57
3 /18 : 09
__ / __ : __
4 /17 : 40
5 /17 : 30 ← 2 Potatoes remaining in CAGE B
6 /17 : 33 ABOUT SAME IN "A".
7 /17 : 17
__ / __ : __

Healthy rats playing vigorously. Cage A is still and inactive

→ There is a lot more movement in both cages at this time. The healthy rats are playfully wrestling; and the arthritics are at least moving about — though these right hindpaw seem to be on the verge of falling off. I underestimated the food quantity in both cages earlier. There are still potatoes in both cages

2 AEM Data Collection

Pull AEM from locker

NOTE

Cage A has 3 arthritic rats and is identified by a red mark. Cage B has 3 normal rats and is unmarked. Rate average condition as:
B = bad, P = poor, F = fair,
G = good, or E = excellent

Tail Marking Scheme	Arthritic Cage A	Normal Cage B
white	#1	#4
white/black	#2	#5
black	#3	#6

During post insertion, rats appeared confused, but not particularly agitated.

MET 0 / 11 : 06 TEMP 80° OF

Condition	Cage A (Red) B	P	F	G	E	Cage B B	P	F	G	E
† Motion - Jt			✓						✓	
- Bdy			✓						✓	
Grooming			✓						✓	
Feeding (?)	No comparitive reference yet									
Morale			✓							✓
⊛ Paw Swelling	?	✓								✓

Comments:
No systemic effects, Left paw unswollen.

Stow AEM in locker

⊛ E = No swelling } On infected paw
B = Extreme swelling }
† Joint refers to arthritic joint for cage A - → On opposite paw
No systemic effects

GAS

STU EXP

SPAS-01 ATT EXP

SPAS-01 DET EXP

SPAS-01 DEACT

SPAS-01 DET PRO

SPAS-01 BACKUP

SPAS-01 RFF DATA

MET 1/17:05 TEMP 85 °F

Condition	Cage A (Red) B	P	F	G	E	Cage B B	P	F	G	E
Motion - Jt			✓							✓
- Bdy				✓						✓
Grooming			✓						✓	
Feeding				✓					✓	
Morale		✓							✓	
Paw Swelling				✓						
										✓

Comments: Movement in both A and B is better, probably adapting to zero-g. A is less responsive than before

Stow AEM in locker

MET 3/5:25 TEMP 82 °F

Condition	Cage A (Red) B	P	F	G	E	Cage B B	P	F	G	E
Motion - Jt		✓								✓
- Bdy				✓						✓
Grooming			✓						✓	
Feeding				✓					✓	
Morale			✓						✓	
Paw Swelling		✓								
										✓

Comments: No detectable swelling on left leg-

Stow AEM in locker

MET 2/01 : 18 TEMP 2 °F

Condition	Cage A (Red) B	P	F	G	E	Cage B B	P	F	G	E
Motion - Jt				✓						✓
- Bdy										✓
Grooming			✓						✓	
Feeding				✓					✓	
Morale				✓					✓	
Paw Swelling		✓		✓						✓

Comments: No swelling seen on ~~paw~~ left paw. Increased Swelling on right paw. This is the most active I've seen them. Even the A's seem more playful. Wish I could set up t.v.

Stow AEM in locker

MET 4/17 : 50 TEMP 90° °F

Condition	Cage A (Red) B	P	F	G	E	Cage B B	P	F	G	E
Motion - Jt			✓	✓						✓
- Bdy				✓						✓
Grooming			✓						✓	
Feeding				✓					✓	
Morale			✓							✓
Paw Swelling		✓								✓

Comments: Beginning to see swelling on #1's left paw. Spirits are good in both cages. Cage A eats as much as B.

Stow AEM in locker

GAS
STU EXP
SPAS-01 ATT FIP
SPAS-01 DET EXP
SPAS-01 DEACT
SPAS-01 ACT DOC
SPAS-01 BACKUP
SPAS-01 RFF DATA

MET 5/6:00 TEMP 86 °F

Condition	Cage A (Red) B	P	F	G	E	Cage B B	P	F	G	E
Motion - Jt		✓							✓	
- Bdy			✓							
Grooming		✓								
Feeding				✓					✓	
Morale			✓						✓	
Paw Swelling	✓									✓

Comments: Rats are still sleeping. Very little movement. Fans were off for ≈ 2-3 hrs. Temp. rose to 86°. Fan switch has been safed. No observable swelling in left paw.
Stow AEM in locker

MET 6/4:30 TEMP 77 °F

Condition	Cage A (Red) B	P	F	G	E	Cage B B	P	F	G	E
Motion - Jt	✓									✓
- Bdy			✓							✓
Grooming	✓								✓	
Feeding				✓					✓	
Morale		✓								✓
Paw Swelling	✓									✓

Comments: Rats still asleep. Today's light on was missed. Will remain off until tomorrow. Not a good time for valuable data.
Stow AEM in locker

MET 7/04:13 TEMP ____ °F

Condition	Cage A (Red) B	P	F	G	E	Cage B B	P	F	G	E
Motion - Jt	✓									✓
- Bdy		✓								✓
Grooming		✓						✓		
Feeding			✓						✓	
Morale		✓							✓	
Paw Swelling	✓								✓	

Comments:

Stow AEM in locker

MET ___/___:___ TEMP ____ °F

Condition	Cage A (Red) B	P	F	G	E	Cage B B	P	F	G	E
Motion - Jt										
- Bdy										
Grooming										
Feeding										
Morale										
Paw Swelling										

Comments:

Stow AEM in locker

MET 7/17:21 TEMP 82 °F

Condition	Cage A (Red) B	P	F	G	E	Cage B B	P	F	G	E
Motion - Jt	✓									✓
- Bdy			✓							✓
Grooming	✓								✓	
Feeding				✓					✓	
Morale			✓							✓
Paw Swelling	✓									✓

Comments:
Rats (healthy) are in great spirits. The arthritics are, without question, far more active than those I saw at JSC. Front paws of arthritics are very active.

Stow AEM in locker

3 AEM Lights Off

NOTE
Lights Off MET after VTR will be when AEM is stowed in locker

(See next page ⇒)

No lights off on day 6

LIGHTS - OFF
✓Fans running

* If fans not running, notify MCC *

Log MET	0/06:51	~~1/18:09~~
	1/07:08	4/6:30
(MET ON TIME PER CAP UPDATE 2/06:00)	~~2/19~~:__ (VTR)	6/1__:__ (VTR)
	~~2/17:58~~	5/6:00
	3/04:07	7/04:15 (VTR)

10-8
3/06:107 (VTR)

STS-11/FIN 1

SPAS-01 GAS
SPAS-01 STU EXP
SPAS-01 ATT EXP
SPAS-01 DET EXP
SPAS-01 DEACT
SPAS-01 DEF
SPAS-01 BACKUP
SPAS-01 DEF DATA

RME (RADIATION MONITOR EQUIPMENT)

From what I have observed in 1-g and zero-g, the condition of the rats at a given point in time (10-18 days post innoculation) is greatly improved by zero-g. The rats I see after 8 days in space (18 days post-innoculation) are considerably better able to function, though they are very sick animals, than the ones I observed for 10 days at JSC. I have found no correlation of activity with sleep cycle.

UTR DATA TAKE
AT 3/06:07:04

C30U ACES/

11-1 STS-11/FIN

ATTACHMENT B

STS-41B RODENT MICROBIOLOGICAL REPORT FROM KSC

National Aeronautics and
Space Administration

John F. Kennedy Space Center
Kennedy Space Center, Florida 32899

NASA

APR 10 1984

In reply refer to: MD-ENV

TO: Distribution

FROM: MD-ENV/William M. Knott, Ph.D.

SUBJECT: STS-41-B Rodent Microbiological Report

The enclosed subject report is forwarded for your information. The conclusions made by the Bionetics microbiologists are subject to interpretation but are their best explanations for the results.

If you have any questions concerning this report, please call me at (305) 867-3152 or FTS 823-3152.

William Knott

William M. Knott, Ph.D.
Biological Sciences Officer

Distribution:
KSC/CO-SPO/W. Munsey
NASA HQ/EBF/T. Perry
ARC/239-14/E. Holton
ARC/236-5/B. Dalton
JSC/EN43/J. Jackson
JSC/SD4/D. Pierson

the bionetics corporation

Biomedical and Environmental Laboratories
Mail Code BIO-2
Kennedy Space Center, Florida 32899
Telephone (305) 853-4034
FTS 824-4034

March 30, 1984
BIO-4-84-024

TO: Jerry Moyer/BIO-3

FROM: Department of Clinical Microbiology

THRU: Stanley C. White, M.D./BIO-1

SUBJECT: STS-11 Animal Monitoring Program

1.0 INTRODUCTION

The Animal Enclosure Module (AEM) was once again flown aboard the Challenger during the STS-11 mission. Six gnotobiotic rats were housed in the AEM during the mission. Three of these rats were untreated (henceforth referred to as "normal") and three were injected in the right hind paw with a complete Freund's adjuvant to stimulate an arthritic response. Six ground control and six backup rats were subjected to the same conditions (except for the lack of microgravity) as those onboard the Challenger. Gnotobiotic rats were chosen for this mission to help ensure the crew's safety as well as the success of the arthritic experiments, both of which could have been seriously jeopardized had bacterial infections overwhelmed either the crewmembers or the "Astrorats".

The animal monitoring program implemented throughout the STS-11 mission was essentially the same as that used during the STS-8 mission. Fecal and nasopharyngeal specimens were taken just after arrival (1/26/84), prior to launch (2/2/84) and shortly after landing at KSC (2/11/84). Periodic samples of the cages, food, bedding, water, potatoes and the AEM were taken for microbial analysis as part of the Life Science Support Facility's (LSSF) sterility assurance program designed to pinpoint any breakdown in the sterilization procedures employed at either the LSSF or other supporting agencies.

2.0 MATERIALS AND METHODS

All bacterial media, with the exception of the Campy blood agar, were incubated aerobically at 35°C for 48-72 hours. The Campy blood agar plates were incubated at 42°C for 48 hours under microaerophilic conditions. All chocolate agar plates were placed in a candle jar and incubated at 35°C for 48 to 72 hours. Fungus cultures were incubated aerobically at 30°C for seven days.

A portion of every specimen was placed in ten milliliters of Thioglycollate broth. Each broth was subsequently cultured onto Trypticase Soy agar containing 5% sheep red blood cells, Columbia CNA agar containing 5% sheep red blood cells, MacConkey agar, and Inhibitory Mold agar after twenty four hours incubation at 35°C. These subcultures were then compared to their respective primary culture plates to detect any microorganisms not previously recovered.

Fecal specimens were submitted in approximately one milliliter of sterile water to help soften the fecal pellets and prevent any further desiccation. Each fecal pellet was emulsified and inoculated onto it's respective culture media with a sterile calcium alginate swab. Formalin (10%) was added to the fecal emulsions, after culturing, to help preserve any parasite present in these specimens.

All fecal specimens submitted were inoculated directly onto Trypticase Soy agar containing 5% sheep red blood cells, Columbia CNA agar containing 5% sheep red blood cells, MacConkey agar, Hektoen enteric agar, Campy blood agar, Inhibitory Mold agar, thioglycollate broth and GN broth.

The presence of anaerobic bacteria was screened for in the initial fecal specimens using Schaedler's KV, CNA and vitamin K enriched agars, all of which contained 5% sheep red blood cells. No attempt was made to speciate the anaerobic bacteria recovered.

Each GN broth was subcultured after twenty-four hours incubation onto Hektoen enteric agar in an effort to detect the presence of any Salmonella or Shigella.

Nasopharyngeal specimens were submitted in one milliliter of Trypticase Soy broth on fine wire Calgiswabs. The swabs were inoculated directly onto Trypticase Soy agar containing 5% sheep red blood cells, Chocolate agar, Columbia CNA agar with 5% sheep red blood cells, MacConkey agar, Inhibitory Mold agar and thioglycollate broth.

Environmental samples were taken randomly from the cages, food, bedding, water, potatoes, food bars and the AEM. These samples were processed using the same techniques as those outlined in the previous STS-8 animal monitoring report (BIO-2-3-442). The specimens were plated directly onto Trypticase Soy agar containing 5% sheep blood cells and Sabouraud agar, modified. The remaining sample or swab was placed into thioglycollate broth and incubated for seven days at 35°C. During the incubation the broth cultures were visually inspected for growth with a blind subculture performed after forty-eight hours of incubation onto the same media as that used for the initial culturing.

The methods used to identify the microorganisms recovered were essentially the same as those previously outlined in the STS-8 report. The VITEK AutoMicrobic System was also employed to supplement our identification capabilities for the duration of the STS-11 mission. Whenever an identification discrepancy occurred between the VITEK and our standard methods used on STS-8 it was fully investigated. If the problem could not be resolved through supplemental testing or research, the organism was given the most probable Genus with no other speciation available.

Saline wet preparations were made on all fecal specimens submitted and examined for the presence of ova and parasites.

3.0 RESULTS

The data gathered are presented in tabular form as seen in Tables 1 through 10.

All fecal examinations failed to demonstrate any medically significant parasites known to infect man.

4.0 DISCUSSIONS AND CONCLUSIONS

The results of the sterility assurance program implemented prior to the receipt of the gnotobiotic rats can be seen in Table 1. The cages, food, bedding and water remained sterile, within the limitations of our testing procedures, throughout the STS-11 mission.

Initial testing of the potatoes, supplied by Ames Research Center as an in-flight water source, resulted in the recovery of several bacteria one of which, Klebsiella pneumoniae, is an organism recommended for exclusion. In light of this fact a new batch of potatoes were purchased in an attempt to provide enough "Klebsiella free" potatoes to support the mission. These "new" potatoes were scrubbed and soaked in either a 1:16 or a 1:32 sodium hypochlorite solution and exposed to approximately six hours of UV radiation to reduce the number of viable bacteria present on the potatoes. Despite these measures the potatoes remained colonized as can be seen by the results in Table 1.

The initial animal monitoring sampling results can be seen in Table 2. It is obvious from the results that the rodents received from Charles River Breeding Laboratories were indeed gnotobiotic.

The preflight microbial analysis for the flight hardware, food and rodents is presented in Table 3. The food bars and AEM failed to demonstrate any microbial growth. The potatoes placed in the AEM proved to be colonized by a wide variety of bacteria as previously brought out in Table 1.

Three out of six of the "Astrorats" proved to harbor a few of the same bacteria recovered from previous potato samples including a Klebsiella pneumoniae. The remaining bacteria that were not recovered from the preflight potato samples were most likely picked up on previous exposures to other potatoes, the first exposure occurring on January 30th, or were part of their controlled flora.

It should be noted that even though it could be theorized that most or all of the extraneous bacterial flora found in both the "Astrorats" and the ground control rats came from the potatoes the possibility of direct transmittal of some of these bacteria from other environmental sources such as the Freund's adjuvant, the various animal handlers or other extraneous sources remains a viable alternative. These parameters were not tested and should be regarded as limiting factors in our microbial analysis.

An interesting point bought out by Table 3 is that two out of the three arthritic flight rodents (A1-RRR, A1-GG) posessed their original compliment of Lactobacillus without any other extraneous bacterial flora as seen in the other flight rodents.

Table 4 presents the postflight microbial results from the flight hardware, food and rodents. A quick overview of the data presented in this table shows that a great deal of cross colonization has occurred leading to a more homogenous bacterial population than seen in the preflight samples. Citrobacter freundii, enterococcus, and Staphylococcus epidermidis appear to have made the biggest gains in the number of recovery sites. Conversely, the Pseudomonads, Corynebacterium and Serratia recovered from the preflight samples seem to have disappeared. This could be due to a bias in our random sampling rather than selective exclusion by environmental conditions experienced during flight.

As expected we see the recovery of a Klebsiella pneumoniae from a nasopharyngeal sample taken from a "normal" flight rodent. Rather than recovering it from the same flight rodent (N1-GR) as in the preflight sampling, it was recovered from a nasopharyngeal sample of flight rodent N1-BBR. This could be an example of direct transmittal from rodent N1-GR to rodent N1-BBR. If this is true then in all likelihood all the "normal" flight rodents harbored the bacterium even though we were unable to recover it from them. Direct transmittal is the most obvious route of cross colonization. However, it should not be considered the only possible source of the Klebsiella recovered.

Other interesting results shown in Table 4 are the recovery of a Trichosporon beigelii and Staphylococcus saprophyticus from potato samples taken during the postflight sampling operations of the AEM. This was the only time that either microorganism was recovered.

The Staphylococcus saprophyticus was identified through the use of the VITEK AutoMicrobic System. All prelaunch Staphylococci were identified by our usual methods including testing for the presence of free and bound coagulase. Those Staphylococci lacking coagulase were called Staphylococcus epidermidis. Those Staphylococci possessing coagulase were called Staphylococcus aureus. Postlaunch Staphylococci were identified using the previously mentioned procedure as well as the VITEK system. During these tests a Staphylococcus saprophyticus was identified by the VITEK.

Although the VITEK gave a confidence value of 99% (identification code 7745616006), we remained skeptical. Confirmation tests were performed in duplicate. The organism proved to be resistant to novobiocin, was coagulase negative and gave positive results when grown on mannitol salt agar. In light of the confirmatory testing results we believe this bacterium more closely fits the saprophyticus species than the epidermidis species.

The Staphylococcus saprophyticus recovered could have easily been classified as an epidermidis had we not run parallel tests with the VITEK. Since Prelaunch testing of all Staphylococcus isolates were not performed on the VITEK we should note here that it could have been recovered in prelaunch samples and not speciated properly using our usual identification procedures.

The preflight microbial results from the ground control hardware, food and rodents are presented in two parts. Table 5a. and 5b. The overall results seen here are very similar to those presented in Table 3 concerning the preflight samples of the "Astrorats" and their respective food and hardware. Again we see that the arthritic ground control rats possessed their original compliment of Lactobacillus without other extraneous bacterial flora, unlike their "normal" ground control counterparts.

The postflight microbial results from the ground control hardware, food and rodents can be seen in Table 6. The results seen here are very similar to those obtained from the flight experimental package seen in Table 4 with Citrobacter freundii, Enterobacter cloacae, enterococcus and Staphylococcus epidermidis making the biggest gain in the number of recovery sites.

Actinobacillus lignieresii, Alcaligenes denitrificans, Bacillus megaterium and Pseudomonas aeruginosa failed to grow out from the postflight sampling. Again, this may be due to a bias in our random sampling technique, reduced numbers or unfavorable environmental conditions.

Tables 7,8,9 illustrate the transition of the microbial burden from pre- to post-flight status. Table 7 lists the bacteria recovered from the experimental rodents during both phases of the flight experiments. Table 8 depicts the AEM's microbial transition from pre- to post-launch status. Table 9 lists all the microorganisms recovered irrespective of their recovery site, attempting only to separate out flight vs ground control results through pre- and post-flight tabulations.

Table 10 rounds out the microbial results by cataloguing the organisms recovered during the entire monitoring program with their respective recovery sites.

The majority of enterococci recovered were speciated as Streptococcus faecium. For the sake of brevity and to remain consistant with the previous STS-8 animal monitoring results those Streptococci belonging to the enterococcus family were listed as entercocccus with no further speciation.

It is our recommendation that future flights involving gnotobiotic rats employ a different water source such as those mentioned in the STS-8 report or a hydroscopic colloid, such as Hydrogel, that can be sterilized while retaining it's moisture content.

Prepared by: Mary K. Smith MT (ASCP)
Mary K. Smith MT(ASCP)
Clinical Microbiologist

Reviewed by: Roger L Blair MT(ASCP)
Roger L. Blair MT(ASCP)
Clinical Microbiology Supervisor

Table 1. LSSF STERILITY ASSURANCE PROGRAM

Date Submitted	Source	Culture results
1/16/84	Potato #4016	Bacillus circulans Enterobacter species enterococcus Klebsiella pneumoniae
1/23/84	Potato #4023 (UV & 1:16 hypochlorite)	Bacillus species Enterobacter species
1/23/84	Potato #4023 (UV & 1:32 hypochlorite)	Enterobacter agglomerans Enterobacter species
1/25/84	Cage #4025B food bedding inside: top & sides	No growth No growth No growth
1/31/84	Cage #4030 food bedding inside: top & sides	No growth No growth No growth
2/6/84	Cage #4033 food bedding inside: top & sides	No growth No growth No growth
2/14/84	Cage #4041 food bedding inside: top & sides	No growth No growth No growth
1/25/84	Rodent drinking water sample #4024-1 sample #4024-2 sample #4024-3 sample #4024-4	<1 CFU/250 ml* <1 CFU/250 ml <1 CFU/250 ml <1 CFU/250 ml
1/31/84	Rodent drinking water sample #4026 sample #4027 sample #4027B	<1 CFU/250 ml <1 CFU/250 ml <1 CFU/250 ml

* CFU - colony forming units

Table 2. INITIAL ANIMAL MONITORING SAMPLES
Cultured 1/26/84

	Bacteria recovered	Fungi recovered	Ova & parasites observed
Feces - R*	Lactobacillus	None recovered	None seen
Nasopharynx - RR	Lactobacillus	None recovered	n/a **
Feces - RRR	Lactobacillus	None recovered	None seen
Nasopharynx - G	Lactobacillus	None recovered	n/a
Feces - GG	Lactobacillus	None recovered	None seen
Nasopharynx - GGG	Lactobacillus	None recovered	n/a
Feces - B	Lactobacillus	None recovered	None seen
Nasopharynx - BB	Lactobacillus	None recovered	n/a
Feces - BBB	Lactobacillus	None recovered	None seen
Nasopharynx - BG	Lactobacillus	None recovered	n/a
Feces - RB	Lactobacillus	None. recovered	None seen
Nasopharynx - GR	Lactobacillus	None recovered	n/a

* R - one red tail mark
BB - two blue tail marks
GGG - three green tail marks
** n/a - not applicable

FLIGHT RODENTS - PREFLIGHT SUMMARY
cultured 2/2/84

Table 3.

Al - arthritic
Nl - normal

	Food bar side A	Food bar side B	Potato side A	Potato side B	Inside module side A	Inside module side B	AEM - Inside	AEM- filter	Feces side A Arthritic	Feces side B Normal	Nasopharynx Al-RRR	Nasopharynx Al-GG	Nasopharynx Al-GGG	Nasopharynx Nl-BBR	Nasopharynx Nl-GGR	Nasopharynx Nl-GR		
No growth	NG	NG			NG	NG	NG	NG										
Actinobacillus lignieresii																		
Acinetobacter anitratus														X	X	X		
Acinetobacter lwoffii																		
Alcaligenes denitrificans																		
Bacillus circulans																X		
Bacillus megaterium																		
Bacillus pulmilus																		
Bacillus species			X	X														
Citrobacter freundii			X						X	X			X	X	X	X		
Corynebacterium species			X	X														
Enterobacter agglomerans																		
Enterobacter cloacae															X			
Enterobacter species				X						X								
Enterococcus									X				X					
Group D-streptococcus nor enterococcus																		
Hafnia alvei									X	X			X		X			
Lactobacillus species									X	X	X	X	X	X	X	X		
Klebsiella pneumoniae																X		
Pseudomonas aeruginosa			X															
Pseudomonas fluorescens/putida				X														
Serratia liquefaciens				X														
Staphylococcus epidermidis			X										X					
Staphylococcus saprophyticus																		
Streptococcus viridans group																		

X - organisms isolated and identified
NG - No growth

R - one red tail mark
BB - two blue tail marks

GGG - three green tail marks

Table 4.

FLIGHT RODENTS - POSTFLIGHT SUMMARY
Cultured 2/11/84

Al - arthritic
Nl - normal
X - organisms isolated & identified
R - one red tail mark
BB - two blue tail marks
GGG - three green tail marks

	Food bar side A	Food bar side B	Potato side A	Potato side B	Inside module side A	Inside module side B	AEM filter	outside module	Feces side A Arthritic	Feces side B Normal	Nasopharynx Al-RRR	Nasopharynx Al-GG	Nasopharynx Al-GGG	Nasopharynx Nl-BBR	Nasopharynx Nl-GGR	Nasopharynx Nl-GR		
No growth																		
Actinobacillus lignieresii																		
Acinetobacter anitratus			X		X	X	X											
Acinetobacter lwoffii							X			X								
Alcaligenes denitrificans																		
Bacillus circulans																		
Bacillus megaterium			X															
Bacillus pulmilus		X			X		X											
Bacillus species			X															
Citrobacter freundii	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
Corynebacterium species																		
Enterobacter agglomerans												X						
Enterobacter cloacae									X		X	X	X	X	X			
Enterobacter species																		
enterococcus	X	X	X	X	X	X	X		X		X	X	X	X	X	X		
Group D-streptococcus not enterococcus													X					
Hafnia alvei	X	X							X	X	X			X	X	X		
Lactobacillus species				X					X	X	X	X	X	X	X	X		
Klebsiella pneumoniae														X				
Pseudomonas aeruginosa																		
Pseudomonas fluorescens/putida																		
Serratia liquefaciens																		
Staphylococcus epidermidis	X	X	X		X	X		X	X	X	X			X	X	X		
Staphylococcus saprophyticus				X														
Streptococcus viridans group								X		X								
Trichosporon beigelii			X															

GROUND CONTROL RODENTS - PREFLIGHT SUMMARY - Part I
cultured 2/2/84

Table 5a.

	Food bar side A	Food bar side B	Potato side A	Potato side B	Inside module side A	Inside module side B	Feces side A Arthritic	Feces side B Normal	Feces - Backup cage 5	Feces - Backup cage 6
No growth	NG	NG			NG	NG				
Actinobacillus lignieresii			X							
Acinetobacter anitratus										
Acinetobacter lwoffii										
Alcaligenes denitrificans			X							
Bacillus circulans										
Bacillus megaterium				X						
Bacillus pulmilus										
Bacillus species			X							
Citrobacter freundii							X	X	X	X
Corynebacterium species			X	X						
Enterobacter agglomerans										
Enterobacter cloacae								X		X
Enterobacter species			X	X			X			
enterococcus							X	X	X	X
Group D- streptococcus not enterococcus										
Hafnia alvei								X		X
Lactobacillus species							X	X	X	X
Klebsiella pneumoniae										
Pseudomonas aeruginosa				X						
Pseudomonas fluorescens/putida										
Serratia liquefaciens										
Staphylococcus epidermidis										
Staphylococcus saprophyticus										
Streptococcus viridans group										

X - organisms isolated and identified
NG - No growth

Table 5b.

GROUND CONTROL RODENTS - PREFLIGHT SUMMARY - Part II
Cultured 2/2/84

A2 - arthritic
N2 - normal
R - one red tail mark
BB - two blue tail marks
GGG - three green tail marks

	Nasopharynx A2-BBG	Nasopharynx A2-RB	Nasopharynx A2-B	Nasopharynx N2-R	Nasopharynx N2-BRG	Nasopharynx N2-RR	Nasopharynx Cage 5	Nasopharynx Cage 6	Water sample A3 Cage 5	Water sample N3 Cage 6
No growth										
Actinobacillus lignieresii									X	X
Acinetobacter anitratus										
Acinetobacter lwoffii										
Alcaligenes denitrificans										
Bacillus circulans										
Bacillus megaterium										
Bacillus pulmilus										
Bacillus species										
Citrobacter freundii				X	X	X	X			
Corynebacterium species										
Enterobacter agglomerans										
Enterobacter cloacae					X					
Enterobacter species										
enterococcus										X
Group D-streptococcus not enterococcus										
Hafnia alvei										
Lactobacillus species	X	X	X	X	X	X	X	X		
Klebsiella pneumoniae										
Pseudomonas aeruginosa										
Pseudomonas fluorescens/putida										
Serratia liquefaciens										
Staphylococcus epidermidis										
Staphylococcus saprophyticus										
Streptococcus viridans group										

Table 6.

GROUND CONTROL RODENTS - POSTFLIGHT SUMMARY
Cultured 2/11/84

A2, A3 - arthritic
N2, N3 - normal
R - one red tail mark
BB - two blue tail marks
GGG - three green tail marks

	Food bar side A	Food bar side B	Potato side A	Potato side B	Inside module side A	Inside module side B	Outside module	Feces cage 5-A3	Feces cage 6-N3	Feces side A&B	Nasopharynx N2-R	Nasopharynx N2-BRG	Nasopharynx N2-RR	Nasopharynx N3-GGB	Nasopharynx A2-RB	Nasopharynx A2-B	Nasopharynx A2-BBG	Nasopharynx A3-RG
No growth																		
Actinobacillus lignieresii																		
Acinetobacter anitratus														X				
Acinetobacter lwoffii							X				X							
Alcaligenes denitrificans																		
Bacillus circulans																		
Bacillus megaterium																		
Bacillus pulmilus																		
Bacillus species																		
Citrobacter freundii	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X		X
Corynebacterium species				X														
Enterobacter agglomerans			X														X	
Enterobacter cloacae		X		X		X	X	X	X	X	X	X	X	X	X	X	X	X
Enterobacter species	X		X		X													
enterococcus	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X
Group D-streptococcus nor enterococcus	X	X								X		X		X	X			X
Hafnia alvei								X	X	X								
Lactobacillus species	X							X	X	X	X	X	X	X	X	X	X	X
Klebsiella pneumoniae																		
Pseudomonas aeruginosa																		
Pseudomonas fluorescens/putida				X														
Serratia liquefaciens																		
Staphylococcus epidermidis	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Staphylococcus saprophyticus																		
Streptococcus viridans group																		

X - organisms isolated and identified

RODENT PRE - VS POST-FLIGHT MICROBIAL SUMMARY

Table 7.

	Preflight organisms recovered from flight rats (2/2/84)	Postflight organisms recovered from flight rats (2/11/84)	Preflight organisms recovered from ground control rats (2/2/84)	Postflight organisms recovered from ground control rats (2/11/84)
Acinetobacter alcoaceticus var. anitratus	X		X	X
Acinetobacter alcoaceticus var. lwoffii		X		X
Bacillus circulans	X			
Bacillus megaterium				
Bacillus pulmilus				
Bacillus species				
Citrobacter freundii	X	X	X	X
Corynebacterium species				
Enterobacter agglomerans		X		X
Enterobacter cloacae	X	X	X	X
Enterobacter species	X		X	
enterococcus	X	X	X	X
Group D - streptococcus not enterococcus		X		X
Hafnia alvei	X	X	X	X
Lactobacillus species	X	X	X	X
Klebsiella pneumoniae	X	X		
Pseudomonas aeruginosa				
Pseudomonas fluorescens/putida				
Serratia liquefaciens				
Staphylococcus epidermidis	X	X		X
Staphylococcus saprophyticus				
Streptococcus viridans group		X		

X - organisms isolated and identified

ANIMAL ENCLOSURE MODULE

Table 8. PRE-VS. POST FLIGHT SUMMARY

	NO GROWTH	Acinetobacter calcoaceticus var. anitratus	Acinetobacter calcoaceticus var. lwoffii	Bacillus pulmilus	Citrobacter freundii	Enterobacter cloacae	Enterobacter species	enterococcus	Staphylococcus epidermidis	Streptococcus viridans group
PREFLIGHT (2/2/84)										
AEM, inside cage Side A	NG									
AEM, inside cage Side B	NG									
AEM - inside module	NG									
AEM Filter	NG									
Ground control, AEM, inside cage - side A	NG									
Ground control, AEM inside cage - side B	NG									
Post Flight (2/11/84)										
AEM, inside cage - side A		X		X	X			X	X	
AEM, inside cage - side B		X			X			X	X	
AEM, outside module					X				X	X
AEM Filter		X	X	X	X			X		
Ground control AEM inside cage - side A					X		X	X	X	
Ground control AEM, inside cage - side B						X		X	X	
Ground control AEM, outside			X		X	X		X	X	

X - organisms isolated and identified
NG - no growth

COMPREHENSIVE PRE- VS POST-FLIGHT MICROBIAL SUMMARY

Table 9.

X - organisms isolated and identified

	Preflight organisms recovered (flight) 2/2/84	Postflight organisms recovered (flight) 2/11/84	Preflight organisms recovered (ground) 2/2/84	Postflight organisms recovered (ground) 2/11/84
Actinobacillus lignieresii			X	
Acinetobacter anitratus	X	X	X	X
Acinetobacter lwoffii		X		X
Alcaligenes denitrificans			X	
Bacillus circulans	X			
Bacillus megaterium		X	X	
Bacillus pulmilus		X		
Bacillus species	X	X	X	
Citrobacter freundii	X	X	X	X
Corynebacterium species	X		X	X
Enterobacter agglomerans		X		X
Enterobacter cloacae	X	X	X	X
Enterobacter species	X		X	X
enterococcus	X	X	X	X
Group D - streptococcus not enterococcus		X		X
Hafnia alvei	X	X	X	X
Lactobacillus species	X	X	X	X
Klebsiella pneumoniae	X	X		
Pseudomonas aeruginosa	X		X	
Pseudomonas fluorescens/putida	X			X
Serratia liquefaciens	X			
Staphylococcus epidermidis	X	X		X
Staphylococcus saprophyticus		X		
Streptococcus viridans group		X		
Trichosporon beigelii		X		

SUMMARY OF ORGANISMS RECOVERED PER SAMPLE SITE

Table 10.

	FOOD BAR	WATER SAMPLE	POTATO	AEM	FECES	NASO-PHARYNX
Actinobacillus lignieresii			X			
Acinetobacter anitratus		X	X	X		X
Acinetobacter lwoffii				X	X	X
Alcaligenes denitrificans			X			
Bacillus circulans			x			X
Bacillus megaterium			X			
Bacillus pulmilus	X			X		
Bacilllus species			X			
Citrobacter freundii	X		X	X	X	X
Corynebacterium species			X			
Enterobacter agglomerans			X			
Enterobacter cloacae	X		X	X	X	X
Enterobacter species	X		X	X	X	
enterococcus	X	X	X	X	X	X
Group D - streptococcus not enterococcus	X				X	X
Hafnia alvei	X				X	X
Lactobacillus species	X		X		X	X
Klebsiella pneumoniae			X			X
Pseudomonas aeruginosa			X			
Pseudomonas fluorescens/putida			X			
Serratia liquefaciens			X			
Staphylococcus epidermidis	X		X	X	X	X
Staphylococcus saprophyticus			X			
Streptococcus viridans group				X	X	
Trichosporon beigelii			X			

ATTACHMENT C

BODY MASS GAIN AND NUTRIENT INTAKE STUDY

UNIVERSITY OF CALIFORNIA, BERKELEY

BERKELEY • DAVIS • IRVINE • LOS ANGELES • RIVERSIDE • SAN DIEGO • SAN FRANCISCO

SANTA BARBARA • SANTA CRUZ

ENVIRONMENTAL PHYSIOLOGY LABORATORY
BUILDING T-2251

BERKELEY, CALIFORNIA 94720

18 April 1984

Dr. Emily Holton
Biomedical Division
NASA Ames Research Center
Moffett Field CA 94650

Dear Emily:

As you requested, I have reviewed the body mass and nutrient intake data from rats studied during Shuttle Flights STS-41B and STS-8. I did not consider the "arthritic" rats of STS-41B because they represent an abnormal population, nor did I consider the STS-8 Flight rats and the STS-8 ARC Control rats because of their restricted food and water intake. This left 4 groups of 3 rats each to look at: the STS-41B Normal Flight, Ground Control and Back-Up Control groups, and the STS-8 KSC Control group.

I have summarized the total body mass changes for each of the 4 groups during the period of the flights in Table 1. It is evident that the 2 sets of STS-41B Control rats were indistinguishable statistically ($P = 0.88$); whereas, the 3 STS-41B Flight rats gained about 70% more body mass during the 8.5 day flight period than did the 6 Control rats ($P = 0.018$).

In order to facilitate comparison with the STS-8 KSC Ground Control rats, which were studied for a 6.5 day period, the body mass changes are also expressed in Table 1 in terms of grams body mass change per rat per day. It is apparent that the 3 STS-8 KSC Ground Control rats gained about 83% more body mass per day than did the 6 STS-41B Control rats ($P = 0.004$). Furthermore, the daily body mass changes of the STS-8 KSC Control rats were statistically indistinguishable from those of the STS-41B Flight rats ($P = 0.51$).

The food and water intake data for the 4 sets of rats are summarized in Table 2. Regrettably, only group consumption values were recorded, so that statistical comparisons cannot be made. However, the data could be expressed as an approximation of water and food energy intake per rat per day during the experimental periods involved.

It is of interest that all 4 groups of rats consistently obtained about half their caloric intake from the food bars and half from the raw potatoes, while the latter provided essentially all of the water intake. The data also clearly indicate that the 3 STS-41B Flight rats ingested about 75% more food energy than did the 6 STS-41B Control rats. This result is in agreement with the finding that the Flight rats gained about 70% more body mass than did the Control rats during the STS-41B flight. As shown in the last column of Table 2, all 3 STS-41B groups of rats exhibited a daily body mass gain of about 0.03 g/kcal ingested, implying metabolic consistency between Flight rats

Dr. Emily Holton

18 April 1984

and Control rats. However, an explanation for the markedly greater food consumption by the Flight rats is not immediately evident.

In contrast, the 3 STS-8 KSC Ground Control rats apparently ingested only about 10% more food energy per day than did the 6 STS-41B Control rats, yet gained about 83% more body mass per day as mentioned earlier. Thus, the STS-8 KSC Ground Control rats exhibited a daily body mass gain of about 0.05 g/kcal ingested, implying a substantially higher efficiency of food energy conversion to body mass than that shown by any of the STS-41B rats.

This seeming anomaly is not possible to resolve with the data at hand, because several alternate possibilities exist. For example, a strain difference may have existed between the STS-41B and STS-8 rats, which involved a difference in metabolic rate.

The results do clearly indicate that careful experiments are warranted in future flights to examine the effects on energy balance. Such experiments should provide for measurement of food and water intake of individual animals, oxygen consumption rate or heat production rate of the same individual animals, composition of the excreta, and total body composition changes. Only in this way will suitable answers to this fundamental question be gotten.

Thanks for letting me look at your data, and please accept my best regards.

Sincerely yours,

Nello

Nello Pace
Professor of Physiology, Emeritus

NP:emn

Table 1. Total body mass data for Shuttle rats.

Animal No.	Start (g)	End (g)	Total Change (g)	Change Per Day (g/d)
Flight STS-41B 8.5 d				
1	282	312	+30	3.53
2	290	322	+32	3.76
3	288	330	+42	4.94
Mean	286.7	321.3	+34.7	4.08
C.V.	1.5	2.8	18.5	18.6
Ground Control STS-41B 8.5 d				
1	296	321	+25	2.94
2	271	294	+23	2.71
3	270	285	+15	1.76
Mean	279.0	300.0	+21.0	2.47
C.V.	5.3	6.2	25.2	25.3
Back-Up Controls STS-41B 8.5 d				
1	341	351	+10	1.18
2	238	261	+23	2.71
3	218	245	+27	3.18
Mean	265.7	285.7	+20.0	2.36
C.V.	24.8	20.0	44.4	44.4
KSC Ground Controls STS-8 6.5 d				
1	234	263	+29	4.46
2	300	330	+30	4.62
3	258	285	+27	4.15
Mean	264.0	292.7	+28.7	4.41
C.V.	12.7	11.7	5.3	5.4

Table 2. Food energy and water intake data for Shuttle rats.

Nutrient	Total Intake (g nutrient)	(kcal)*	(g water)**	Intake Per Rat Per Day (g water)	(kcal)	Body Mass Gain Per Rat Per Day (g)	(g/kcal)
STS-41B, Normal Flight, 3 Rats, 8.5 d							
Food Bar	531.7	1,808					
Potato	2,120	1,611	1,692				
Total		3,419	1,692	66.4	134.1	4.08	0.0304
STS-41B, Ground Control, 3 Rats, 8.5 d							
Food Bar	292.8	996					
Potato	1,230	935	982				
Total		1,931	982	38.5	75.7	2.47	0.0326
STS-41B, Back-Up Control, 3 Rats, 8.5 d							
Food Bar	254.8	866					
Potato	1,480	1,125	1,181				
Total		1,991	1,181	46.3	78.1	2.36	0.0302
STS-8, KSC Ground Control, 3 Rats, 6.5 d							
Food Bar	252.0	857					
Potato	1,059	805	845				
Drinking Water	50		50				
Total		1,662	895	45.9	85.2	4.41	0.0518

* The food bar provides 3.4 kcal usable energy per gram, and raw potatoes provide 0.76 kcal usable energy per gram.

** Raw potato contains 79.8% water.

ATTACHMENT D

STS-41B AEM SUPPORT TEAM ASSIGNMENTS AND TIMELINES

STS-41B
AEM SUPPORT TEAM ASSIGNMENT

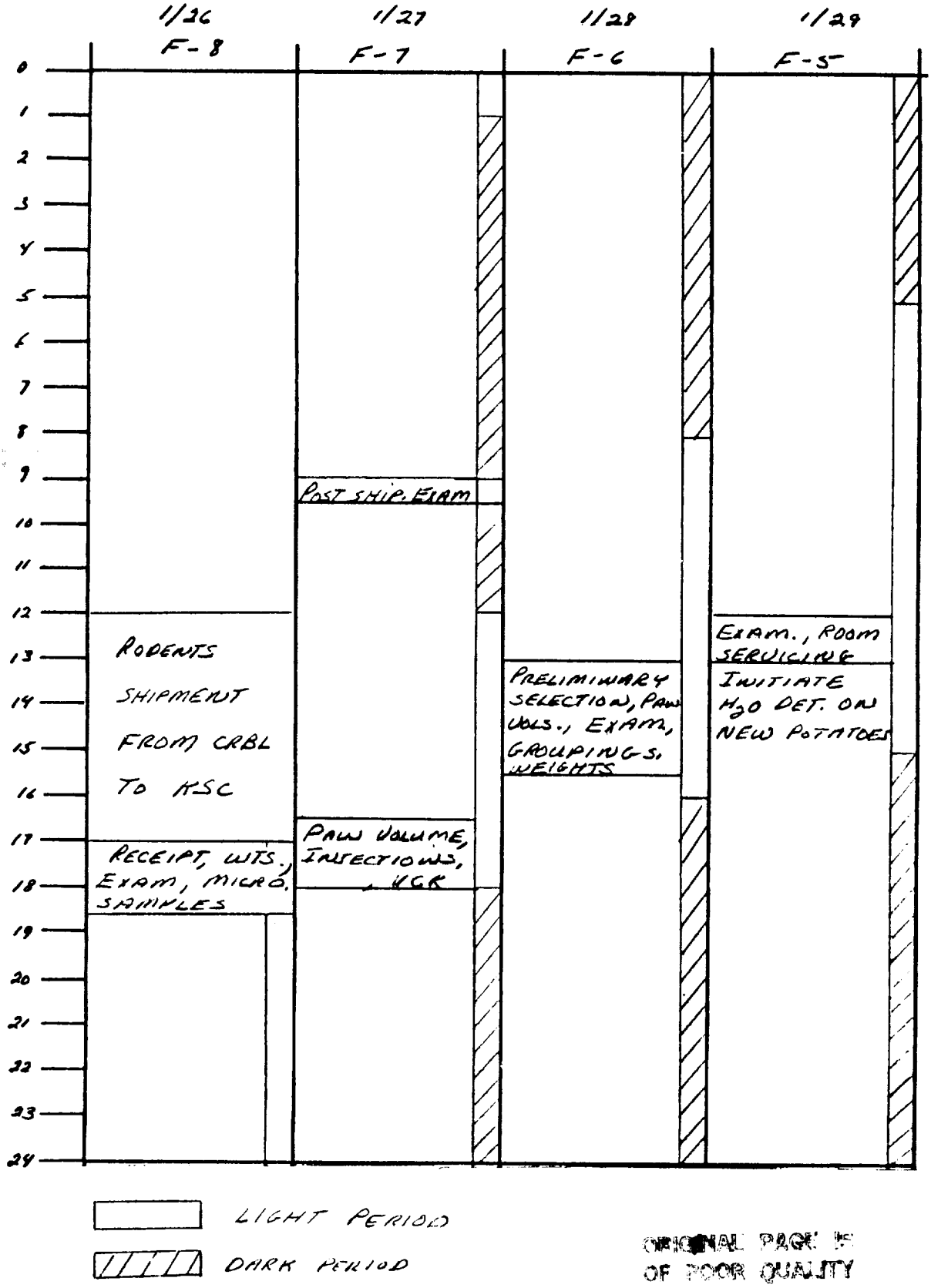
AEM HARDWARE SUPPORT TEAM	POTATOE/ FOOD BAR	RODENT SUPPORT TEAM	PUBLIC RELATIONS
KESSLER	HOLTEN	LARSON 1	RASMUSSEN
JACKSON	WEBER	HANNAGAN 1, 2	BUCHANAN
CHENG	SEBESTA	GOLDSBORO 1, 2	BOWIE
TIMM	CHENG	MORELAND 1, 2	LADWIG
UEBER	YOST (Recorder)	ANTOGNLI 1	SALZMAN
Photo support	Photo support	SEBESTA 1	WEBER
		WEBER 2	
		Photo support 1, 2	

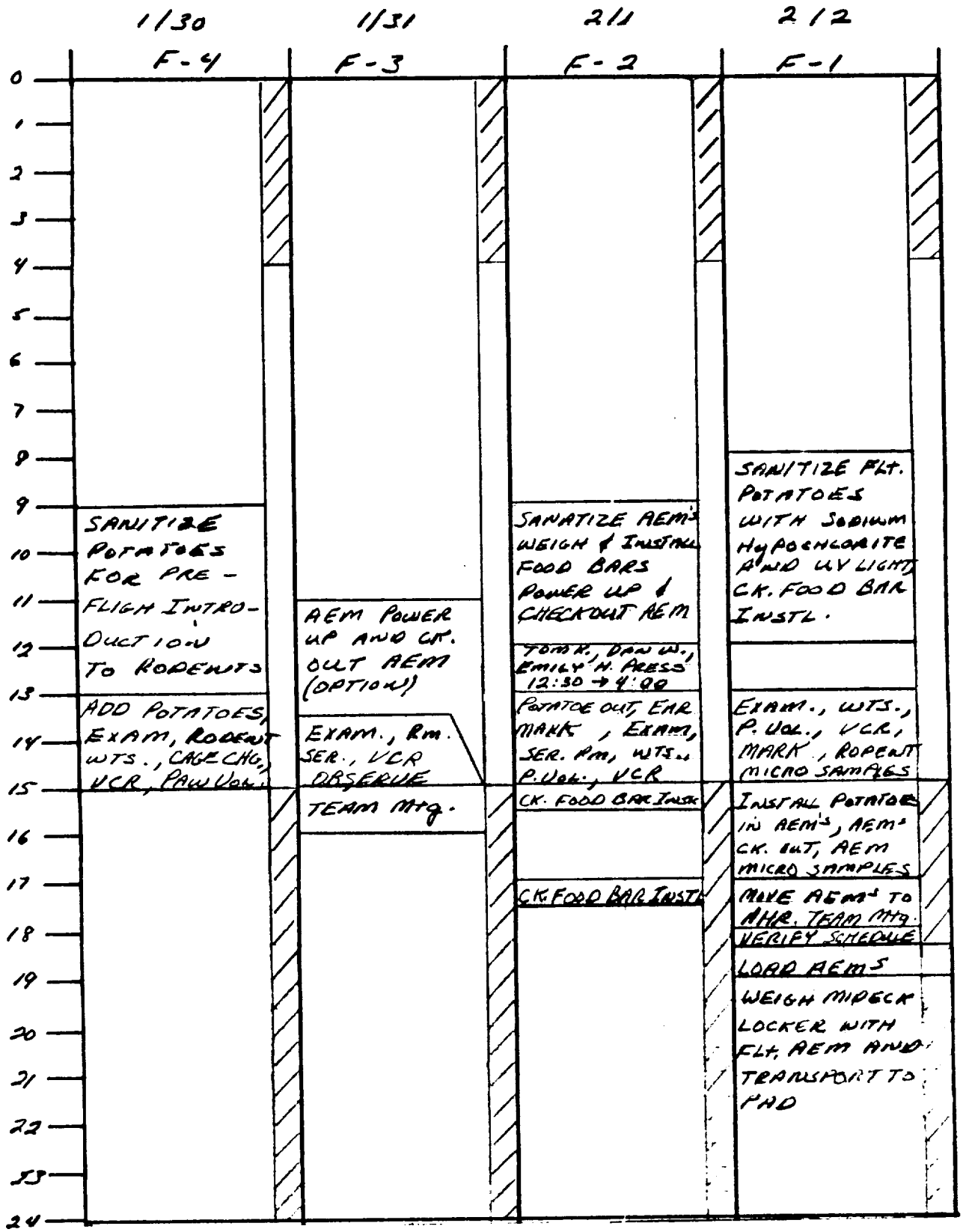
NOTE:

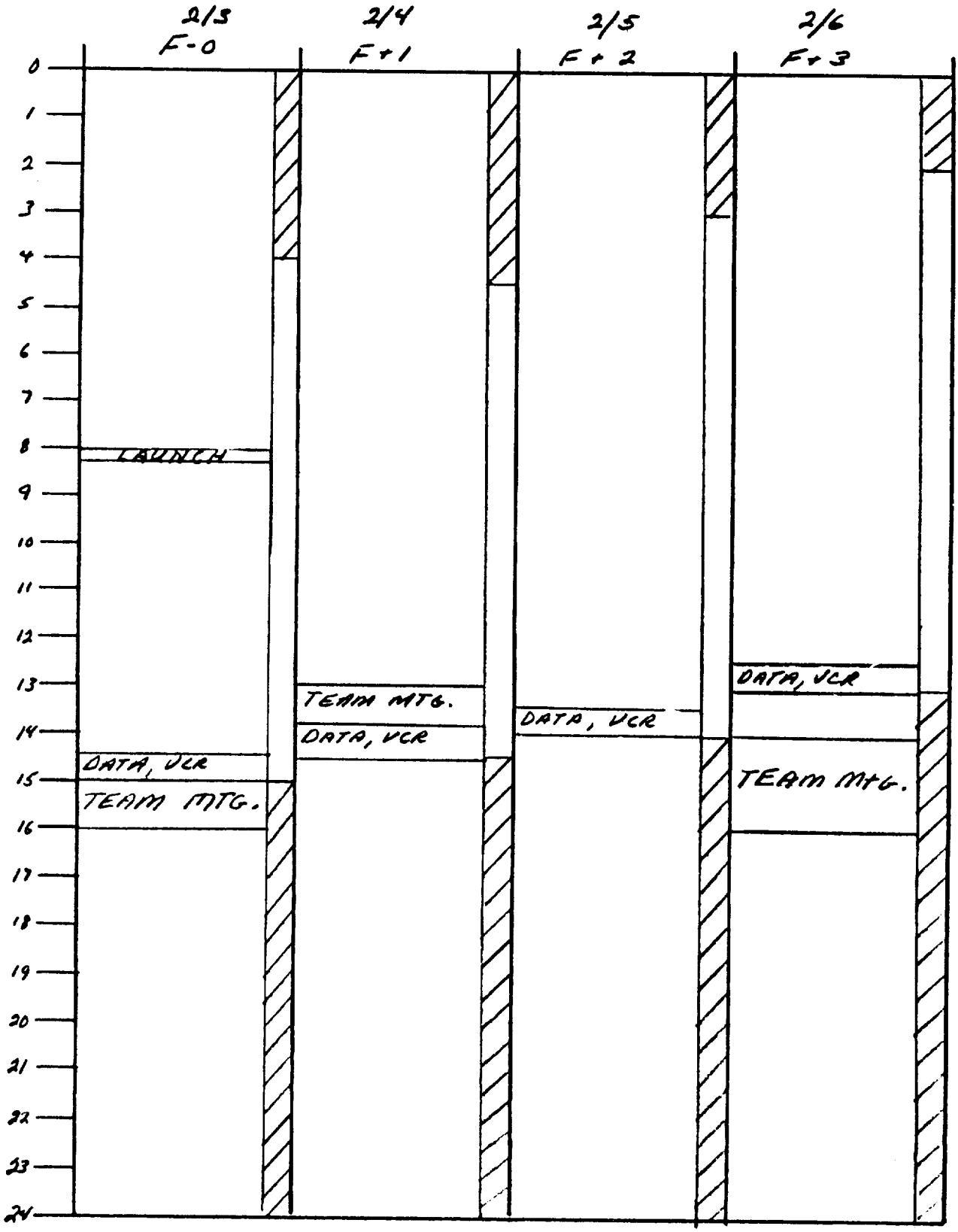
Number 1 indicates: Access to Animal Holding Rooms prior to loading of AEM.

Number 2 indicates: Access to Animal Holding Rooms during loading of AEM.

EXPERIMENT SE81-10 PROCESSING SCHEDULE



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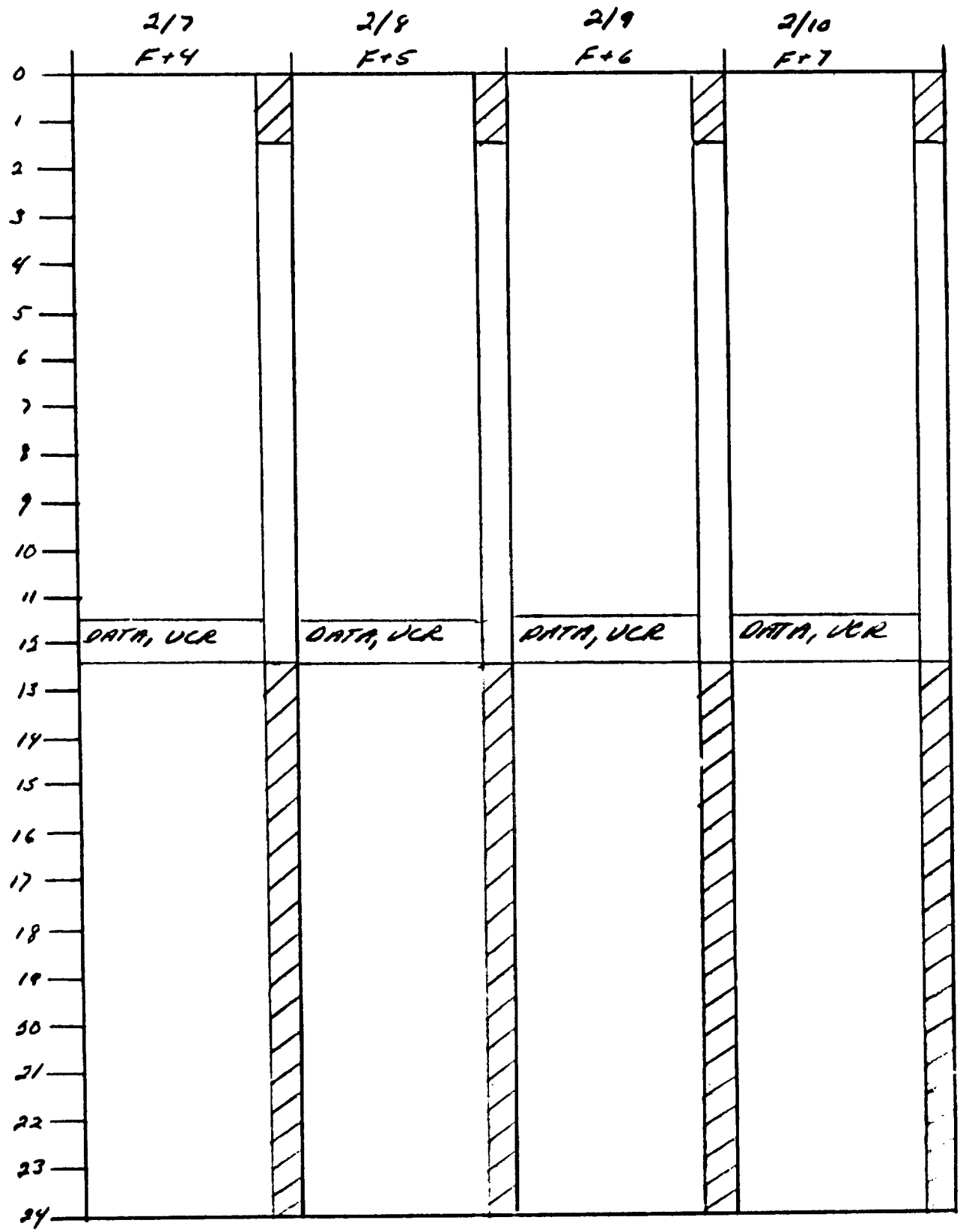
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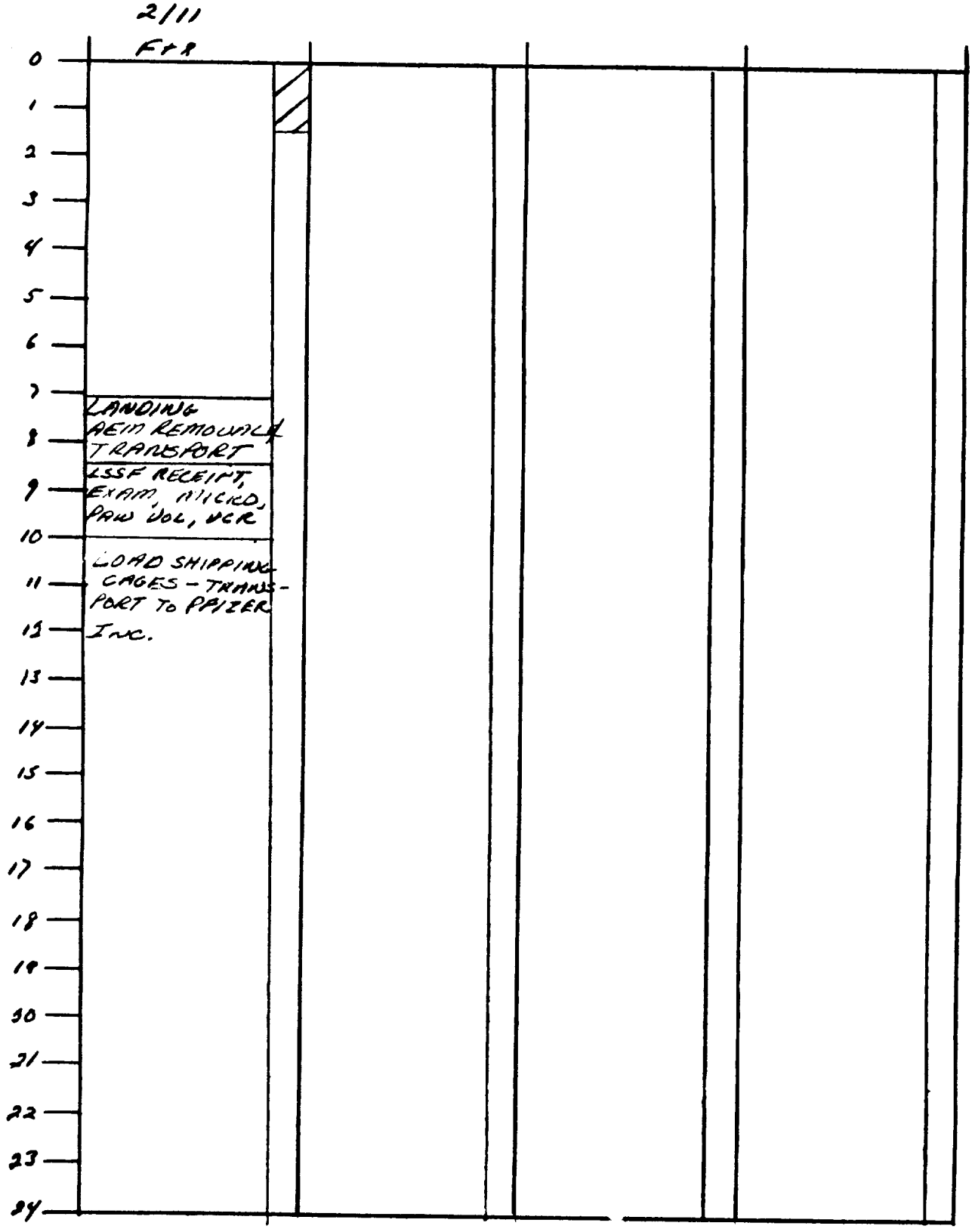

ATTACHMENT E

DIRECTORY OF TEAM MEMBERS FOR SE81-10

DIRECTORY OF TEAM MEMBERS FOR SE81-10

STUDENT:

Mr. Daniel J. Weber
950 Park Avenue
New York City, NY 10028
212/249-1020
or
709 Stewart Ave.
Ithaca, NY 14850
607/273-2447

TEACHER:

Ms. Francine Salzman
1 Thurston Drive
Livingston, NJ 07039

NSTA:

Dr. Helenmarie Hofman
NSTA
1742 Connecticut Ave., NW
Washington, DC 20009

CORPORATE SPONSOR:

PFIZER:

Dr. David Larson
Central Research Division
Pfizer, Inc.
Eastern Point Road
Groton, CT 06340
203/441-4691 (office)
203/441-4656 (lab)
203/739-0856 (home)

Dr. Mike Ernest
Central Research Division
Pfizer, Inc.
Eastern Point Road
Groton, CT 06340
203/441-3836

GENERAL DYNAMICS:

Mr. Thomas Kessler
DOD Advanced Space Programs
General Dynamics - Convair Division
PO Box 80847, Mail Code 21-9530
San Diego, CA 92138
619/~~573-5106~~ 576-3166
619/755-4779 (home)

Mr. Gerry Huston
DOD Advanced Space Programs
General Dynamics - Convair Division
PO Box 80847, Mail Code 21-9530
San Diego, CA 92138
619/573-9783
619/487-5287 (home)

NASA ARC:

Dr. Emily Holton
Biomedical Research Division
M/S 239-14
NASA-Ames Research Center
Moffett Field, CA 94035
415/965-5471 (FTS = 448)
415/965-5247
408/246-7440 (home)

Mr. Paul Sebesta
Life Sciences Flight Experiments
Project Office
M/S 240A-3
NASA-Ames Research Center
Moffett Field, CA 94035
415/965-6455 (FTS = 448)
408/996-8335 (home)

Dr. Jerome Goldsboro, Jr.
Biosystems Division
M/S 236-5
NASA-Ames Research Center
Moffett Field, CA 94035
415/965-6703 (FTS = 448)
415/965-6390
415/921-3552 (home)

NASA-JSC:

Mr. John Jackson
Crew Station Integration Section
Mail Code SP-33
NASA-Johnson Space Center
Houston, TX 77058
713/483-2291 (FTS = 525)
713/333-4542 (home)

Mr. Neil Christie
Crew Station Integration Section
Mail Code SP-33
NASA-Johnson Space Center
Houston, TX 77058
713/483-2291 (FTS = 525)

Dr. Duane L. Pierson
Mail Code SD-4
NASA-Johnson Space Center
Houston, TX 77058
713/483-4086 (FTS = 525)

Dr. Ron McNair
Mail Code CB
NASA-Johnson Space Center
Houston, TX 77058
713/483-3856 (FTS = 525)
2321

NASA HEADQUARTERS:

Mr. Alan Ladwig
Office of Space Flight
Code ME
NASA Headquarters
Washington, DC 20546
202/453-1138
703/237-4195 (home)

Mr. Michael Bowie
Office of Space Flight
Code MCS
NASA Headquarters
Washington, DC 20546
202/755-2350

Dr. Thora Halstead
Life Sciences Division
Code SBE-3
NASA Headquarters
Washington, DC 20546
202/453-1525
703/356-1397 (home)

Ms. Evvie Rasmussen
Public Affairs Office for OSSA
Code E-6
NASA Headquarters
Washington, DC 20546
202/453-1551

NASA-KSC:

Dr. William Knott
Code MD-RSB-2
NASA-Kennedy Space Center, FL 32899
305/867-3152 (FTS = 823)
305/267-1321 (home)

Mr. John Bryant
Code CS-SED-4
NASA-Kennedy Space Center, FL 32899
305/867-3044 (FTS = 823)

Mr. Jerry Moyer
BIO-3, Hanger L
NASA-Kennedy Space Center, FL 32899
305/853-3165 (FTS =253)
305/268-0672 (home)
Nancy x7828

Others:

Mr. Jack Sweeney
Bone and Connective Tissue Research Program
Orthopaedic Hospital
2400 South Flower St.
Los Angeles, CA 90007
213/742-1396
714/989-2347 (home)

ATTACHMENT F

RODENT HEALTH CHECK LIST

RODENT HEALTH CHECK LIST

1. HAIR COAT
____a) normal
____b) dermatitis
____c) pruritis
____d) reddening
____e) hair loss
____f) scaliness
____g) other: _____

_____

2. RESPIRATORY SYSTEM
____a) normal
____b) labored breathing
____c) coughing
____d) sneezing
____e) chattering
____f) nasal discharge
____g) pawing of nose
____h) other: _____

_____

3. LOCOMOTION
____b) head tilted
____c) circling
____d) convulsions
____e) paralysis
____f) muscle weakness;
location: _____

_____

____g) other: _____

_____

4. ARTHRITIS
____a) none
____b) swollen joints;
location: _____

_____
____c) stiff gait
____d) lameness
____e) other: _____

_____

5. LYMPH NODES
____a) normal
____b) enlarged; location:

_____

6. GROWTH
____a) normal
____b) stunted
____c) abnormal pattern
(describe on back of sheet)
____d) excessive
____e) other: _____

_____

7. WEIGHT: _____gms
____a) normal
____b) greater than expected
____c) less than expected

8. EYES
____a) normal
____b) conjunctivitis
____c) encrusted eyelids
____d) reddened eyelids
____e) ocular discharge
____f) bulging eyes
____g) other: _____

_____

9. URINE
____a) normal
____b) hematuria
____c) hemoglobinuria
____d) other: _____

_____

10. DIARRHEA
____a) normal
____b) soiled anal area
____c) soiled hair coat
____d) other: _____

_____

11. ANEMIA
____a) none
____b) weakness
____c) pale mucous membranes
____d) other:

_____

_____

RAT NUMBER: _____

GROUP: _____

CHECK PERFORMED BY: _____ DATE: _____
(signature)

ATTACHMENT G

STS-41B AEM/SSIP EXPERIMENT SUPPORT PLANS FOR LANDING

STS-41B

AEM/SSIP EXPERIMENT SUPPORT PLANS

KSC LANDING

BEGINNING R+1.5 HRS:

-Rodent receipt at LSSF

-Health exam

-Micro samples
  -Rodent fecal and N.P.)
  -Cage wipes) Flight and Ground
  -Food and potatoe)

-Rat paw volume measurements

-Transfer to sterile cage
  (Fresh food and H_2O)

-Observe and video

-Stabilization preshipment as required

-1:30 P.M. or 4:30 P.M. flight to Pfizer, Hartford, Connecticut (all animals - total 18)

BIONETICS PERSONNEL:

-A. Moreland, D.V.M.
-J. Moyer
-N. Hannagan
-S. Williams

AT DFRC:

-ARC personnel on hand for early landing.

-With adequate notification, N. Hannagan to DFRC then to Pfizer (Flight animals remaining at Pfizer) then to KSC.

-Dave Larson to Pfizer from KSC with Ground animals following landing. He will be accompanied by Dr. Goldsboro, D.V.M/ ARC.

-All OPS planned for KSC will occur at DFRC in the event of a DFRC landing.

-ARC will provide all necessary supplies other than micro at DRFC.

-N. Hannagan remains lead Animal Technician to assure humane treatment and proper handling - Bionetics/ARC D.V.M. also present.

APPENDIX H

WEBER SSIP SLIDES AND GROUP PHOTOGRAPH

NOT INCLUDED

SLIDES FOR THE WEBER SSIP

1. The student, Daniel Weber, and his parents, Judith and Lawrence Weber. The picture was taken atop the Sea Gull Beach Club the day of launch.

2. Dan Weber, Pearl Cheng (NASA/ARC engineer), Tom Kessler (General Dynamics engineer who built the hardware), and Mary Chetirkin (KSC/Bionetics). The photo was taken on a relaxing day at Epcot Center, Saturday, Feb. 4, 1984.

3. Preparation of AEM, ground control unit and installation of food bars. The AEM and ground unit are in a laminar flow hood in the X-ray prep. room in the animal facility in Hanger L at KSC. The wire housing units for the rats are to the left.

4. A closer view of the food bar installation. Note also the temperature probe which was on a wire spring and had a gasket around the top to tightly seal the probe to the lexan top so that waste material would not interfere with reading the temperature.

5. A yet closer view of 4.

6. The potatoes as a water source of this mission were processed somewhat differently than on the STS-8 mission. The potatoes were weighed out first and arranged into bags for processing; the bags were marked as to which surface in which wire housing unit they were to be mounted. The potatoes were then washed in a dilute chlorox solution.

7. After washing the potatoes in a chlorox solution, the potatoes were exposed to UV light in a microbial laminar flow hood for 1-1/2 hours per side.

8. The potatoes were transported from the microbiology lab on the second floor of the hanger to the X-ray prep. room in sterile cages; potates for flight were in one cage and potatoes for the ground control unit were in the other cage. The potatoes in each cage were for the two areas in the rat housing unit; a sterile drape separated the two batches of potatoes.

9. Paul Sebesta (ARC) and Duane Pierson (JSC) installing the potatoes in the flight and ground control units. Duane is holding the potato and Paul is twisting the wire, which supports the potato, around the outside of the wire grid.

10. A view of Paul spearing another potato with the wire that will hold the potato in the cage. Note also the twisted and clip wires holding the potatoes in the finished unit to his left.

11. A closer view of 10 showing also the sterile pliers and wire cutters used for the installation of the potatoes.

12. A beautiful day for launch. View from the VIP site. Challenger on pad is in middle of slide.

13. We have liftoff at 0800 EST, Friday, Feb. 3, 1984.

14, 15. Later views associated with 13.

16. Ice cream cake supplied by Pfizer, Inc. to show appreciation to KSC Hanger L team, Friday afternoon, Feb. 10, the day before landing.

17. The press site very early Saturday morning, Feb. 11.

18. Dan Weber in front of the MMU in the press site.

19. The press site 10 sec. before scheduled touchdown. The shuttle landed just after this slide was taken and must have been several seconds early. Note the clouds off shore which waited until after landing to move inland.

20. Back at Hanger L getting ready for the rats to arrive. Jerry Moyer and Sarah Williams are setting up in the large portable clean room to process the animals when they arrive at the Hanger.

21. The tables in the clean room for supplies.

22. The van arriving with the AEM and rats. Touchdown was at 0716 EST, and the van arrived at Hanger L at 0845.

23. AEM being transported from van to clean room in hanger.

24. AEM being removed from middeck locker. Note how much cleaner lexan top is over the control side vs the side containing arthritic rats. Note that the temperature probe is clean and easy to read.

25. A closer view of 24. Note that control rats are visible.

26. Another view of 25.

27. Dan Weber opening the AEM

28. View into the AEM immediately after opening. Note the difference in potato and food consumption between controls (right side) and arthritics. The control animals had only about 3/4 of a potato remaining.

29. Veterinarians Jerry Goldsboro and Al Moreland doing postflight rodent health checks. Dan Weber is recorder.

30. Healthy rats were processed first. Note that rat isn't particularly interested in water bottle.

31. Arthritic animals were processed after normal controls. Note that rat is thirsty. These animals drunk 35 ml water after they were placed in the colony cage in Hanger L; the normal controls which were processed first only consumed about 25 ml.

32. The flight animals being videotaped for activity sequence following postflight processing. These animals were quite lethargic and appeared to sleep through most of the videotaping. The ground controls were much more active and had to be watched closely during the videotaping to prevent them from leaping out of the colony cage.

33. Microbiology samples being taken from the AEM postflight. Nasopharyngeal were taken from each rat and samples of feces, potato, food, and interior and exterior of AEM were taken.

34. Jerry Moyer's hand holding the lexan top from the flight unit.

35. The interior cage from the flight unit after food and potatoes removed.

36. Waste products from flight AEM. Note pieces of hair, which indicate that the animals were grooming, as well as feces and crumbs of food and scraps of potato.

37. Ground control unit at end of experimental period. Note how much cleaner lexan top is in this unit.

38. Nancy Hannagan (KSC/Bionetics Animal Health Tech), Dr. Al Moreland (KSC/Bionetics), and Dr. Jerry Goldsboro (ARC) preparing to transport rats to Pfizer. Each cage had a center divider so that each group (flight, ground controls, or backups) could be transported in one cage and housed similarly to flight and ground control units.

39. A different angle of 38.

40. Sunrise on Cocoa Beach--dawn of a new era in Space Biology.

SUBJECT INDEX

APPENDIX

WEBER FINAL REPORT

The Effects of Weightlessness on Arthritis

Daniel J. Weber
NASA/NSTA Student Involvement Project

Teacher/Advisor:
Mrs. Francine Salzman
Hunter College High School
New York, NY

NASA Advisor:
Dr. Emily Holton
Ames Research Center
Moffett Field, CA

Corporate Sponsors:
Pfizer, Inc.
Groton, CT
Dr. David L. Larson, Science

General Dynamics Convair Division
San Diego, CA
Mr. Tom Kessler, Hardware

Faculty Advisor:
Dr. Lennart Krook
New York State College of Veterinary Medicine
Cornell University
Ithaca, NY

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ACKNOWLEDGEMENTS

The success of this project hinged on a tremendous team effort involving countless individuals. Recognition only of those with whom I came in contact is, I realize, just acknowledging the tip of the iceberg since this project involved: Hunter College High School; National Science Teachers Association; NASA Headquarters; two corporate sponsors – Pfizer Inc. and General Dynamics; three NASA centers – Ames Research Center (ARC), Johnson Space Center (JSC) and Kennedy Space Center (KSC); and Cornell University. My gratitude to all contributors throughout this project cannot be measured with mere words and dictates that this section should appropriately begin, rather than end, this Final Report.

Mrs. Francine Salzman of Hunter College High School was the prime motivation behind the project. Her stimulating Chemistry class fostered the creativity that inspired ideas such as mine to be encouraged and developed. Her enthusiasm, energy and dedication were and will always remain an inspiration to me.

I would like to thank the National Science Teachers Association for sponsoring the Shuttle Student Involvement Project (SSIP) and in particular, Dr. Jerrold Maben, Dorothy Culbert and Helenmarie Hoffman. Promotion of science education among high school students is greatly appreciated by all the student participants in the annual Regional and National SSIP Conferences.

I am extremely grateful to Dr. Glenn Wilson and Alan Ladwig of NASA Headquarters, who were instrumental in locating corporate sponsorship for the experiment. Alan's commitment to both this experiment and the ideals of the SSIP as well as his strength and courage during several critical periods will never be forgotten. I would also like to formally thank Lieutenant General James A. Abrahamson, Associate Administrator of Space Flight, for his vision and support of the project and the SSIP.

Corporate sponsorship is perhaps the most critical component of the SSIP. With this experiment, the generosity of Pfizer Inc. (Central Research Division) and General Dynamics (Convair Division), in

supplying facilities, personnel and travel support, was greater than ever expected. I would like to acknowledge the corporate administrative support of Dr. Barry Bloom and Dr. Ted Wiseman of Pfizer Inc. and Gerry Huston of General Dynamics.

I am greatly indebted to my two corporate advisors, Dr. David Larson of Pfizer and Tom Kessler of General Dynamics. During my senior year in high school, Dave introduced me to countless experimental techniques and instilled in me the discipline required for scientific inquiry. He then spent numerous months, including two summers, guiding the many experiments that constitute the data base for this project. His patience, faith, and tutelage during the past four years have been indispensible to me. I would also like to thank Gerry Antognoli, Karen Caise, and Bernie Bliven who helped with the experiments at Pfizer and at KSC.

Tom Kessler's ingenuity and creativity resulted in the design and fabrication of the unique life support system for the rats, the Animal Enclosure Module. Without his efforts and resourcefulness, this experiment would never have flown. My personal and working relationship with Dave and Tom have meant a great deal to me and I thank them both sincerely.

Dr. Emily Holton of NSAS-Ames Research Center served as my NASA advisor. Her advice, encouragement, moral support and most of all, her friendship, have been my mainstay throughout the project. Her bi-weekly NASA reports kept the entire team organized and moving forward. Without Emily as a focal point for the project, the experiment would not have achieved nearly as much success as it did. I also want to thank Mary Gosalves, Elizabeth Enayati and Chris Maese who assisted with the experiments I performed at ARC and who made my time in the Bay area most enjoyable.

I gratefully acknowledge the assistance of other people at Ames Research Center. In particular, I would like to thank Paul Sebesta, Pearl Cheng, Dr. Jerry Goldsboro, Gary Bowman, Bill Berry and Bonnie Dalton for their generous and enthusiastic support.

John Jackson and Neil Christie of NASA-Johnson Space Center were responsible for perhaps the most difficult aspects of the experiment-manifesting the AEM and assuring appropriate integration of the experiment aboard the Shuttle. I greatly admire John's wisdom, integrity and patience. His genuine concern for the SSIP program in general and this experiment in particular was indispensable to the success fo the project.

I would like to thank Dr. Ron McNair for the superb job he did monitoring and observing the rats during flight. I appreciate the generous sharing of his preflight time to familiarize himself with the project at a time when numerous other demands were pressing and for continuing his interest after the flight.

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Finally, I would like to thank my parents and brother for their love, patience and support. I dedicate this experiment to my grandparents, Ben and Alice Weber and Alfred and Deborah Eichler whose pain and suffering with arthritis inspired the idea for this project.

The Effects of Weightlessness on Adjuvant-induced Arthritis in Rats

Daniel J. Weber

I. Abstract

This experiment, co-sponsored by the NASA/NSTA Shuttle Student Involvement Project, hypothesized that the development of adjuvant induced arthritis had a gravity related component. Studies on an animal suspension model simulating some aspects of spaceflight (unloading of rear limbs, cephalad fluid shifts) suggested that the loading of the limbs and/or fluid shifts contributed to the onset of the disease process. The experiment flew on STS41-B in February 1984.

Data collected immediately post-flight and radiographic and histologic studies conducted several days afterward suggested that gravity did not contribute to the development of the arthritic process. However, imunologically different animals had been used for pre-flight data base; gnotobiotic animals were used for flight and specific pathogen free (SPF) animals had been used for all ground based studies. The flight experiment was based on a time course of the disease process found in SPF animals (about 10 days for apparent systemic disease), whereas the onset of the systemic disease required about 14 days in the gnotobiotic rats. Re-entry at the time the systemic disease occurred may have significantly impacted the data.

The healthy control rats aboard STS41-B ate more food and gained more weight than the ground controls. However, analysis of the data suggested that both groups were adding body mass at the same rate when expressed as a gained/kcal food consumed.

II. Introduction

Adjuvant-induced arthritis in male Lewis rats is a degenerative auto-immune disease. This model shares a number of characteristics with human rheumatoid arthritis. For example, the rat disease has a chronic immunopathological basis which includes cell infiltration, proliferative synovitis and swelling of the extremities which lead to the erosion of cartilage and bone and finally to loss of joint function (6). Unlike rheumatoid arthritis in humans, however, the experimental disease is non-progressive in character. The disease is self-limiting, with deterioration lasting rarely more than a month (8). Pearson, et. al. (9,10) found that after the initial acute phase, the disease subsided or stabilized and many animals experienced two or more spontaneous exacerbations at predictable intervals. These exacerbations and remissions as well as the development of a systemic lesion suggest the operation of a cyclical phenomenon originating in the immune system (9,10). Pearson, *et al.*, also found that the degree of destruction in the most severely affected joints greatly exceeded the degree of joint damage generally seen in the human disease (8). This destruction in the arthritic rat includes osteonecrosis of the tarsal and metatarsal bones, erosion of the tarsals, and periosteal reactions in the metatarsals. Fibrosis and cyst formation can be observed in the metatarsals 14 days after injection with Freund's complete adjuvant and in the tibia, fibula, and tarsals by day 21 and later becomes the dominant abnormality by day 35 (1). Aberrant build-up of calcium also occurs in the disease model which results in the coating of the affected joints. This latter phenomena is also a major symptom of rheumatoid arthritis. Histopathological studies of the joints and periarticular tissues in the adjuvant disease show osteoblastic proliferation with formation of osteoid on the bones adjacent to the joints (7). Rat adjuvant polyarthritis has been used extensively as a model for evaluating anti- arthritic drugs (6).

Swimming and hydrotherapy have long been popular forms of therapy for people suffering from rheumatoid arthritis. From the Sixteenth Century onwards, major therapeutic centers developed at spas and became the most important places for treatment of rheumatic diseases.

Since the early 1950's, interest in rheumatic diseases and the spread of physical therapy departments in hospitals have led to a wider understanding of the use of hydrotherapy (2). In hydrotherapy, weakened muscles and joints perform motions under water which would be impossible in a 1 g laboratory environment. The buoyancy afforded by water nullifies the load of gravity, thereby decreasing muscle spasms and hastening the rebuilding of the atrophied muscles (3). The possible effects of weightlessness on the development of the disease for a prolonged period of time have not been studied.

Studies conducted by NASA on the effects of zero gravity on human physiology indicate that mineral shifts and unloading of the joints occur in healthy subjects after prolonged exposure to conditions of weightlessness. Gemini, Apollo and Skylab astronauts exhibited a negative calcium balance as defined by hypercalciuria. In addition, the bone mineral density of the calcaneus declined approximately 4% in Skylab crew members after 84 days of orbital flight (11). In addition, astronauts were found to have increased up to an inch in height on Skylab, apparently due to the decrease in pressure on the spine and discs. This decrease in pressure may be the result of reduced resistance to the joint cartilage and thereby minimize its destruction (4).

Animal models for simulating certain aspects of weightlessness have been developed. A "head-down" suspension model for simulating the cephalad fluid-shifts and unloading of hindquarters produced by weightlessness has been shown to minic many of physiological alterations induced by space flight (5). These models provide information on potential changes during space flight and are a cost effective means of predicting parameters to be measured during flight. Data obtained from this "head-down" suspension model are comparable to data received from the 20 day Soviet Cosmos biological satellite missions in terms of weight gain and decreased periosteal bone formation in the rat (5). The suspension of rats with a head-down tilt of 30 degrees results in total mechanical unloading of the hind limbs and a cephalad shift of body fluids similar to orbital fight. The skeletal abnormalities that occurred within 2 weeks in

the proximal tibial and humeral metaphyses of suspended rats were determined to be the result of a diminished rate of longitudinal bone growth, a reduced mass of trabecular bone, and an increased fat content of bone marrow (12). In addition, suspended rats exhibited decreased numbers of osteoblasts and an increased osteoclast populaton immediately adjacent to the growth plate - metaphyseal junction at both skeletal sites (12). Since simulations and space flight produce changes which may protect against the arthritic disease, a proposal was submitted to NASA/NSTA suggesting that space flight might interfere with the pathogenesis of induced arthritis in rats.

III. Objectives

Four objectives were included in this study.

A. The first objective was to establish parameters such as weight and paw volume changes, potato and food consumption and the time of the onset of the systemic response to evaluate the development of the disease. If gravity is a component of the arthritic disease process, then animals launched into space 8 days after inoculation of adjuvant should show less joint destruction, weight loss and paw inflammation, and consume more food than the inoculated ground controls.

B. The second objective was to determine if the development of the arthritic disease process might have a gravity related component by conducting simulation studies at 1 G to determine if the flight experiment was necessary.

The second part of the objective was accomplished through two studies in which adjuvant arthritic Lewis rats were suspended for periods of 7 or 16 days. These studies indicated that placing rats in the suspension model inhibits the systemic arthritic syndrome. One week following removal from the apparatus, the animals did not display a delayed onset of the disease as compared to non-suspended arthritic control rats. These data supported

the hypothesis that gravity and/or fluid shifts may indeed be a component in the arthritic disease process and verified the necessity for a flight experiment.

C. The third objective was to design, construct, and test a self- contained life support system to house the rats during flight.

D. The final objective was to successfully integrate the experiment onto the Space Shuttle and to analyze the data obtained from the flight experiment.

IV. Material and Methods

Four series of experiments were conducted. Series 1 established the adjuvant arthritis baseline data. Experiments in Series 1 recorded weight, paw volume, blood and behavior changes induced by injection of Freund's complete adjuvant. Series 2 used the "head-down" rat model to determine whether unloading and a cephalad fluid shift might alter the progress of the arthritic disease. Series 3 established the flight experimental baseline data. This series included both suspension studies, testing of the AEM, potato and Ames food bar studies, and establishing the time course of the arthritic disease process in gnotobiotic rats. Series 4 was the fight experiment. Analytic techniques included radiography, histopathology, locomotor activity cages and blood analysis.

A. General Procedures (series 1,2, 3, and 4)

1. Animals

Male Lewis rats in weight range of 225-275 g bred by Charles River were used for the study. The Lewis strain is extremely sensitive to inoculation with Freund's complete adjuvant (7). Other strains of rats do not respond with the consistency and predictability of inflammation noted in this strain.

2. Feeding

Rats were fed a standard rat diet (Teklad L-356) and a water source *ad libitum* unless otherwise noted.

3. Adjuvant-induced arthritis

Arthritis was produced by a single subcutaneous injection of 1 mg *Mycobacterium butyricum* suspended in 0.1 ml mineral oil in the right plantar region of the tarsus (6). The swelling of the injected paw was considered the primary response and the increase in volume of the uninjected contralateral tarsus constituted the secondary response. The systemic inflammation in the latter phase is thought to involve the immune system and became apparent about 10-12 days after inoculation in SPF animals. Thus, flight and suspension studies were to begin 7-9 days after inoculation.

4. Paw volume measurements

The volume of the injected or non-injected foot was measured up to a mark made on the tibio-tarsal joint with a mercury plethysmograph. In other cases, where noted, a calibrated millimeter tape or caliper was used.

5. Weight measurements

Animals were weighed to the nearest gram before, during and after each experiment.

B. Pre-flight Experiments and Procedures (Series 1, 2, and 3)

1a. Experimental design (series 1, 2 and 3)

1. Animals

Baseline studies employed specific pathogen free Lewis animals.

2. Light/dark cycle

A normal light/dark cycle of approximate 12 hour intervals was used with all experiments.

3. Locomotor activity measurement

Locomotor activity data were continuously monitored and recorded by a PDP 11/34 computer for 15 days in the preflight database experiment, and for 24 hours beginning 12 hour postflight in the flight experiment. Locomotion was measured as the number of crossovers from one quadrant of a chamber to another. Rearing was measured as the number of times contact was made with a touch-plate 7 cm above the floor of the box. Contact with food containers and drinking spouts was also computer monitored. During both experiments animals were constantly confined to these chambers and data were recorded continuously except for brief periods when animals were removed for paw measurement or routine chamber maintenance.

4. Suspension apparatus

A "head-down" suspension model for simulating weightlessness has been shown to reproduce many of the physiological alterations induced by space flight (5). The suspension model's critical components include the unloading of the rear limbs, use of the front limbs primarily in a pulling mode, and head- down rat orientation at 30

degree tilt to cause a cephalad fluid shift similar to that encountered during exposure to weightlessness.

5. Radiography

Radiographic analysis of bone lesions were performed at Ames Research Center by the use of a GE model Aristocratt II and Kodak Industrial M film. Focal film distance was 40 in. with no added filtration. Voltage was set at 57 kVp. current at 300 mA, and exposure time for 1 s.

Bone lesions were assessed in the rats from X-rays by allocating a score of 0-10 to the swelling and necrosis of the tibia, fibula, metatarsals, and phalanges of each foot.

6. Animal Enclosure Module

The unique Animal Enclosure Module was designed by General Dynamics Convair Division and incorporated all the inputs from NASA Ames Research Center and Johnson Space Center. Figure 3 in Addendum A shows the end result. Three Lexan panel cover, from front to rear, the inlet filter, the cage and the exhaust filter including an electrostatic 0.3 micron biological filter at the very end. Rubber gaskets seal these covers. The fiberglass-charcoal fiberglass filter "sandwiches" are contained with stainless steel screens which slide in on guides machined in the aluminum side walls. The cage is a single welded unit which also slides in (on Teflon guides) and has a removable divider to which the food bars were to be glued (a practice which was not used in flight due to flexure of the divider). Electrical power for the four fans and four cage lights (located in the corners of the cage adjacent to the inlet filter) enters the cage on the left side and goes to two switches. Two rheostats control the fan speed (a concept that was dropped for the second flight) and are cooled by air exhausting from the four radial blowers mounted on the front.

In late July 1982 the AEM was shipped to Pfizer Inc. for preliminary live animal testing. Results of these tests led to several minor modifications to the hardware, mainly to improve the rubber gaskets, which were accomplished in September-November 1982.

Further testing by NSAS JSC in March-April 1983 verified the ability of the cage to contain the odors of six dead animals for up to ten days before any trace of odor was detectable. Tape was added as a final seal of the covers to the sides of the AEM. The "worst case scenario" was performed as a final verification that the crew would not have to open the cage and access the animals under any contingency. Worry about microbial contamination was the overriding concern.

The AEM carried six healthy animals which were flown on STS-3 in August 1983 for a successful 8 day flight test of the system. The hardware performed well (and animals) and only a few minor modifications were required. More rubber gasket material was added to further improve the sealing of the cage. Also, temperatures in the cage had risen into the mid-to-high eighties during the flight which led to concerns that the airflow rate was insufficient. In order to improve this, the fan rheostats (which cut the fan voltage by about 2 volts) were removed and the 3M G-0115 filter which reduced pressure drop. These changes improved the flow velocity by about 20-30%. The AEM was returned to JSC in early December 1983.

See Addendum A for a more detailed description of the AEM.

C. Flight Experiment (series 4)

1. Animals

The six flight animals, ground controls, and back-ups were gnotobiotic. Eighteen animals were equally divided into the 3 groups; the flight animals were

preferentially grouped to show the smallest variance while the back-ups had the largest variability.

2. Feeding

Rats were fed an autoclaved Teklad L-356 diet which was compressed into food bars by Ames Research Center for flight. Sterile water was allowed *ad libitum* before and after flight. UV irradiated, chlorine washed Idaho potatoes were used as the water source during flight.

3. Light/dark cycle

Animals were kept as closely as possible on a 12 hour light/dark cycle throughout the flight experiment. Ground control animals were put on the same approximate 12 hour photoperiod as that employed in the Animal Enclosure Module aboard the Challenger.

4. Video Recording

Back-up rats were video taped with a Panasonic VHS system with 1/2" RCA tapes approximately every other day for approximately 30 minutes just before lights out. At the same time paw volume measurements were made. The flight animals were also videotaped on the third and sixth day of the mission for approximately 45 minutes. Flight and flight control rats were not handled during the flight portion of the experiment.

5. Radiography

The limbs of the flight animals and gound controls were radiographed laterally and cranially with a Picker GX-150 X- ray machine by the New York State College of Veterinary Medicine Department of Radiography. An X-ray collimeter was used to

restrict the beam to the proper size. Total part filtration was equal to 3.5 mm of aluminum. The exposures were standardized as follows: For lateral exposures, 50 kVp and for cranial exposures 60 kVp. mA was 300, exposure time was 0.5 seconds and the focal distance was 100 cm. Kodak TL2 film was used. The film was processed for 90 seconds in a Picker Diplomat Automatic Processor with Kodak RP Developer and Fixer.

6. Euthanasia.

All rats were euthanized by CO_2 inhalation in a closed chamber.

7. Gross dissection and histopathological techniques

   a. Gross dissection. Following termination, all four limbs were excised (the pelvic limbs in the coxo-femoral joint and the thoracic limbs by excision of the entire limb including scapula) and fixed by immersion in 10% buffered formalin for two days. The appropriate bones (femur, tibia, tarsus, metatarsus and humerus) were then demineralized in toto in 10% formic acid buffered to pH 4.5 with sodium citrate. Mid- sagittal sections were excised of all bones except the metatarsus which was cut transeversely at the mid-shaft. The slices were embedded in paraffin, sectioned at 4 micrometers and stained with hemotoxylin and eosin (H&E). The slides were examined and photographed in a Zeiss "Ultraphot" photomicroscope on Kodak Tri-X 4" x 5" photographic plates which were developed in Kodak DK-50. The plates were contact printed on appropriate photographic paper.

8. Locomotor activity measurement

See B.3. Preflight Experiment and Procedures.

V. Results

A. Baseline Studies (series 1)

1. Paw volume

Injection with Freund's complete adjuvant in two-month old male Lewis rats produced primary swelling in the injected foot. The right paw swelled an average of 2.2 ml in the first seven days after inoculation ranging from 2.0 ml to 4.2 ml (Figure 1). Chronic swelling of the right paw continued to day 16, with a peak at 6.3 ml. From 16-49 days, paw volume declined to an average value of 4.6 ml. As expected, the secondary response in the left hind paw started 7 and 16 days post-injection. During this time period, paw volume increased a mean of 1.8 ml to a total volume of 3.8 ml. The left paw volume reached a maximum of 4.8 ml on day 28. From 28-49 days, paw volume decreased by 1.1 ml. Paw volume of healthy controls shows a slight increase of 0.2 ml during the duration of the study (Figure 2).

2. Weight

Rats inoculated with Freund's complete adjuvant lost an average of 37 g from 0-22 days post-injection; from 22-49 days, the rats gained an average of 62.5 g (Figure 3). Healthy controls steadily gained 130 g during the duration of the study (Figure 4).

3. Activity

Three arthritic rats individually housed in electronically monitored behavior cages for a 15 h time period at 8 days postinoculation showed substantially less activity than three control animals in several parameters. The arthritic animals crossed the cage 68% fewer times than the controls. The experimental group reared 89% less than

the controls and made contact with food 43% fewer times. The arthritic animals licked the water dispenser 90% more often than the healthy rats.

8. Pre-fight Experiments (series 2 and 3)

1. Suspension studies

Two experiments were performed with the use of the rat model simulating certain aspects of spaceflight. All animals in these experiments were inoculated with complete Freund's adjuvant. Data from the first experiment conducted at Ames Research Center are found in Table I and relative hind paw thickness is graphed in Figure 5. Animals on the suspension apparatus showed significantly less swelling in the uninjected left paw than did control arthritic animals. The difference between the suspended and non-suspended left paws on the fifth day of suspension was significant at $P < 0.001$ while on the seventh day, $P < 0.05$. No differences between groups in the size of the inoculated right paw were noted.

Body mass changes in the second experiment (Figure 6) corresponded closely with those in the first experiment (Table I). Figure 7 shows the paw circumference in all arthritic rats at different times after injection and treatment. Paw circumference was measured with a calibrated millimeter tape rather than the micrometer type caliper used in the first experiment. The rats suspended for seven days were significantly more like the healthy non-suspended controls in terms of systemic infection (left hind paw) as compared to the non-suspended arthritic rats. The systemic infection did not resume during the 15 day post-suspension period in this group. The differences between the seven day suspended and non-suspended left paws on day 16 post-injection were significant at $P < 0.005$ and on day 28 at $P < 0.001$. The arthritic rats suspended for 16 days showed slightly less significance from the non-suspended arthritic rats. The difference between the 16 day suspended and non- suspended left

paws on day 16 post-injection was significant at $P < 0.02$ while on day 28, $P < 0.01$. The secondary response was inhibited and did not resume during the five day post-suspension period. Bone deterioration (Table II) was strikingly different between suspended and control (non-suspended) groups in the left paw 32 days post-inoculation. No differences were noted at other time periods or in the inoculated right paw at any time.

The radiographs of the pelvic limbs of suspended and non-suspended rats are presented in Plate 1. The swelling and destruction of tarsal bones of the injected tarsus (right) were similar in all animals. The late response in the left tarsus was mild or absent in suspended rats while it was moderate to pronounced in the non-suspended rats. Plate 2 shows a radiograph of the pelvic limbs of rats injected 32 days previously. Two rats (A and B) were suspended during days 9-16 after injection while the others (C and D) were not. The lesions in the right tarsus were extremely severe and similar in all four rats. The destruction concerned the distal tibia and the entire metatarsus. In the non-suspended rats, the lesions in the left tarsus (C and D) were severe with regard to both swelling and bone destruction, whereas in the suspended rats, the degree of swelling was considerably less and bone destruction was only mild. Plate 3 shows the radiograph of the pelvic limbs from rats injected in the right paw 32 days earlier with a suspension period from day 7 to day 23 (A and B). The radiograph of the non-injected, non- suspended control is presented in C. The swelling and destruction of the tarsus and metatarsus in the injected paw was severe in both cases (A and B) but the response in the left tarsus differed greatly. Destruction of tarsal and metatarsal bones was pronounced in rat A but mild in B.

2. Diet

Arthritic rats fed with Ames food bars and potatoes showed no substantial difference from the arthritic rats fed with Purina Rat Chow and water. Both the right and left hind paws swelled the same degree between 8-14 days post-injection. The right paws grew 0.5 ml during this 6 day interval while the left paws expanded 1.4 ml. The rats fed with chow and water gained 7% more body mass than the rats fed with Ames food bars and potatoes during the same 6 day period following the onset of the secondary lesion.

3. Gnotobiotic study

Gnotobiotic rats from Charles River showed no difference in the development of the adjuvant-induced arthritis as compared to the specific pathogen free rats during a 16 day period in terms of both paw volume and weight loss (Table III). However, these animals were not kept under absolutely sterile conditions after receipt at Pfizer Inc.

4. Extensive preflight testing of animals in the AEM was conducted both at Pfizer Central Research and at Johnson Space Center. The data are found in JSC memo SD3-83-336 dated 5/13/83.

C. Flight Experiment (series 4)

1. Paw volume

The increase in paw volume in both the right and left paws between the arthritic flight animals and arthritic ground controls was not significantly different. The average increase in the right paw of the flight arthritic group during flight was 6.7 mm +/- 2.5 while the left paw swelled 15.3 mm +/- 3.0 (Figure 8, Table IV). The right paw of the arthritic ground controls increased 6 mm +/- 2.6 while the left paw

swelled 12.7 +/- 6.5 mm (Figure 9, Table IV). Both groups of healthy animals showed minor paw volume increases. The right paw of the healthy flight animals grew an average of 2.3 mm +/- 5.8 while each ground control grew 2 mm. The left paw of the healthy flight rats increased 1 mm +/- while the ground controls increased 2 mm +/- 1.

2. Weight

Changes in body mass of the arthritic flight animals did not differ significantly from the arthritic ground controls (Table IV, Figures 8 and 9). The three flight arthritics lost an average of 32 g +/- 3.6 during the eight day flight while the ground controls lost 40 g +/- 12.5. The three contingency animals housed in normal caging lost an average of 27 g +/- 9.3 (Figure 10). The healthy flight controls gained 35 g +/- 6.4 while the healthy ground controls gained only 21 g +/- 5.3 (Figure 8 and 9, respectively). The contingency annimals gained an average of 20 g +/- 8.9 (Figure 10).

3. Potato/food consumption

Both flight groups consumed more potatoes and food bars per day than their respective ground counterparts (Table VI). The arthritic flight group ate an average of 84 g of potato and 25 g of food per day. The arthritic ground controls consumed an average of 70 g of potato and 20 g of food per day. The healthy flight animals consumed 249 g of potato and 63 g of food per day. The ground controls at 145 g of potato, 58.2% less than the flight animals, and 34 g of food per day, 54% less than the flight controls. Based on the amount of water and potato consumed during the 3 day period prior to flight, the amount of potato estimated to be eaten during the flight per group of healthy controls would be approximately 190 g per day. During the flight period the healthy ground controls ate about 10-20% less than this

calculated amount while the healthy flight animals consumed 30% more than projected.

4. Flight observations

Astronaut Ron McNair observed that the arthritic flight rats looked more normal than the injected animals he had witnessed at JSC prior to flight. During an inflight press conference on Day 7, Dr. McNair reported that, "I've seen some pretty dramatic differences. I had the opportunity to observe a similar experiment on the ground for a couple of weeks, and I would say that the rats that we had here on orbit are probably much, much better off than ground controls. I have seen very little migration of the (...garble...) to compare from the paw, that was affected with the arthritis to the opposite paw. There's been very little migration, as opposed to what you see on the ground in similar situations."

5. Locomotor activity measurement

Table VII shows the number of cross-overs, rears, eats and licks performed by each experimental group during a 24 hour period beginning 12 hours post-flight. The ground arthritics showed no activity in all four fields of study. For example, the flight arthritics ate and licked a significant number of times. The healthy flight animals licked the water dispenser almost three times as often as the healthy ground controls.

6. Blood analysis

Results from orbital bleeds conducted one day post-flight at Pfizer Inc. of the four experimental groups can be found in Table VIII. Major differences were noted

between healthy and arthritic rats but no major differences were found between flight and ground controls.

7. Necropsy

The degree of swelling of the injected and non-injected pelvic limb of a flight rat is shown in medial and cranial view in Plate 4 (A and B) as compared to a healthy flight control (C and D). The swelling of the limbs of the arthritic flight rats is compared to those of the injected ground controls in Plate 5. There were no definite differences between flight and ground arthritic rats.

8. Radiography

Plate 6 depicts radiographs of the pelvic limbs of three arthritic flight animals (A, B, and C) and one arthritic ground control (D). All rats were injected 23 days previously. Seven days post-injection, groups A, B and C were exposed to zero gravity conditions aboard the Space Shuttle Challenger for a period of eight days. The swelling and osseous destruction were similar in all cases. The lesions in the contralateral tarsus and metatarsus are illustrated and described in Plate 6. The lesions in the arthritic flight animals were more advanced or similar to those of the arthritic ground control. The normal radiograph of a healthy flight and ground control is presented in Plate 7 for comparison.

9. Histology

The normal morphology of the distal tibia and the hock in the mid-sagittal section is shown in low magnification in Plate 8A and that of the metatarsal bones in the transverse section in the mid-shift region in Plate 8B.

The response to inoculation is shown in Plate 9. In embedded sections the oil droplets produced a negative image; the alcohol treatment during staining procedures dissolved the oil of the vehicle (Plate 9: A and B). A large mantle of neutrophil leukocytes surrounded these droplets (Plate 9: A and B). Many of these neutrophil leukocytes were necrotic. A pronounced edema with frequent admixture of neutrophil leukocytes occurred in the sub-cutous (Plate 9: B and C) as did soft tissue necrosis. The necrotic tissue sometimes dissolved with formation of cysts.

Bones in immediate juxtaposition to these processes showed extensive necrosis (Plates 9: C and D and 10; A and B). Remnants of still visible bone were surrounded by edema and a large number of neutrophil leukocytes.

The articular cartilage appeared to be more resistant but was sometimes destroyed (Plate 10: A). The periosteum was remarkably resistant to the necrotizing processes and reactive bone formation. The periosteum, was a prominent feature even with advanced osteonecrosis (Plates 9: C and 10: B).

The degree of involvement of the tibia and tarsal bones in a ground control is shown in Plate 11: A.

The morphology of the left tibio-tarsal region was qualitatively similar to that of the right side with the obvious exception of the absence of oil droplets.

The morphology of the right limb of the arthritic flight rats was the same in the ground controls. The response in the left limb did not differ histologically with that of the ground controls (Plates 11, 12, 13 and 14). It is noteworthy that the lesions in the left distal femur occurred in one of the three arthritic flight rats but in none of the ground controls.

VI. Discussion

The sponsorship and flight of this experiment is just one example of the NASA/NSTA Shuttle Student Involvement Project. The program is designed to spur interest in sciences among the nation's youth and increase the quality of science education within the nation's high schools. The program encourages students to design small scale experiments suitable for inclusion aboard a Space Shuttle mission. Several thousand experiments are proposed each year, out of which ten projects are selected as national winners. This project was among the first group of national winners (1980-81) and was unique because two corporate sponsors were required (Pfizer Inc. for science and General Dynamics for hardware development). Several years and much involvement with numerous individuals in industry, academics, and NASA were required to assure a successful flight of this experiment.

The objective of "The Effects of Weightlessness on Arthritis" was to record the effects of zero-gravity environment on the development of adjuvant-induced arthritis in rats. The experiment was initially based on the hypothesis that people with arthritis find relief by swimming and undergoing hydrotherapy. The problem with this form of therapy is that it can only be done in limited time intervals. The extended length of time in a weightless environment is what made the Shuttle conducive for this project.

Three series of pre-flight experiments were included in the project. The first series established baseline arthritis data in ground-based SFF Lewis rats, the second series of studies used the "head-down" rat model to determine whether unloading and a cephalad fluid shift might alter the progress of the arthritic disease, and the third series provided ground based data on environmental conditions on the Shuttle that could impact the disease process.

Series 1 (Baseline data)

This series of experiments were performed at Pfizer Inc. and were critical to define the time course of the disease. Paw volume, weight, skeletal changes, and behavior in arthritic rats were examined over a 49 day period. After injection of the adjuvant, the arthritic process developed very similar to that reported in the literature (6, 7, 8, 9). Onset of local inflammation occurred immediately, whereas the systemic disease was not apparent until day 7 post-inoculation (Figure 1). Body mass of the arthritic rats declined steadily during a 22 day post-injection period (Figure 3). After losing 35 g, the rats gained an average of 55 g from days 22-49. These studies determined that future experiments attempting to alter the disease process should concentrate on the 7-16 day post-inoculation period when the secondary infection in the left hind paw becomes apparent.

Series 2 (Suspension studies)

This series of experiments provided data suggesting that the experimental hypothesis might be valid. Specifically, studies in which arthritic rats were suspended at NASA-Ames Research Center for periods of 7 or 16 days indicated that the head-down suspension inhibited expression of the systemic infection. It was hypothesized at the time that either the unloading of the joints and/or cephalad fluid shifts might be a factor in the inhibition of the disease process. In the first suspension study, paw measurements were performed with calipers on suspended and non-suspended rats at various times following the CFA injection (Figure 5, Table I). Non-suspended rats showed significantly more swelling than their suspended counterparts (Figure 5, Table I). A second experiment was conducted in order to confirm the data and to determine whether the difference was simply a delayed onset rather than a true suppression of the disease. In this experiment, paw circumference was measured with a calibrated tape. Significant differences in the inflammation of the left hind paws of suspended and non-suspended rats could be seen as early as day 13 post-

injection or after four days on the suspension apparatus (Figure 7). Rats suspended for 7 days showed no signs of systemic disease during the 13 day recovery period (Figure 7). It is important to note that the rats in these studies were fed with a normal Teklad L-356 diet and water *ad libitum*. Since potatoes were not used as a water source, it was not determined whether arthritic animals on the model would show inhibition of the systemic disease when given only potatoes as a water source.

Series 3 (Environmental Studies)

This series conducted at Pfizer Inc. resulted in data which sought to define how the environmental conditions on the Shuttle might affect the disease process. For technical and practical reasons, it was determined that the flight rats would recieve potatoes as a water source. Ground experiments indicated that the combination of potatoes and Teklad-356, from which NASA-Ames flight food bars are made, would not alter the normal course of the disease. Suspension studies were not conducted with potatoes and food bars, leaving open the possibility that rats abroad the Space Shuttle were unable to counter the disease as effectively as the suspended animals due to difficulty in grasping and using potatoes.

NASA required all rats flown aboard the Challenger to be gnotobiotic. Ground experiments showed that gnotobiotic rats and SPF rats contracted the disease with the same severity during the same time frame (Table III). The gnotobiotic rats in this study, however, were not housed in a completely germ free environment. Literature searches disclosed a report that gnotobiotic rats contract the disease at a slower rate than SPF animals (8). If true, then perhaps the flight experiment time frame should have been delayed a similar interval. The delayed onset of 14 days rather than the 10 days anticipated could have potentially impacted the data.

Series 4 (Flight)

The flight experiment consisted of 12 gnotobiotic rats with six back-up controls. Three of the nine arthritic gnotobiotobiotic rats flew aboard the Challenger while the remaining six arthritic animals were ground controls. Three of the nine healthy gnotobiotics flew aboard the Shuttle with the remaining six healthy animals serving as ground controls. Ground controls were housed either in a flight simulation unit or colony cages. Those animals in the colony cages were handled and videotaped during the mission so that a time-course of the disease could be obtained (Figure 10).

The immediate assessment of the flight animals at Kennedy Space Center within 90 minutes of landing showed no significant differences between flight and ground control animals in either body mass or paw thickness (Figures 8, 9; Table IV, V). Specifically, the healthy flight animals gained weight in a manner anticipated based on the performance of the ground controls; and the arthritics lost weight comparabele to that seen in the ground controls. furthermore, in the latter group, the progression of the swelling in both hind paws of the flight and ground, were comparable.

In spite of the immediate post-flight results, important observations made by the astronauts, Dr. McNair in particular, indicated that the flight animals appeared to be in far better condition with regard to the spread of the arthritic lesion than animals he had observed earlier under 1 g conditions at Johnson Space Center.

In addition, food consumption data indicated that the normal flight animals ate significantly more food and potato and gained more weight than their earth bound counterparts. One possible explanation for these observations may be that the rats in flight might have been more comfortable than the ground controls. Alternatively, the increased potato consumption might have been due to dehydration of the animals as indicated by the postflight locomotor lick data (Table VII). If the latter possibility is indeed

correct, it may have had an adverse effect on the ability of arthritic rats to counteract the onset of the disease. Interestingly, arthritic flight rats drank more water in the 2 hour post-landing period at Hanger L (35 ml vs. 15 ml for normal flight rats, 10 ml for arthritic flight controls, 20 ml for colony-housed arthritics, and 25 ml for both groups of normal ground controls).

Another potential problem illucidated by the daily systematic visual examinations of the flight animals by Dr. McNair showed that the animals clearly had not followed expected circadian rhythms. This phenomenon was observed even though the animals had been deliberately adapted to the light/dark cycle anticipated aboard the Shuttle during flight. This environmental stress may have a bearing as well on the rats' ability to alter the progression of the disease.

Video documentation was obtained by Dr. McNair several times during the flight. However, because of the unexpected problem of the circadian rhythms noted in these animals, clear conclusions on the rats' behavior cannot be made at this time.

Post-flight assessment of the flight and ground control animals conducted at Pfizer Inc. with regard to relative weight and paw volume reveal the same trends as those obtained immediately after flight (Table IX). Furthermore, hematologic studies of the circulated lymphoid cell populations reinforces the fact that there were no differences between the healthy flight and control rats and the space and ground arthritics (Table VIII).

Further quantitative assessment of the animal's behavior was conducted at Pfizer Inc. for 24 hours beginning 12 hrs after re-entry. The flight arthritics did not behave in a manner similar to their healthy counterparts (Table VII). The overall relative behavior of all the animals in the study indicated that they were extremely exhausted. This might be expected considering the Shuttle landing and 1 g load, the 8 day flight portion of the experiment, the previous hours of travel from KSC to Pfizer Inc., and the experimental

manipulations performed at KSC and Pfizer Inc. Such exhaustion may have contributed to the unexpected sensitivity of the animals to anethesia, during which 2 of the healthy flight controls expired, prior to taking of X-rays.

Histological studies also indicated that there were no significant differences in bone and joint structure between the flight and ground control healthy and arthritic animals (Plates 1-15).

Arthritis remains one of the major widespread diseases that still baffles the scientific and medical world. Our research indicates that either unloading of the joints and/or a cephalad fluid shift might indeed impact the progression of the disease. Based on our findings it is recommended that further experimental work be conducted in the following three areas. First, studies should be conducted in 1 g conditions on the underlying changes in bone metabolism occurring in healthy and arthritic animals. Second, studies should be continued utilizing the "head-down" suspension model with arthritic and healthy animals fed with potatoes and food bars to determine the influence of potatoes as a water source on development of arthritis. Third, studies should be performed in a weightless environment with animals subjected to a constant light/dark cycle and an appropriate time period for the onset of the disease. If gnotobiotic rats are to be used, it is imperative that they be used for ground-based experiments and kept gnotobiotic throughout the experiments. The preflight manipulations and time of launch should be based on the data from these additional experiments. We would expect that under optimal conditions, rats housed in a weightless environment will show fewer signs of a secondary lesion, duplicating the results described here achieved in the two "head-down" suspension studies.

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TABLE I

WEIGHT, gm

DATE: GROUP n	7/9	7/12	7/14	7/15	7/19	7/21	7/23
AC 7	210 ± 6.9	209 ± 5.9	211 ± 4.8	213 ± 4.7	216 ± 7.8	202 ± 8.4	211 ± 7.8
AU 7	211 ± 7.6	212 ± 8.3	210 ± 11.5	215 ± 10.2	219 ± 14.1	215 ± 11.2	213 ± 10.3

	INJECTED PAW (right)					NON-INJECTED PAW (left)				
DATE: GROUP n	7/13	7/15	7/19	7/21	7/23	7/13	7/15	7/19	7/21	7/23
AC 7	329 ± 26.7	312 ± 24.1	316 ± 28.8	346 ± 42.0	373 ± 26.9	167 ± 9.5	142 ± 4.9	158 ± 15.2	191 ± 6.9	221 ± 34.0
AU 7	357 ± 43.9	301 ± 44.5	317 ± 38.6	326 ± 41.6	361 ± 30.2	167 ± 22.1	144 ± 15.4	153 ± 7.0	156 ± 14.4*	179 ± 31.5*

Adjuvant injected: 7/10/82
Animals unweighted: 7/16/82
Experiment ended: 7/23/82

A = arthritic
C = control
U = unweighted
* = significantly different from control, p at least 0.05
Data expresses as mean ± S.D.

TABLE I. Data from the first suspension study conducted at Ames Research Center. Animals were suspended for a 7 day period from 76/16/82 - 7/23/82.

TABLE II.

Bone Deterioration Qualitative Analysis
(Scale: 0-10)

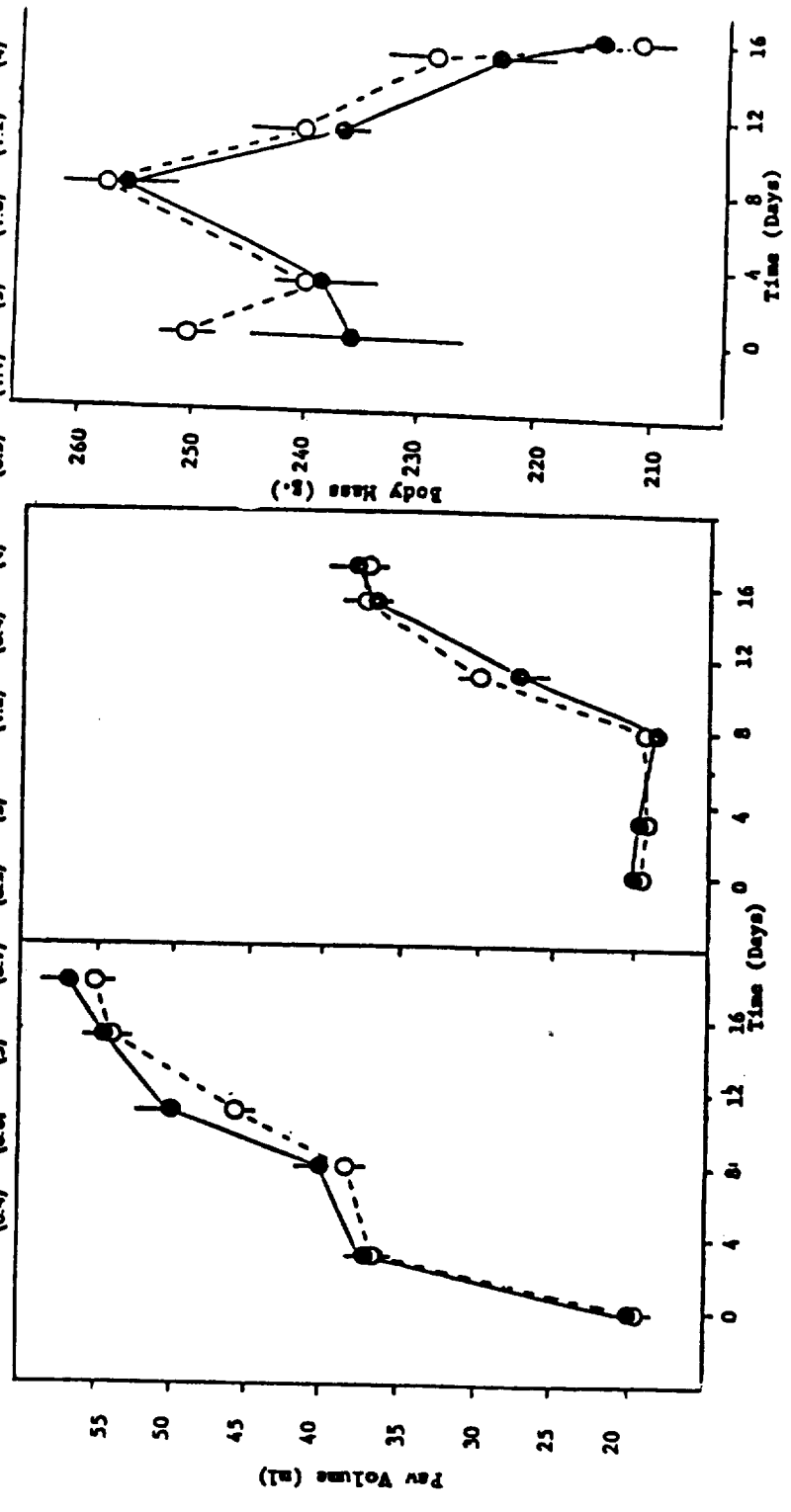
Time Post-Induction	Right	Left
32 Days		
Suspended	3.6 +/- 2.3	5.0 +/- 2.8
Recovery (1 week)	6.7 +/- 1.5	1.5 +/- 1.2
Control (single-housed)	5.4 +/- 2.3	7.8 +/- 2.2
Control (group-housed)	4.3 +/- 2.6	6.7 +/- 2.8
17 Days		
Recovery (0 days)	5.0 +/- 0.6	0.0 +/- 0.0
Control (single-housed)	5.2 +/- 0.8	0.0 +/- 0.0
9 Days		
Suspended	0.4 +/- 0.5	0.0 +/- 0.0
Recovery (-7 days)	0.5 +/- 0.6	0.0 +/- 0.0
Control (single-housed)	0.2 +/- 0.4	0.0 +/- 0.0
Control (group-housed)	0.4 +/- 0.5	0.0 +/- 0.0

** X-rays taken 32 days post-induction with Freund's Complete Adjuvant.

TABLE II. Qualitative bone analaysis on a scale of 0-10 of suspended (9 and 16 days) and non-suspended rats 32 days post-injection.

TABLE III. Paw volume and body mass of arthritic specific pathogen free and gnotobiotic rats over a 15 day period. Standard deviation in parenthesis.

DATE		10/10			10/13			10/18			10/21			10/25		
DAY		0			3			8			11			15		
MEASUREMENT		R	L	Wt.	R	L	Wt.	R	L	Wt.	R	L	Wt.	R	L	Wt.
N = 6																
I. Arthritic SPF		20 (0.3)	19 (0.4)	236 (11)	37 (1.3)	19 (0.4)	238 (5)	40 (1.9)	18 (0.5)	257 (4)	50 (2.5)	27 (1.4)	237 (3)	54 (1.3)	37 (0.8)	223 (5)
II. Arthritic Gnotobiotic		20 (0.4)	19 (0.6)	256 (3)	37 (0.7)	19 (0.5)	240 (3)	38 (1.2)	19 (0.4)	253 (4)	46 (0.9)	30 (1.1)	241 (5)	54 (1.6)	37 (1.2)	229 (4)



		Pre-Flight			Post-Flight		
GROUP	N	L	R	Wt.	L	R	Wt.
Healthy Flight	3	23 (1.0)	22 (1.0)	287 (2.0)	25 (1.0)	24 (1.0)	328 (3.0)
Arthritic Flight	3	23 (1.0)	41 (1.0)	236 (2.0)	38 (1.0)	48 (1.0)	204 (1.0)
Healthy Ground	3	23 (1.0	23 (0)	279 (8.0)	25 (1.0)	25 (1.0)	300 (11.0)
Arthritic Ground	3	23 (0)	41 (.10	254 (6.0)	36 (4.0)	47 (1.0)	216 (5.0)
Healthy Contingency	6	23 (1.0)	23 (1.0)	266 (38)	24 (1.0)	24 (1.0)	286 (33)
Arthritic Contingency	6	23 (0)	39 (1.0)	234 (24)	36 (3)	46 (1.0)	207 (19.0)

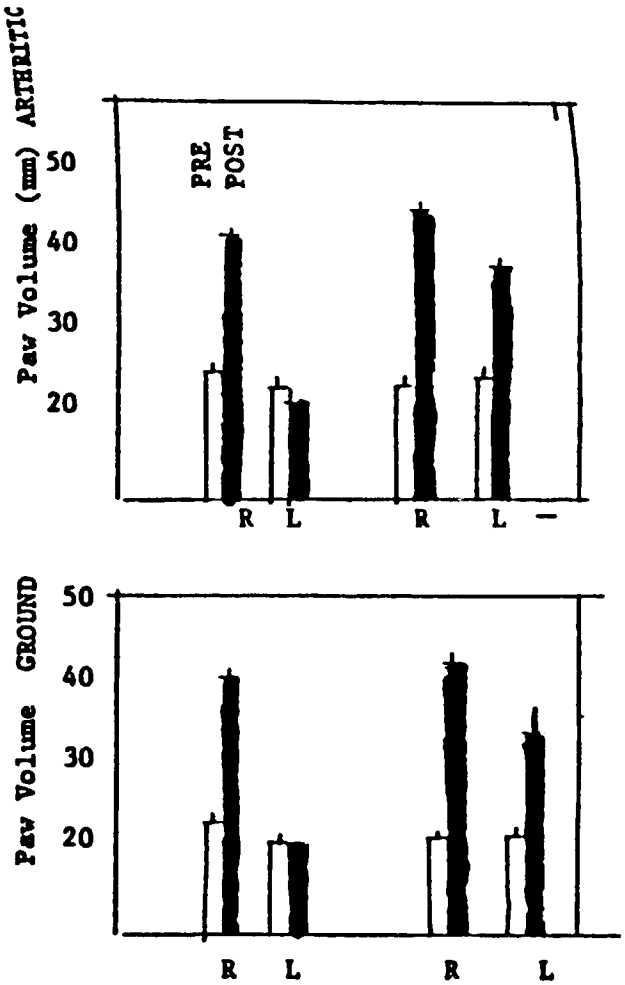


TABLE IV. Immediate pre-flight and post-flight paw volume and body mass data. Standard deviation in parenthesis.

TABLE V.

GROUP / FLIGHT:		DATE 2/2/84	DATE 2/11/84	CHANGE IN MASS
ARTHRITIC	1	232	203	-29
	2	236	205	-31
	3	240	204	-36
Mean +/- S.D.		204 +/- 1	236 +/- 4	-32 +/- 3.6
NORMAL	1	282	312	+30
	2	290	322	+32
	3	288	330	+42
Mean +/- S.D.		287 +/- 4.2	321 +/- 9	+35 +/- 6.4
GROUND CONTROLS:				
ARTHRITIC	1	254	226	-28*
	2	265	212	-53
	3	243	209	-39
Mean +/- S.D.		254 +/- 11	216 +/- 9	-40 +/- 12.5
Without A1:		254 +/- 15.6	211 +/- 2.1	-46 +/- 9.9
*A1 did not develop the systemic disease				
NORMAL	1	296	321	+25
	2	271	294	+23
	3	270	285	+15
Mean +/- S.D.		279 +/- 14.7	300 +/- 18.7	+21 +/- 5.3
BACK-UP RATS:				
ARTHRITIC	1	283	246	-37
	2	214	190	-24
	3	206	187	-19
Mean +/- S.D.		234 +/- 42.3	208 +/- 33.2	-27 +/- 9.3
NORMAL	1	341	351	+10
	2	238	261	+23
	3	218	245	+27
Mean +/- S.D.		266 +/- 66	286 +/- 57.7	+20 +/- 8.9

TABLE V. Body mass data from the flight experiment. Weight is in grams. Rats were weighed just prior to loading in the flight or ground unit. Weights were taken about 1300 EST pre-flight and 0930 post-flight.

TABLE VI. Food and potato and/or water consumption by rats during the flight experiment. Data for both pre-flight and post-flight periods are included. All data are expressed per group of 3 rats; numbers in parentheses are consumption for the experimental period whereas numbers not in parentheses are consumption in g or ml/day. Potatoes were placed in colony cages along with sterile water for a 3 day period prior to the day of loading the animals for launch; during the flight period, animals only had potatoes as a water source. Idaho potatoes were used for the flight and ground controls but Washington potatoes were used for the contingency rats; Ames food bars (Teklad diet L-356) were used during the flight and ground controls, during other periods and for contingency controls pelleted L-356 was used. Ground controls were palced in a ground-simulation cage which was identical in configuration to the Animal Enclosure Module interior but did not contain any electrical systems. Contingency rats were kept in colony cages; only these animals were handled during the flight period and every other day paw volumes, weights, and videotaping for 30 minutes were taken.

TABLE VI.

Potato Consumption (g/day/3 rats)
NOTE: Potatoes are about 70% water

ARTHRITIC	FLIGHT RATS	GROUND CONTROLS	BACK-UP CONTROLS
Pre-flight water (ml water/3 days)	85 (255)	90 (271)	85 (256)
Pre-flight potato (g/3 days)	35 (105)	30 (91)	37 (112)
Flight (g IN/g OUT in 8.5 days)	84 (1792/1081.3) ID potatoes	70 (1421/829) ID potatoes	59 (1603/1101.4) WA potatoes
NORMAL			
Pre-flight water (ml water/3 days)	57 (170)	50 (150)	68 (205)
Pre-flight potato (g/3 days)	104 (312)	116 (349)	100 (300)
Flight (g IN/g OUT in 8.5 days)	249 (2291/170.5)	145 (1669.6/439.6)	174 (1762.7/282.3)

FOOD CONSUMPTION (g/day/3 rats)

ARTHRITIC	FLIGHT RATS	GROUND CONTROLS	BACK-UP CONTROLS
Pre-flight (g/3 days)	36 (109.3)	35 (105.8)	29 (86.3)
Flight (g IN/g OUT in 8.5 days)	25 (810.7/601) Food bars	20 (364.7/192) Food bars	12 (261.5/157/3) Teklad L356
NORMAL			
Pre-flight water (ml water/3 days)	47 (139.8)	48 (143.1)	48 (143.9)
Flight (g IN/g out in 8.5 days)	63 (806.7/275)	34 (476/183.2)	30 (428.1/173.3)

TABLE VI. Food and Potato/Water Consumption Pre-Inflight for STS-41B.

Table VII

GROUP	N	X-OVERS	REARS	EATS	LICKS
Ground AA	2	0.5 (0.5)	0.5 (0.5)	0 (0)	0 (0)
Space AA	3	138 (3)	1 (1)	160900 (28354)	47314 (16566)
Ground Healthy	2	248 (67)	48 (29)	63905 (54044)	33329 (33329)
Space Healthy	3	220 (3)	23 (1)	45556 (6882)	94166 (15162)

Table VII. Locomotor Activity – 24 Hour Period Means (+/-SE)

Table VIII

GROUP	N	RBC ($x10^3$)	HAB (gm)	HCT (%)	Plat ($x10^3$)	WBC ($x10^3$)	Lym (L)	SEG (s)	4s
Healthy Flight	3	10.7 (0)	16.5 (0.2)	56.7 (0.1)	1008 (32)	7.1 (0.6)	87 (1)	12 (1)	7.1 (0.5)
Healthy Ground	3	10.2 (0.6)	16.1 (0.6)	54.7 (2.8)	835 (85)	5.7 (0.9)	84 (2)	16 (2)	5.8 (1.2)
Contingency (SPF)	6	9.3 (0.1)	14.5 (0.1)	48.8 (0.7)	738 (94)	7.4 (0.5)	87 (0.2)	12 (2)	7.6 (1.0)
Arthritic Flight	3	10.0 (0.3)	16.5 (0.2)	52.1 (1.9)	1265 (115)	27.2 (1.65)	45 (5)	53 (5)	0.9 (0.2)
Arthritic Ground	3	8.8 (0.2)	16.5 (0.2)	45.0 (0.8)	1006 (137)	25.3 (1.5)	44 (4)	55 (3)	0.8 (0.1)
AA Contingency (SPF)	3	8.5 (0.1)	16.5 (0.2)	42.9 (0.7)	1324 (49)	21.1 (0.1)	30 (3)	69 (3)	0.4 (0.1)
Normal Laboratory Range	6	7.2-9.8	14-17.5	38-52	—	4-12	—	—	—

Table VIII. Peripheral blood analysis of flight rats and ground controls 12 hours post-flight.

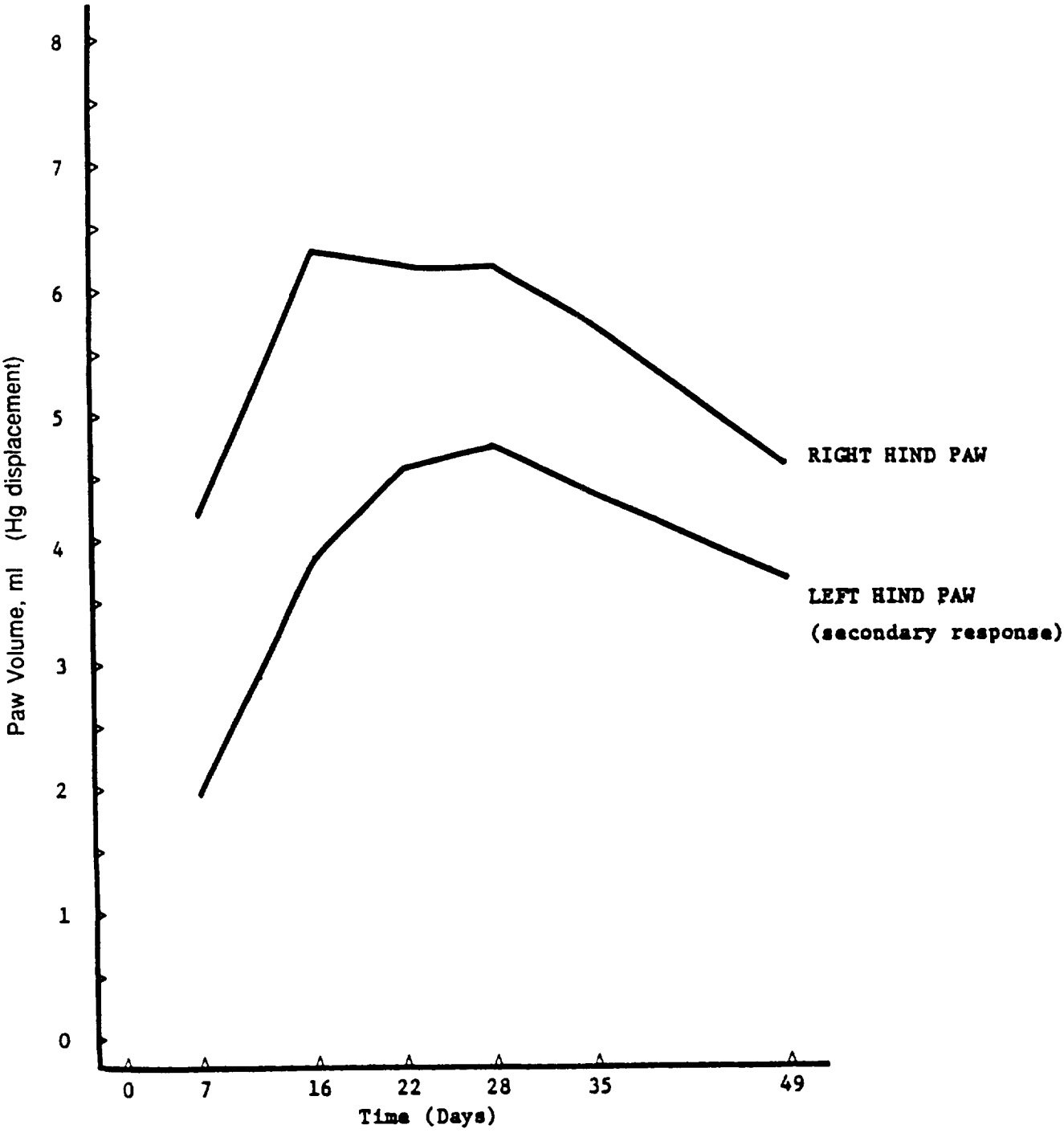


Figure 1. Paw volume of injected rats during a 49 day period. Arthritis was induced by a subplantar injection of 0.1 ml of complete Freund's adjuvant (CFA) into the right hindpaw.

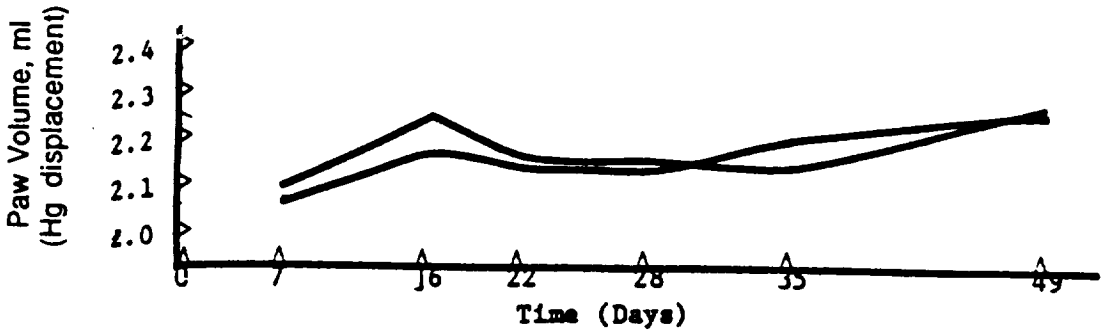


Figure 2. Paw volume of non-injected rats during a 49 day period.

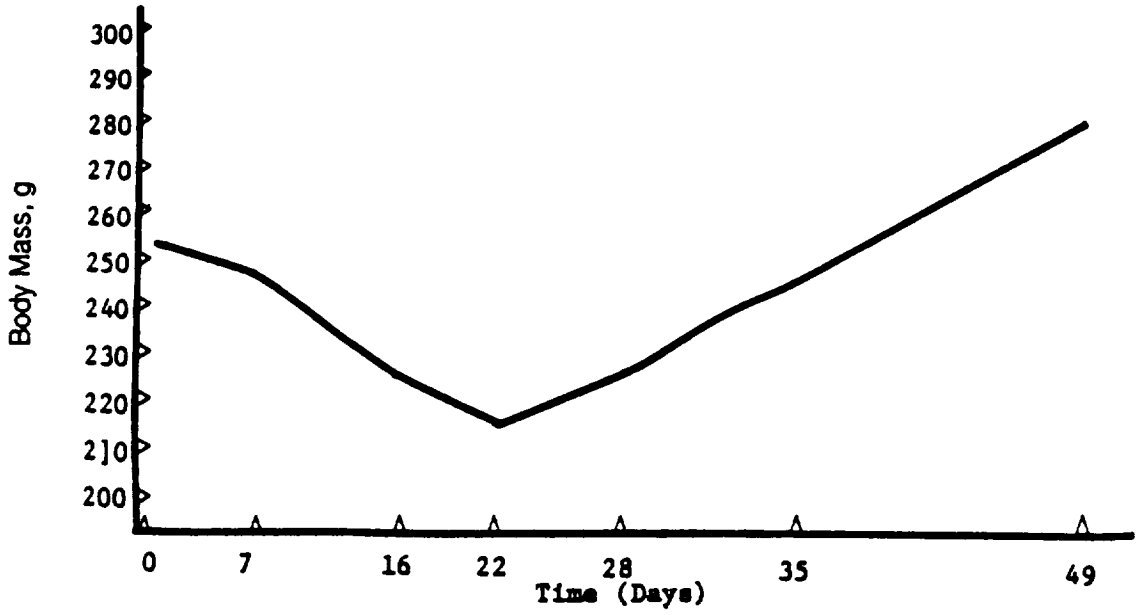


Figure 3. Body mass of injected rats during a 49 day period.

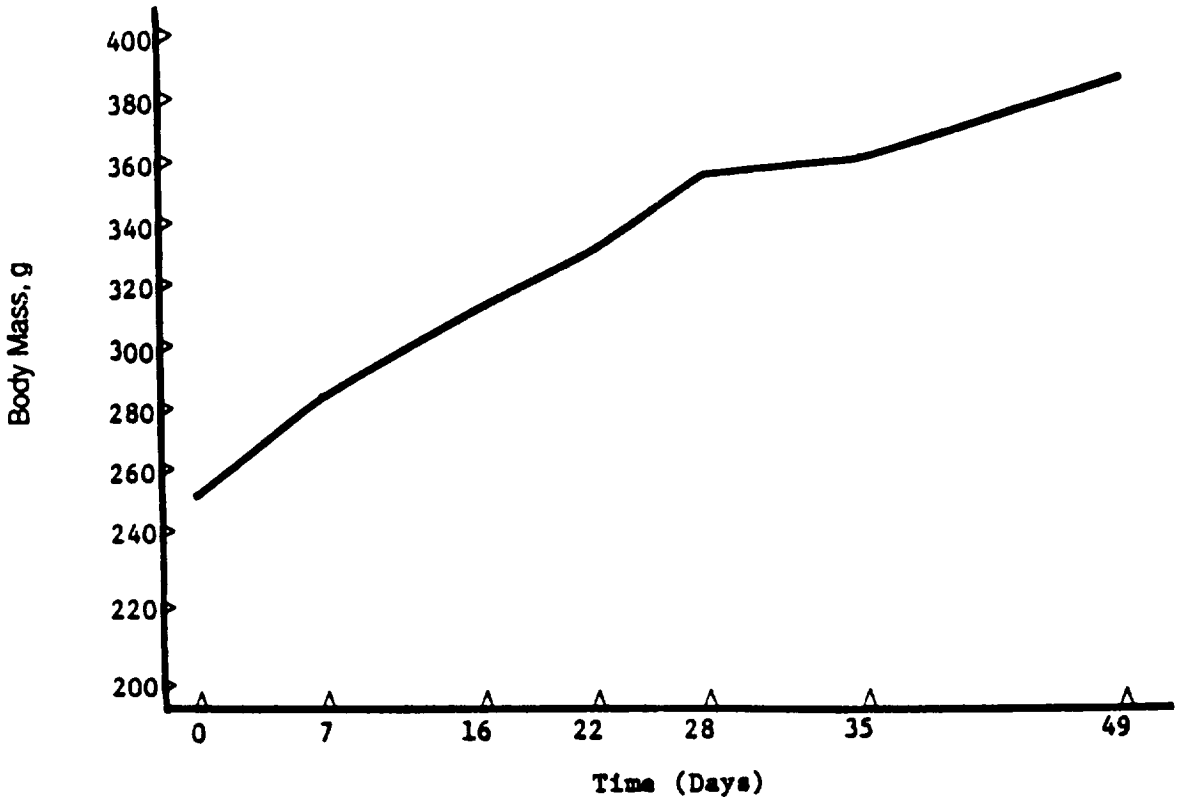


Figure 4. Body mass of non-injected rats during a 49 dav period.

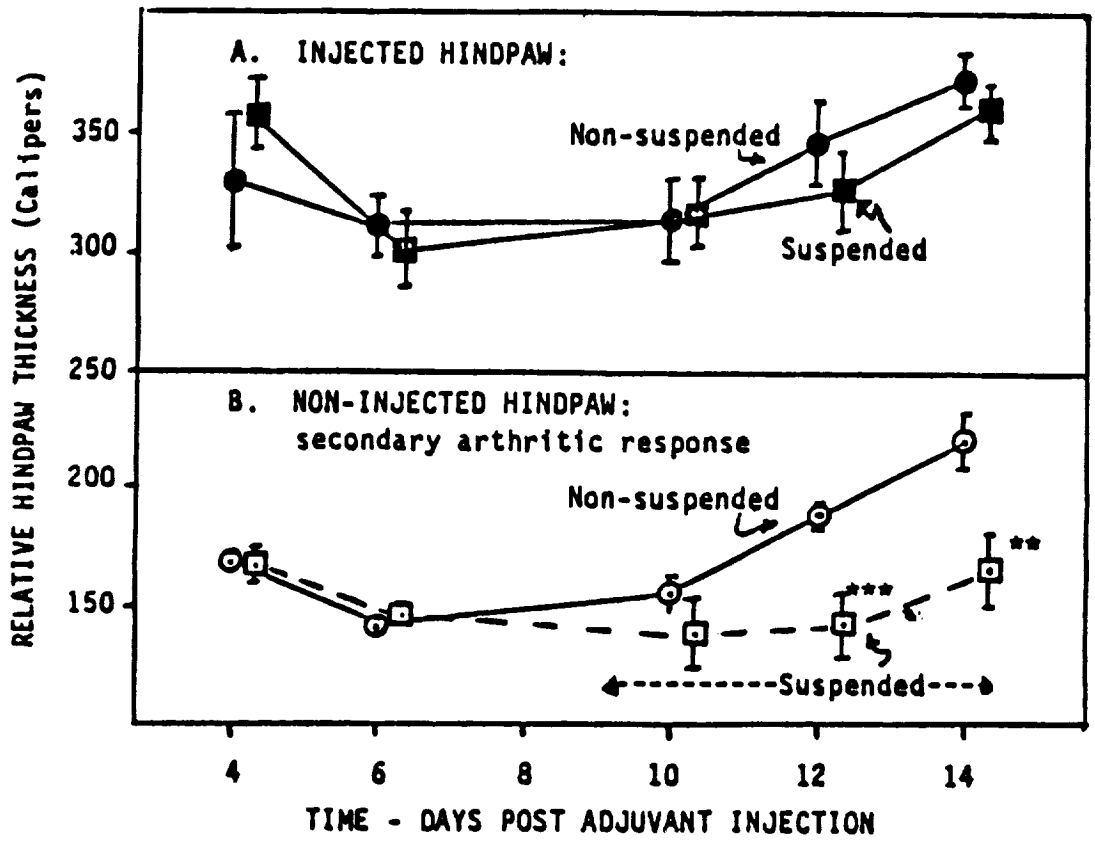


Figure 5. Hindpaw thickness of rats suspended for a seven day period (squares). Non-suspended rats (circles) served as controls. Measurements of hindpaw thickness were performed with calipers on rats from each group (N = 7 rats/group) at denoted times following CFA infection. Results are expressed as mean hindpaw thickness +/- standard error (X +/- SE) and significance was tested by the student's T-test (two-tailed) for non-paired data (** = $p < 0.05$; *** = $p < 0.001$).

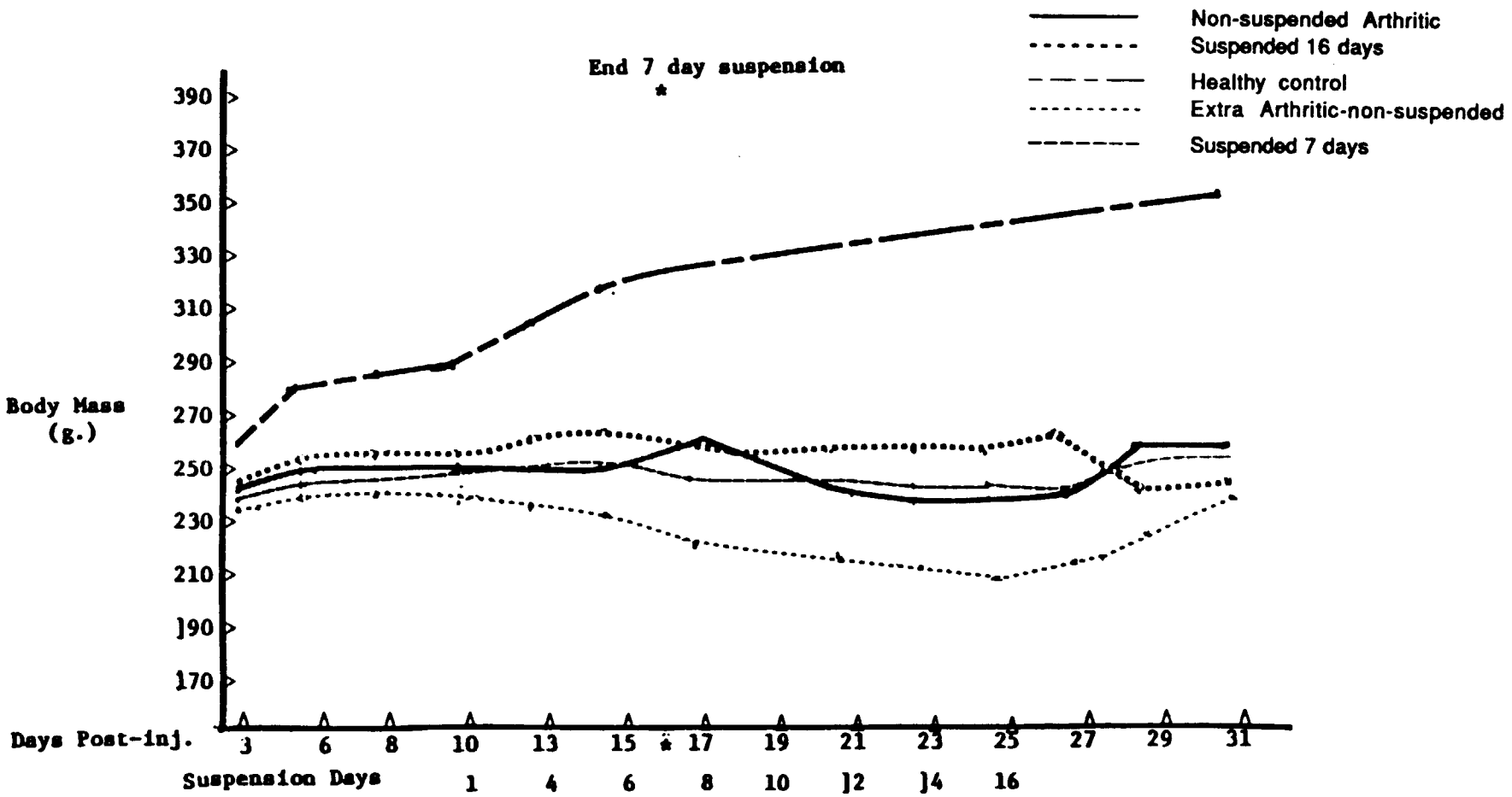


Figure 6. Body mass changes of rats involved in the second suspension study conducted at Ames Research Center. One group was suspended for a 7 day period and recovered for a 9 day period (see key). The other group was suspended for a 16 day period. Non-suspended arthritic and healthy animals are included for comparison.

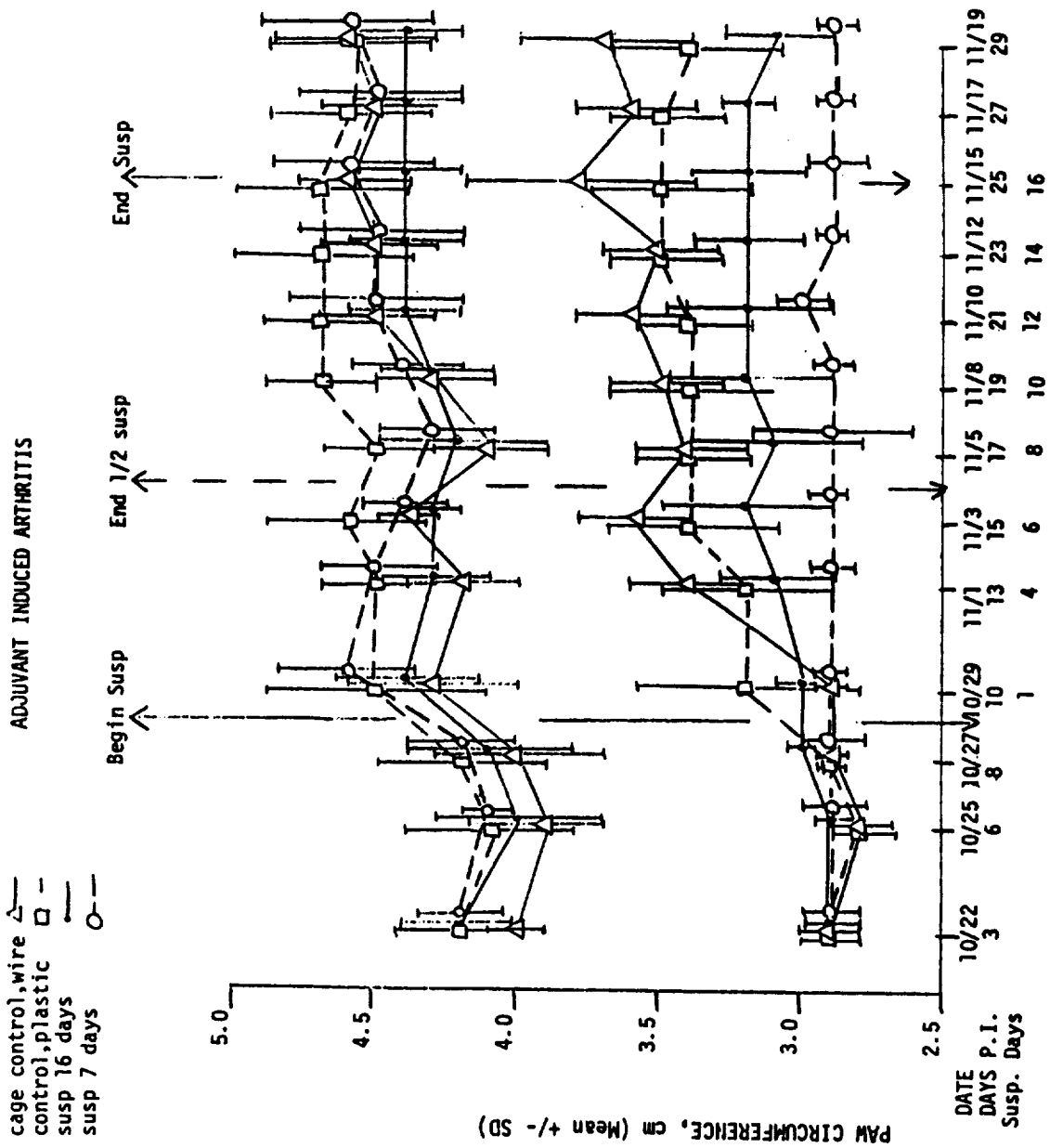


Figure 7. Paw circumference changes of rats involved in the second suspension study. Bars denote standard deviation.

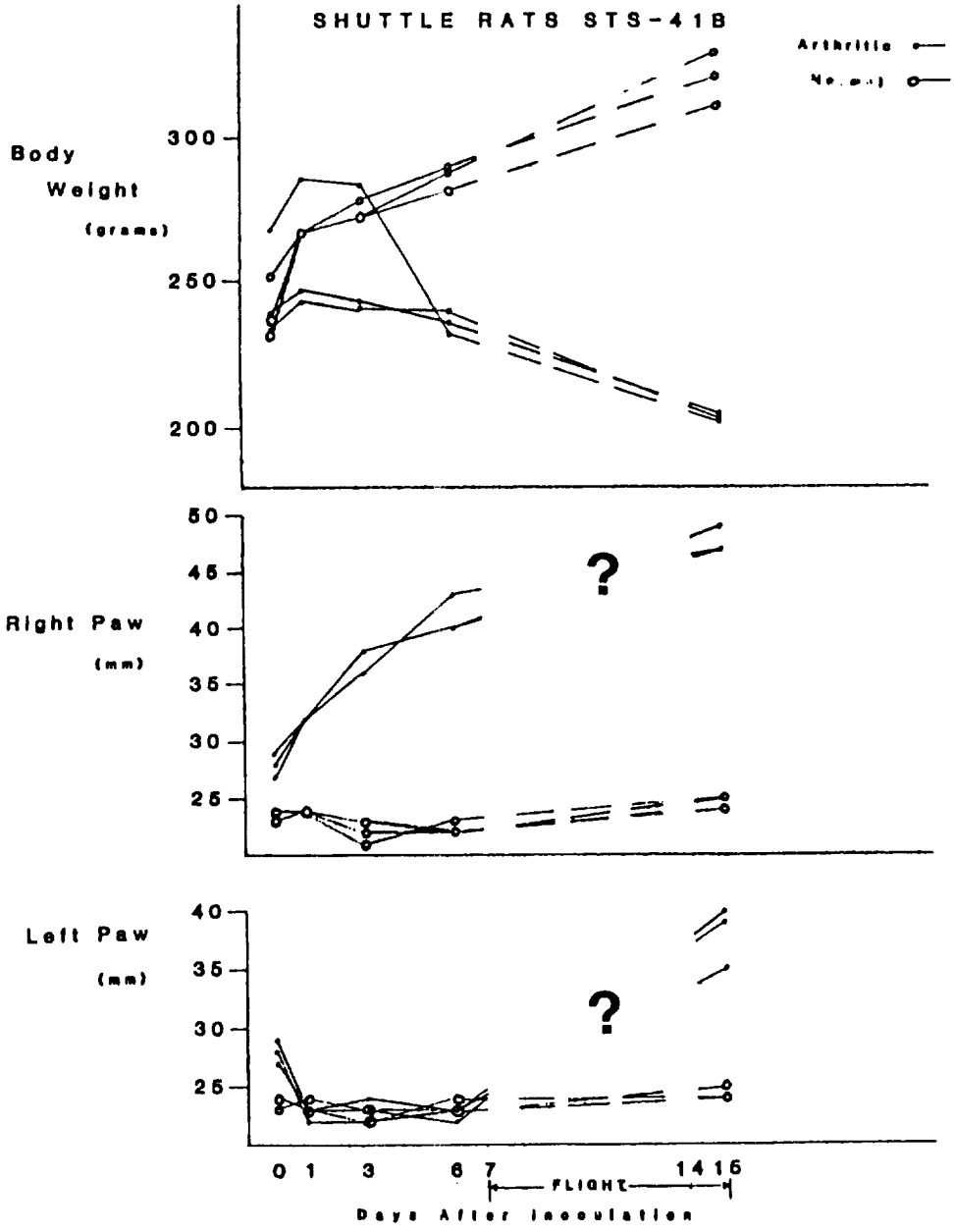


Figure 8. Body weight and paw volumes for flight animals. Rats were inoculated with complete Freund's adjuvant ,0.1 ml, subplantar, 7 days before flight. Paw volumes are actually paw circumference measured to the nearest mm with a cloth metric tape; the top of the tape was placed at the ankle joint. Arthritic animals are closed circles while normal controls are open circles.

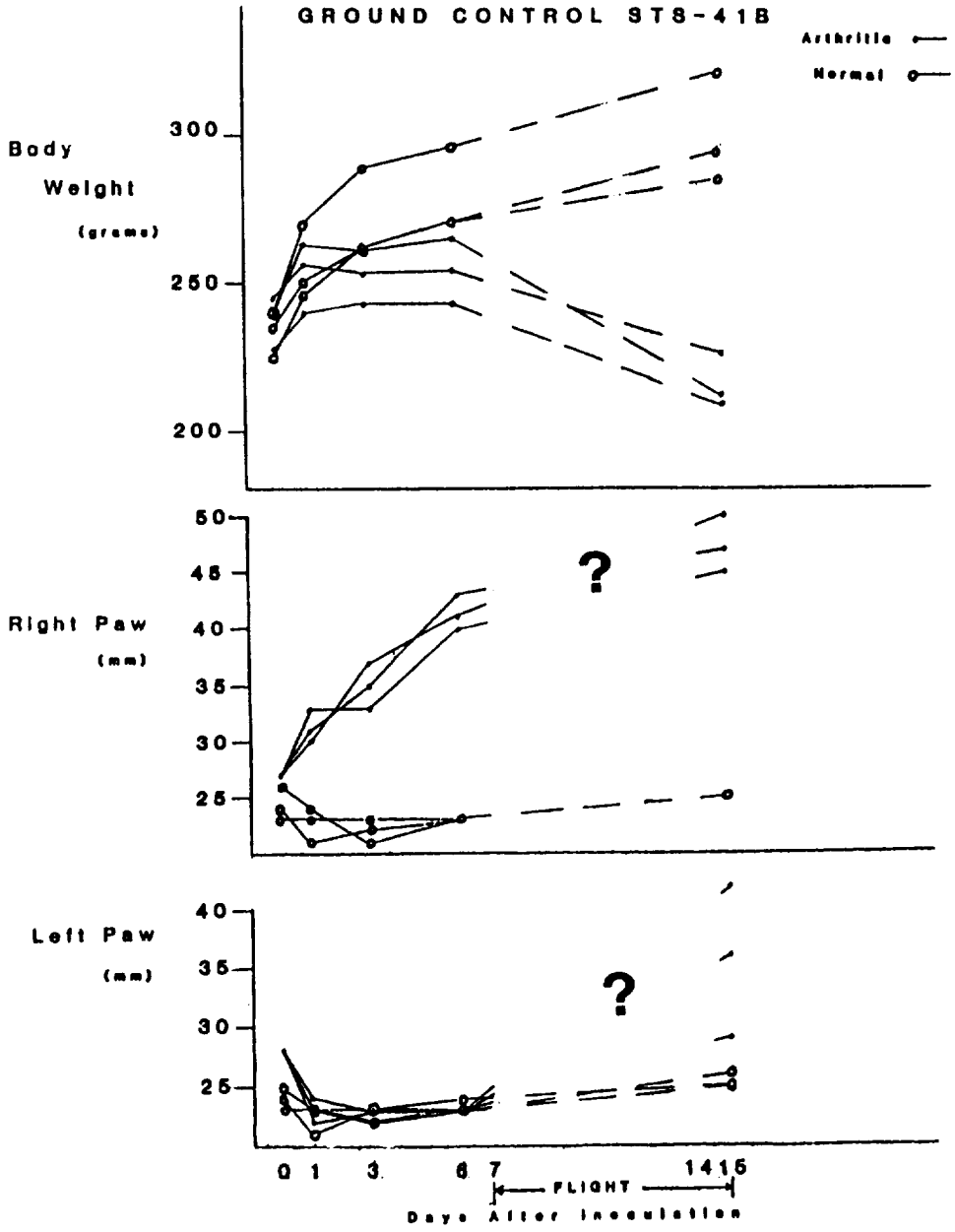


Figure 9. Body weight and paw volumes for ground control animals. See legend to Figure 8. Note that all arthritic animals lost weight and showed swelling of the right paw, but one rat did not show noticeable swelling in the left paw at the end of the flight period indicating a delayed onset of the systemic disease in this animal.

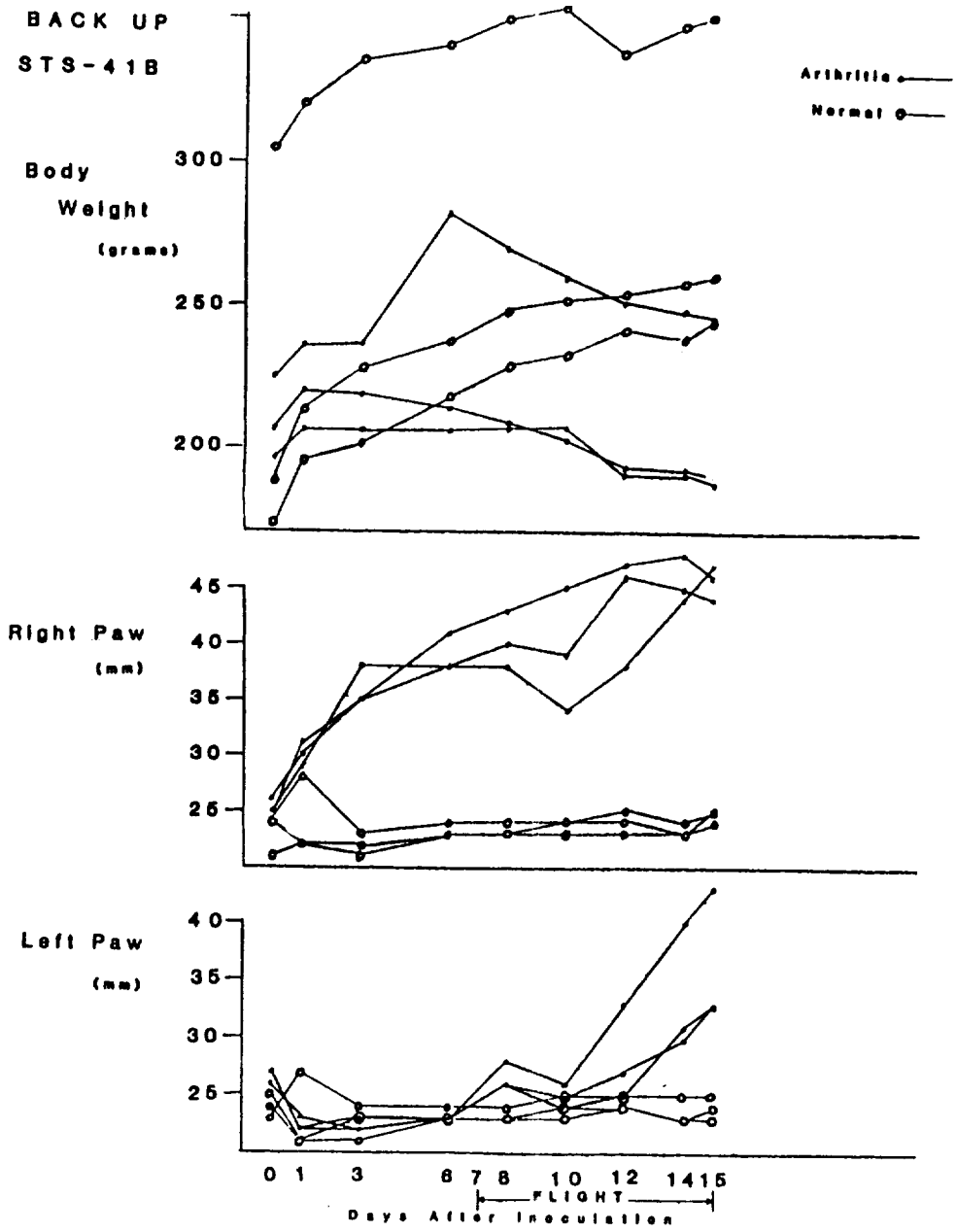


Figure 10. Body weight and paw volumes for the contingency animals. See legend to Figure 8. Note that the left paw circumference in 2 of 3 arthritic animals was not noticeably increased until the day before the flight ended.

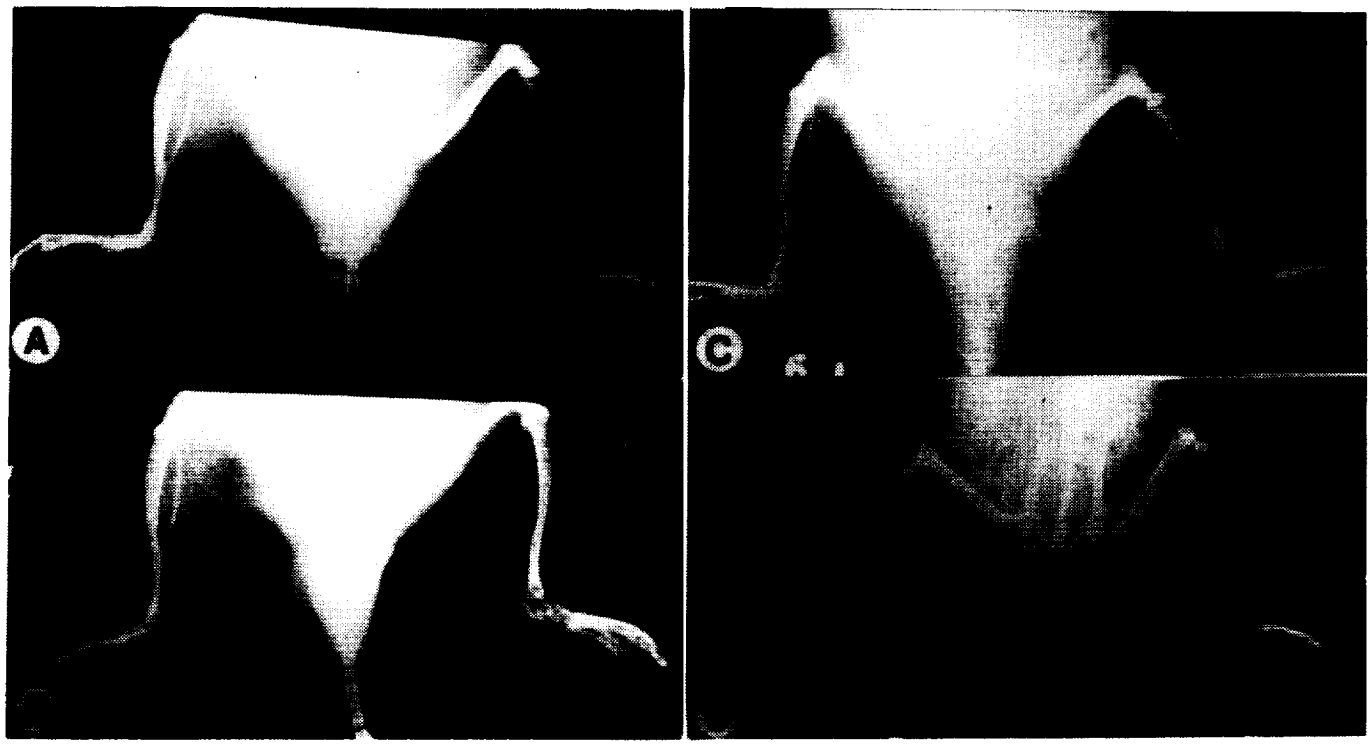


PLATE 1. Radiographs of pelvic limbs in ventral recumbency. All rats injected in the right paw 16 days previously. A and B were suspended from days 7-16; C and D non-suspended.

The lesions in the right tarsal region are comparable in all four rats with severe swelling and advanced destruction of bone. In the suspended rats (A and B) the swelling of the left tarsus is far less than that of the non-suspended rats (C and D). Bone destruction in suspended rats is mild (A) or absent (B) whereas it is moderate to pronounced in the non-suspended rats (C and D).

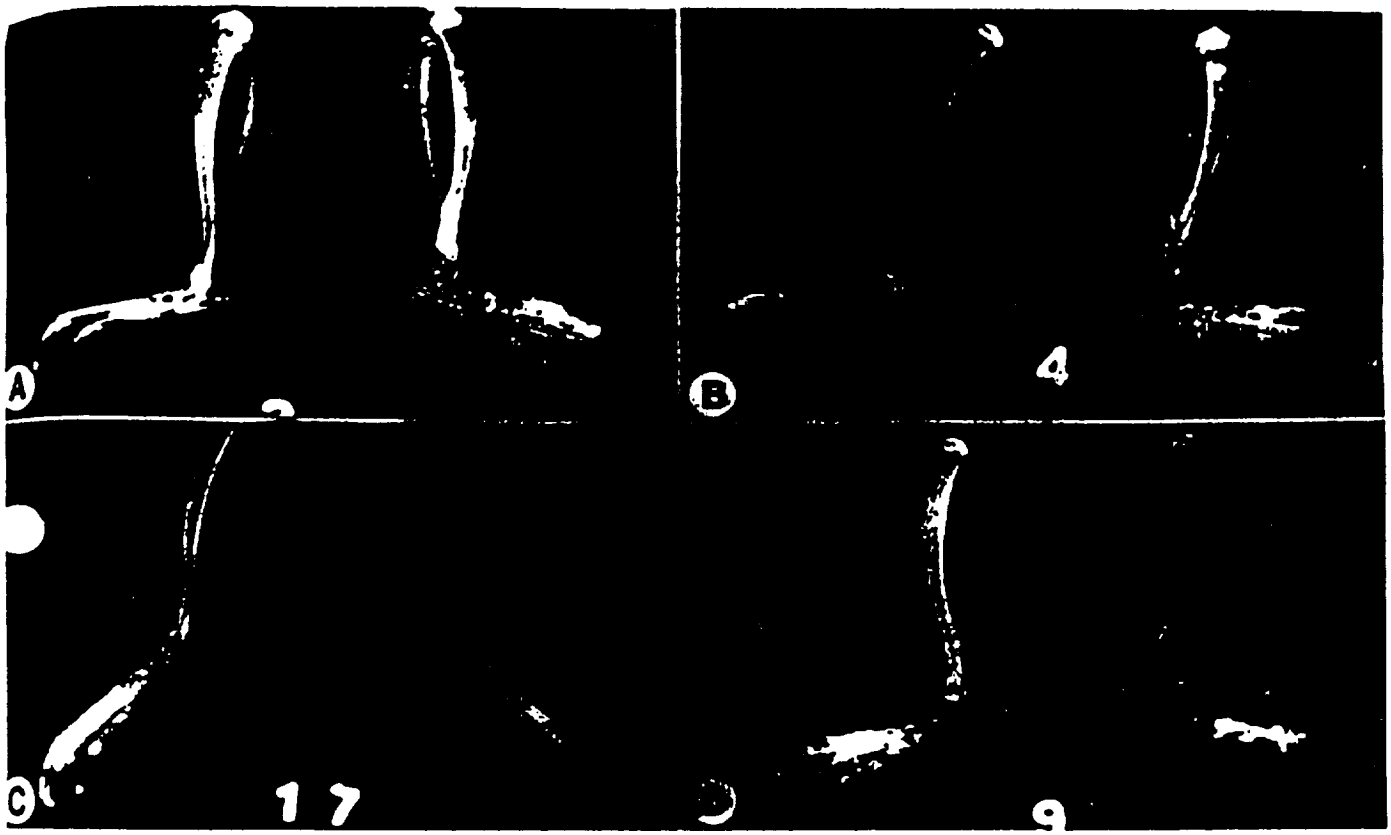


PLATE 2. Radiographs of the pelvic limbs in ventral recumbency. All rats were injected in the right paw 32 days previously. A and B were suspended during days 9-16; C and D were not suspended.

The lesions in the right leg are extremely severe and similar in all four rats. Notice that the destruction concerns the distal tibia, the entire tarsus and the proximal metatarsus (B and C) or almost entire metatarsus (A and D). In the left tarsus, the lesions in the non-suspended rats (C and D) are severe both concerning swelling and bone destruction; note in figure D that the bone destruction is almost as severe in the left as in the right side.

In the suspended rats, the degree of swelling is considerably less and the bone destruction is only mild.

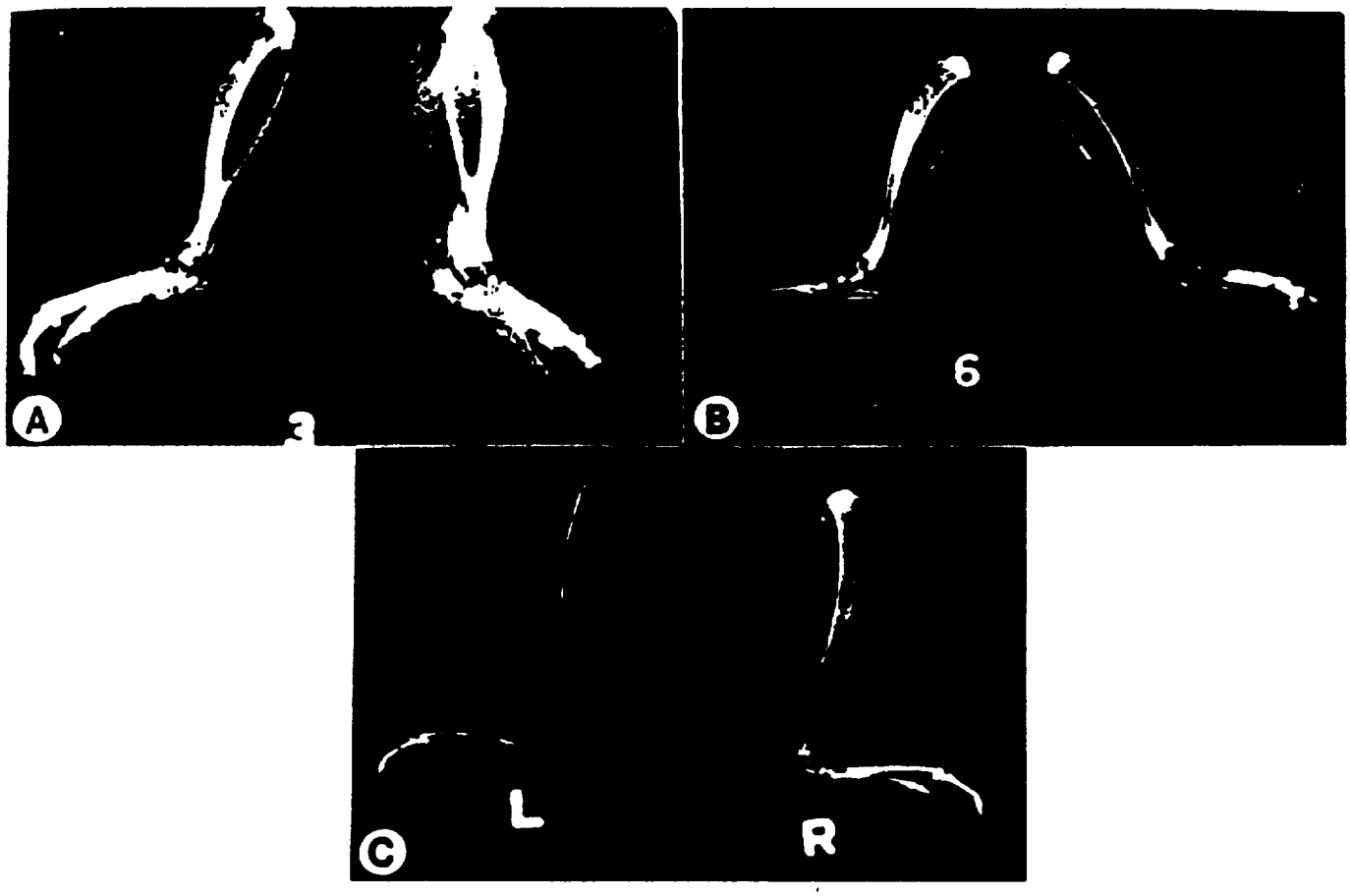


PLATE 3. Radiographs of the pelvic limbs in ventral recumbency. A and B were injected in the right paw 32 days previously. A and B were suspended from day 7-23 post-injection. C is a non-suspended healthy control.

In the right limb of A, the swelling is severe and the osseous destruction involves the distal tibia and in the entire tarsus and metatarsus. There is pronounced reactive bone formation around the distal tibia. In B, the swelling in the right limb is less pronounced than in A. The bone destruction concerns only the most distal part of the tibia, the entire tarsus, and the proximal quarter of the metatarsus.

The left limb of A shows pronounced swelling and moderate bone destruction. In B, the lesions in the left limb are far less pronounced concerning both swelling and bone destruction.

Figure C shows the normal radiographic morphology of the pelvic limbs.

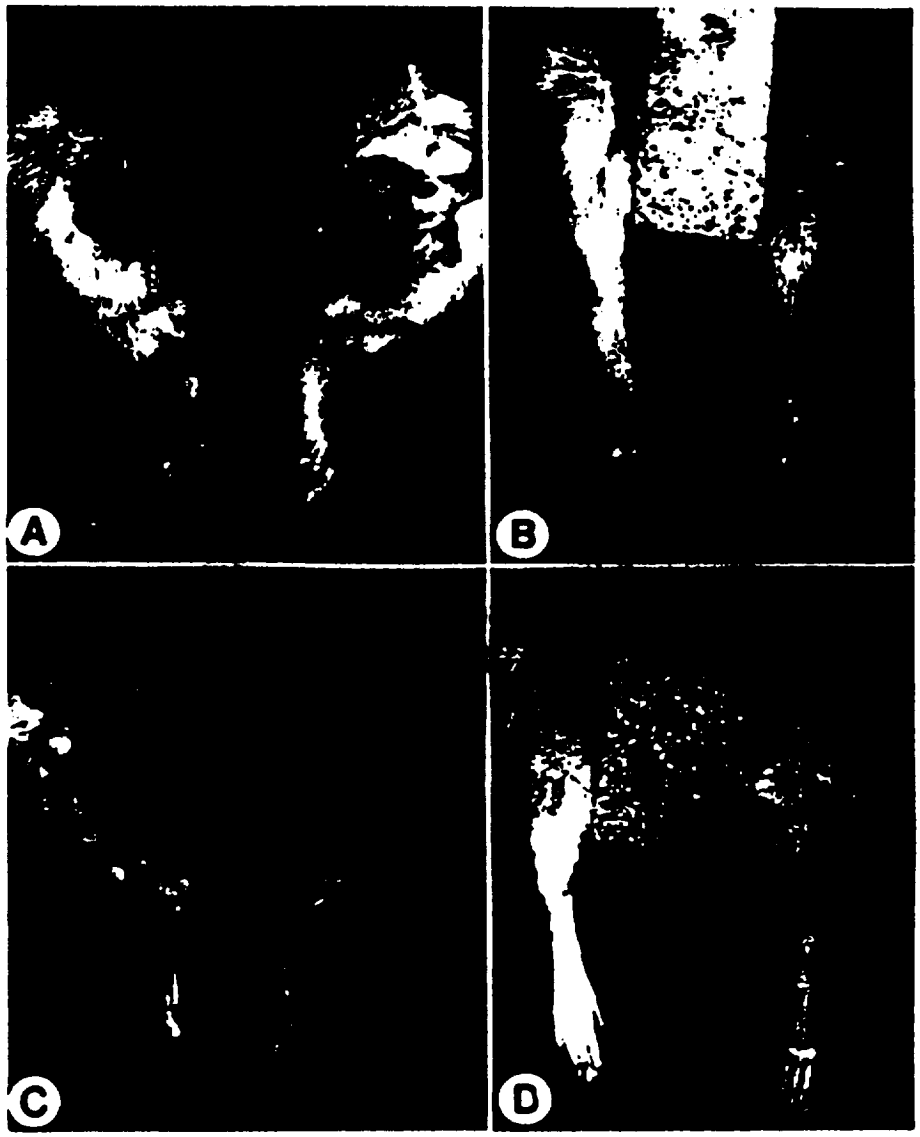


PLATE 4. Necropsy specimens of one arthritic flight (A and B) and one healthy flight control (C and D). A and C are from a medial view and B and D from a cranial view; therefore, the right leg is to the left in all pictures.

A and B show severe swelling of the right leg and moderate swelling of the left leg. C and D are normal.

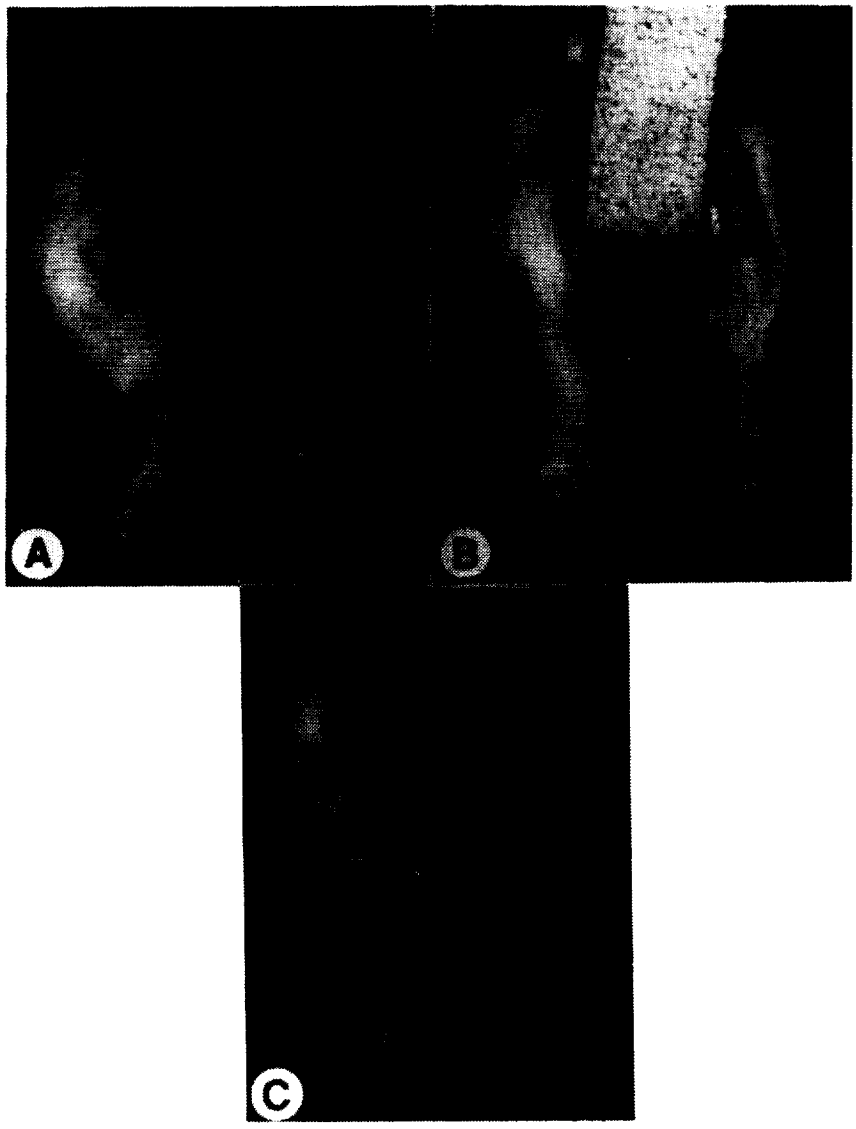


PLATE 5. Necropsy specimens of arthritic ground controls. A and B arranged as A and B in Plate 4; C is a caudal view.
The right leg shows severe swelling in both A and B. The left leg leg shows slightly milder swelling.

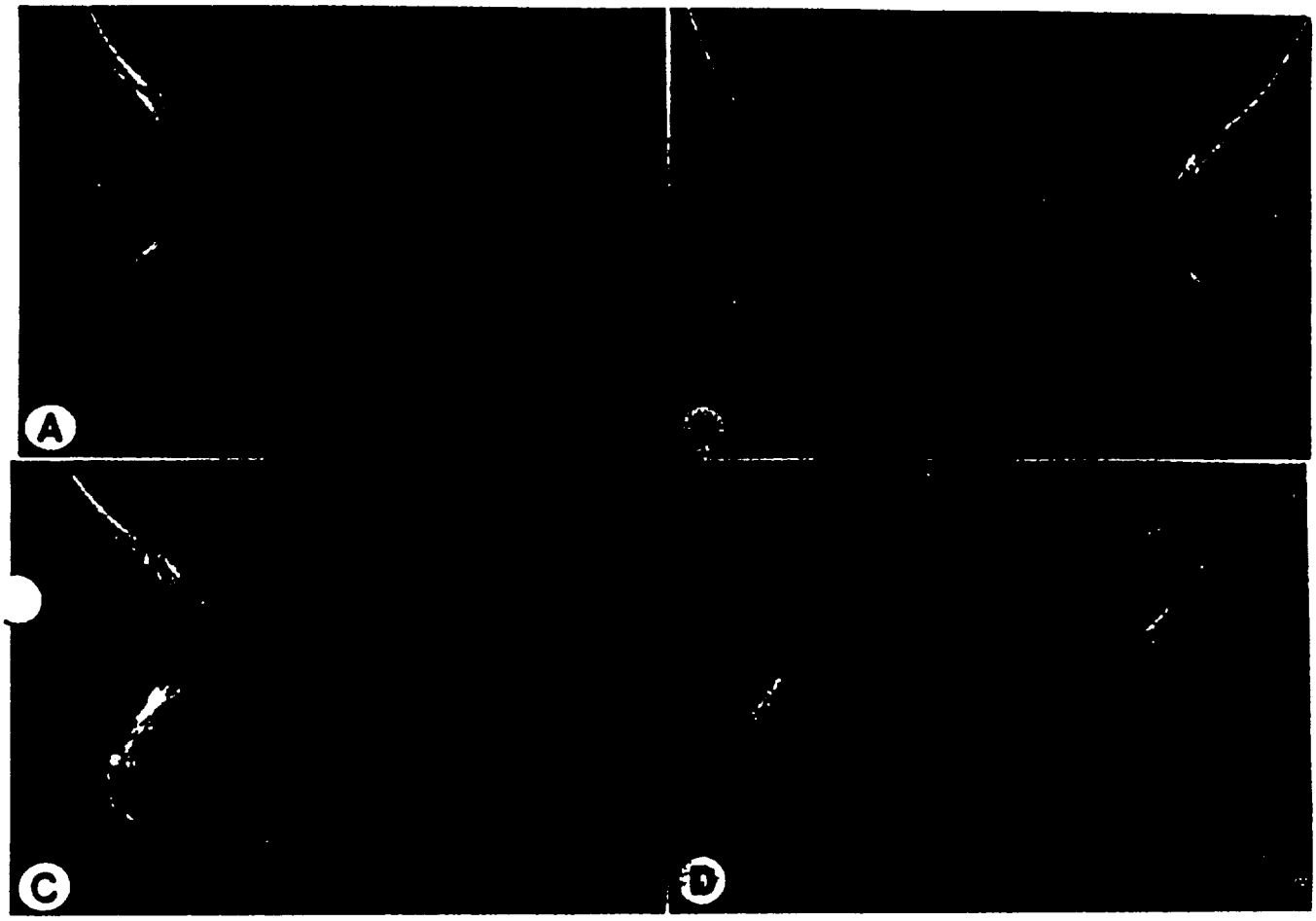


PLATE 6. Radiographs of the pelvic limbs of three arthritic flight animals (A,B and C) and one arthritic ground control (D). All rats were injected 23 days previously. A,B and C were exposed to zero gravity conditions aboard the Space Shuttle Challenger for a period of eight days, beginning seven days post-injection.

The lesion in the right limb (to the left in the plate) are of similar severity in all four cases, concerning both swelling and osseous destruction.

In A (left), there is minimal destruction on the distal tibia, whereas the tarsal bones, especially the fibular tarsal bone, is the site of severe destruction. This destruction involves also the proximal quarter of the metatarsus. B (left), whereas the swelling is of similar degree as in A (left), the osseous destruction is not as far advanced. The fibular tarsal bone is clearly visible as are the bones of the distal tibia row. There is no involvement of the metatarsus.

The lesser involvement of B (left) compared to A (left) is all the more remarkable since the bone destruction in B (right) is much more advanced than A (right). C (left) lesions are similar to those in B (left) but slightly more accentuated; note that the fibular tarsus bone is well defined but that the proximal end at the metatarsus bones are in early destruction. In D, the swelling is considerably more pronounced than in A,B and C. In D (left) the osseous destruction is comparable to that of B and C, but not as advanced as in A.

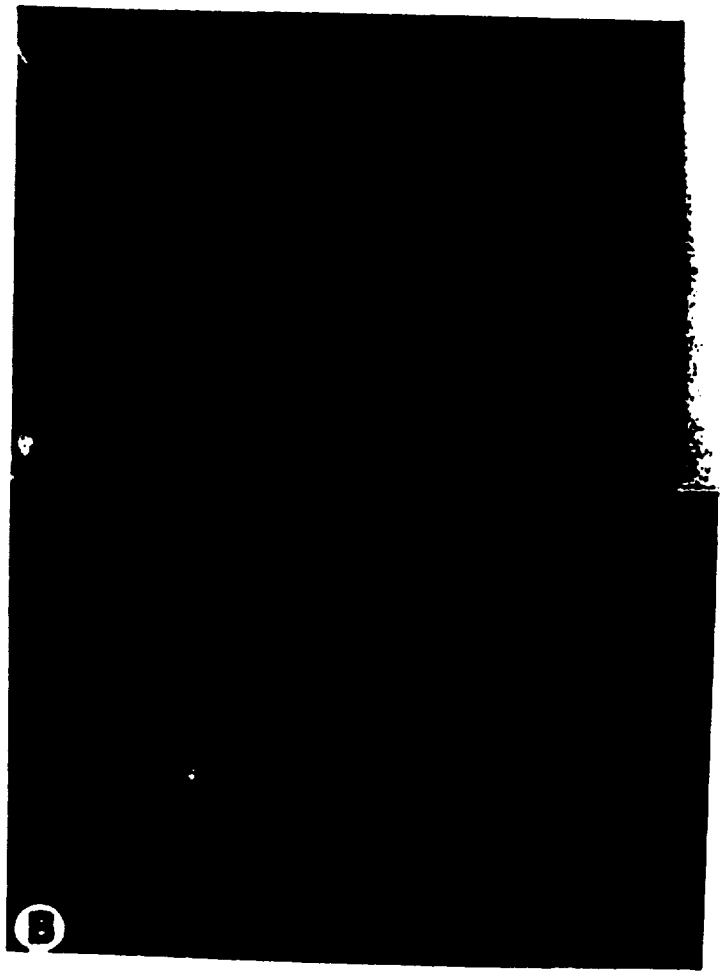
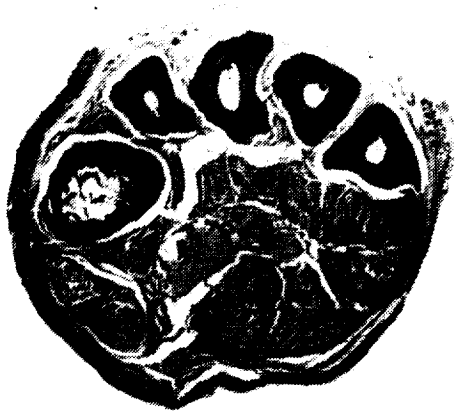


PLATE 7. Radiographs of one healthy flight animal (A) and one healthy ground control (B). Both specimens show normal radiographic architecture.

A



B

PLATE 8. (A) shows the normal anatomy of the tibio tarsal region. t = tibia, tt = tibio tarsal, ft = fibular tarsal bone. H+E 4.2.
(B) shows the normal anatomy of the mid-metatarsal region. H+E 7.8.

PLATE 9. (A) is from the subcutous. The negative space in the center is an oil droplet which is surrounded by neutrophil neutrocytes, many of which are necrotic. The periphery consists of necrotic and edemous tissue. H+E 450.

(B) shows the extent of sub-cutaneous edema and necrosis in reaction to the oil droplets with surrounding neutrophil neutrocytes. H+E 140.

In (C), skin (s) is on top of picture and oil droplets are indicated by arrows. (e) stands for edema in the sub-cutous. (n) is an area of necrosis undergoing cyst formation. Only fragments of bone (b) of the distal tibia remain and are surrounded by necrotic tissue. (r) indicates reactive bone formation by remaining periosteum. H+E 12.

(D) shows the tibio-tarsal bone. Almost the entire bone is necrotic. H+E 10.

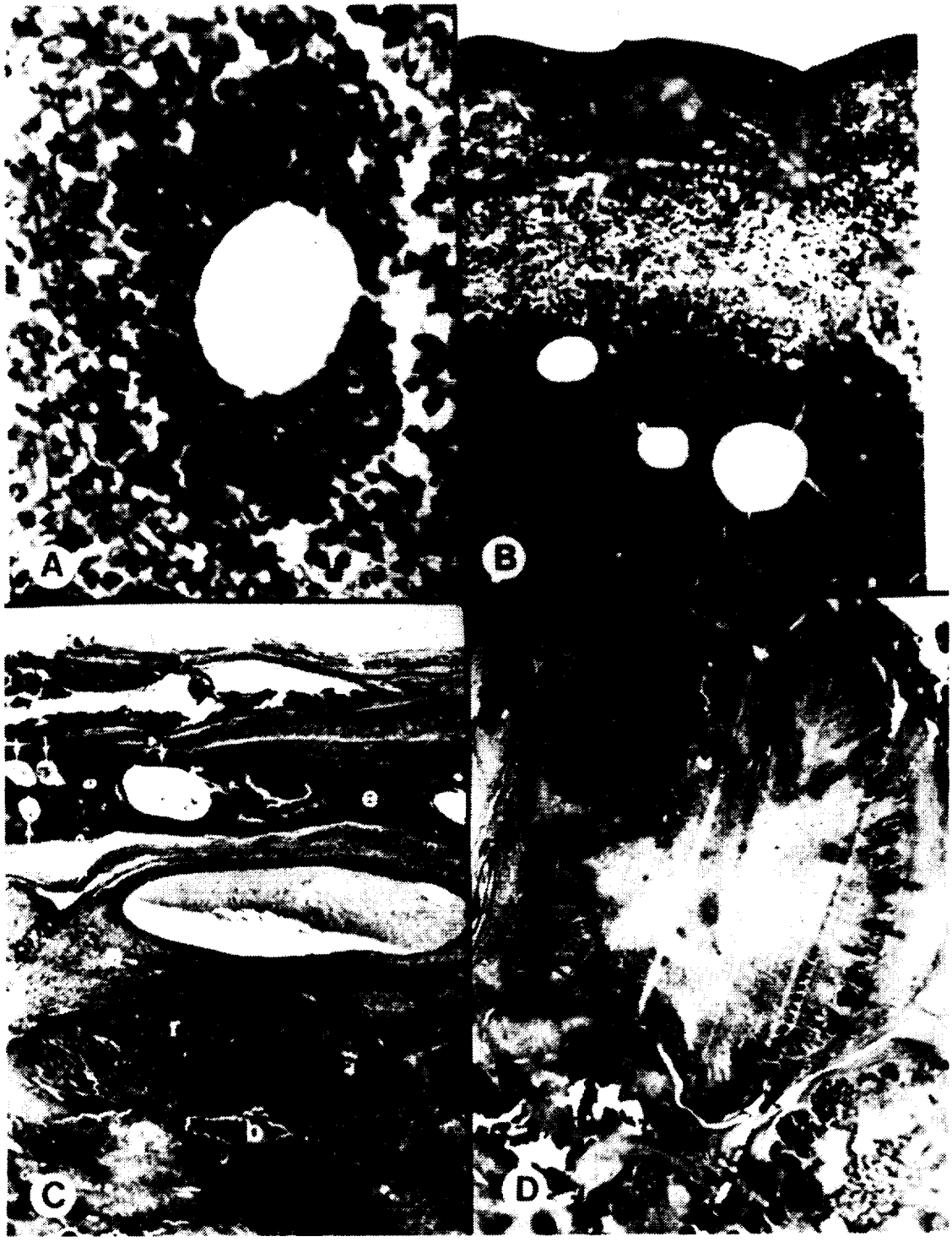


PLATE 10. In Figure A shows extremely severe necrosis of all bones. t = tibia, tt = tibio tarsal bone; arrows point towards joint space.

(B) shows the distal tibia. Only a fragment of the distal cortex (b) remains. This fragment is surrounded by neutrophil leukocytes. Normal tibial cortex begins distally at (t). The tissue surrounding the cortex is severely edematous (e). Reactive bone (r) is formed by elevated periosteum.

Figure C shows the distal femur with patella (p). gp = growth plate, m = bone marrow, c = corteces of the distal femur. (C) is normal.

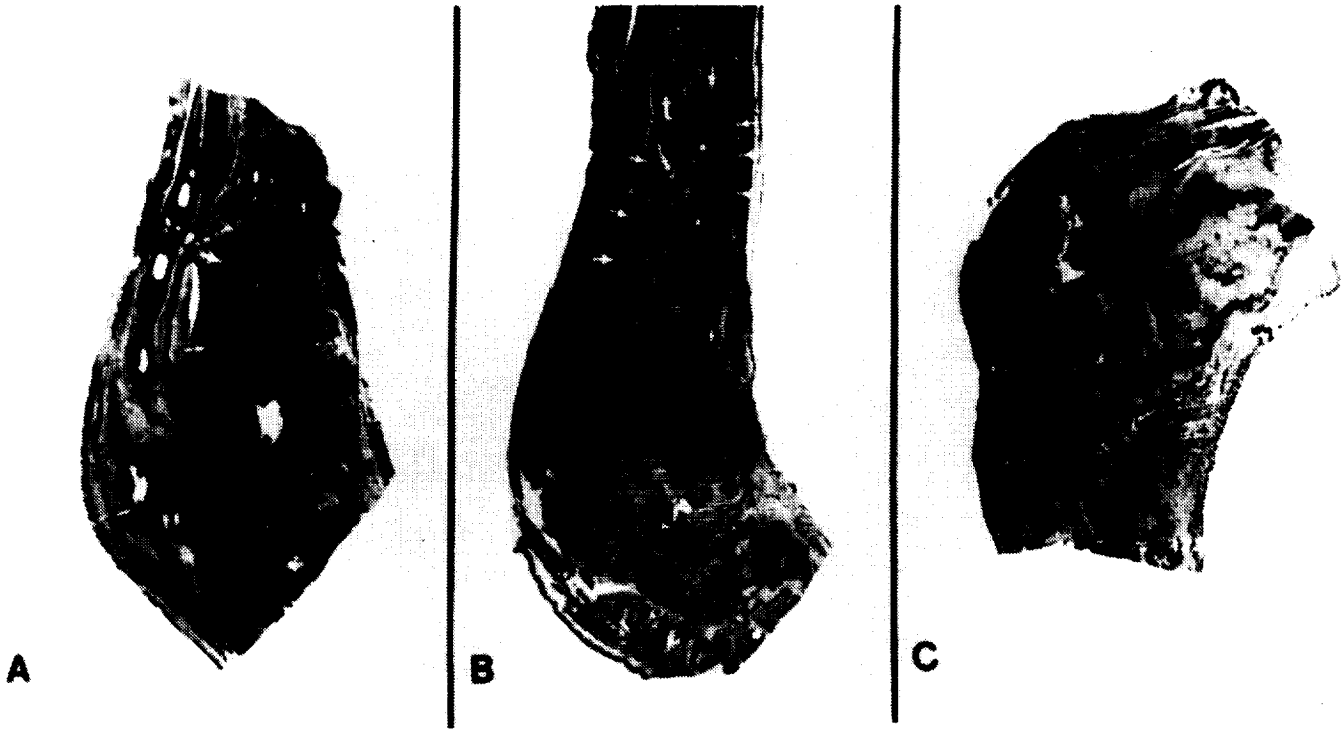


PLATE 11. Figure A is a low power (4.2X) photograph of the tibio tarsal segment showing various degrees fo osteonecrosis. The distal tibia is necrotic but the contours of the tarsal tibia (tt) and fibular tarsal are still present. In (B), the architecture of the entire hock and distal tibia is completely destroyed. The tibial cortex (t) is discernible only in the top of the picture. There is reactive bone formation at arrows. In Figure C, all bones are completely destroyed.

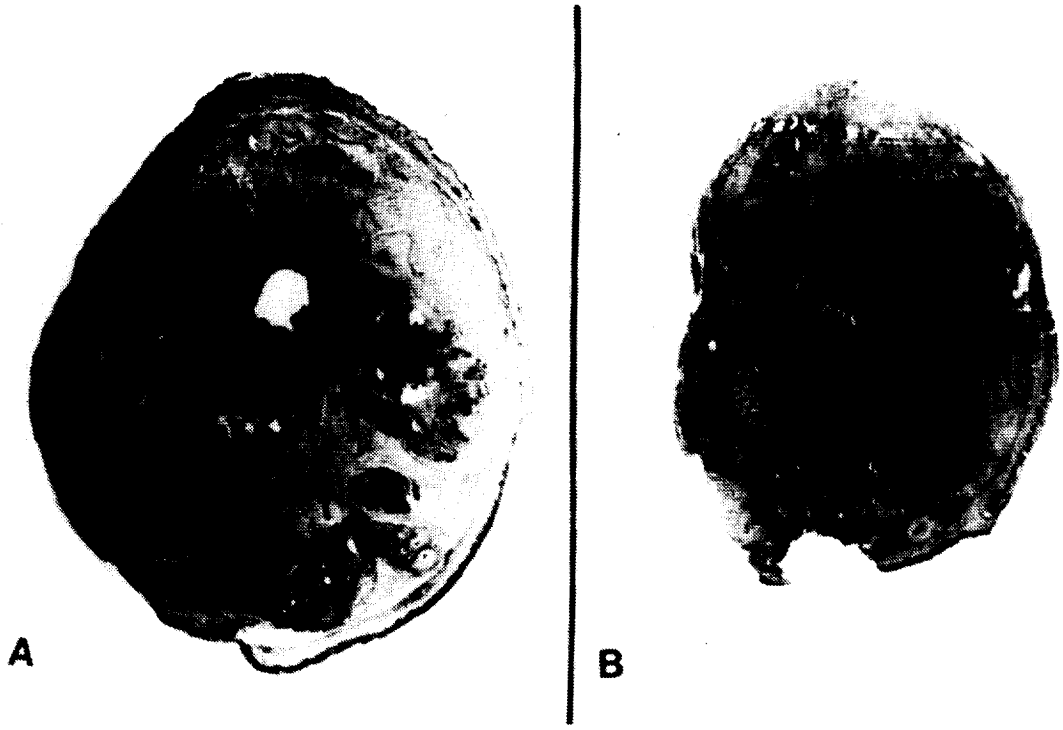


PLATE 12. (A) and (B) are transverse sections of the proximal metatarsal region. There is extensive swelling and total necrosis of the bones.

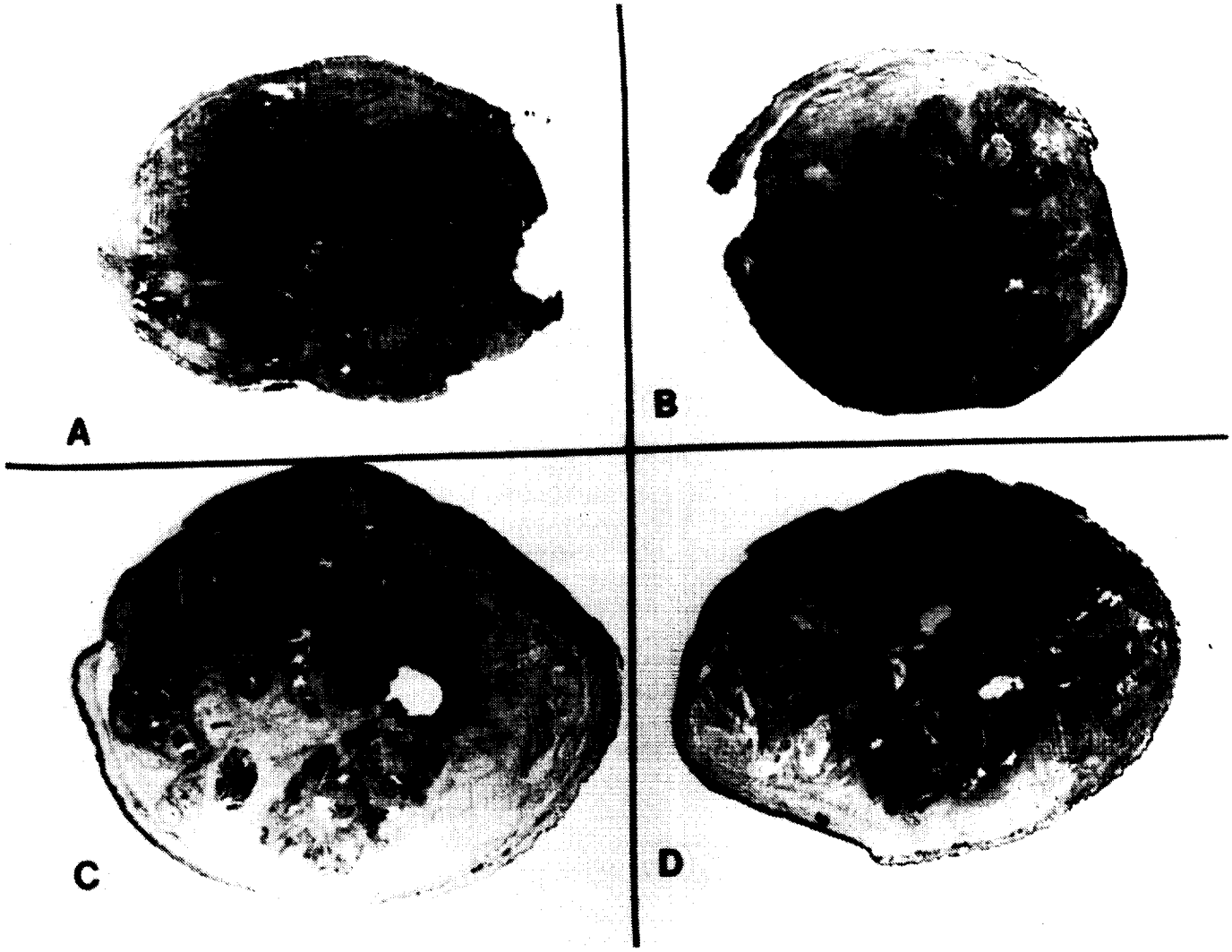


PLATE 13. Transverse section through the mid-metatarsal bones of the hind paws of the injected rats . A and B are flight animals, C and D are ground controls. A and C. right. B and D. left. 7.8X.

In (A) the swelling is very extensive. Extensive bone necrosis and inflammatory cell infiltration obscure the localisation of the metatarsal bones..

In (B) there is again extensive reactive bone proliferation around the old metatarsal bones.

(C) as (A).

In (D) the lesions are about as severe as in (C) and, in regard to osteonecrosis, far more accentuated than in (B).

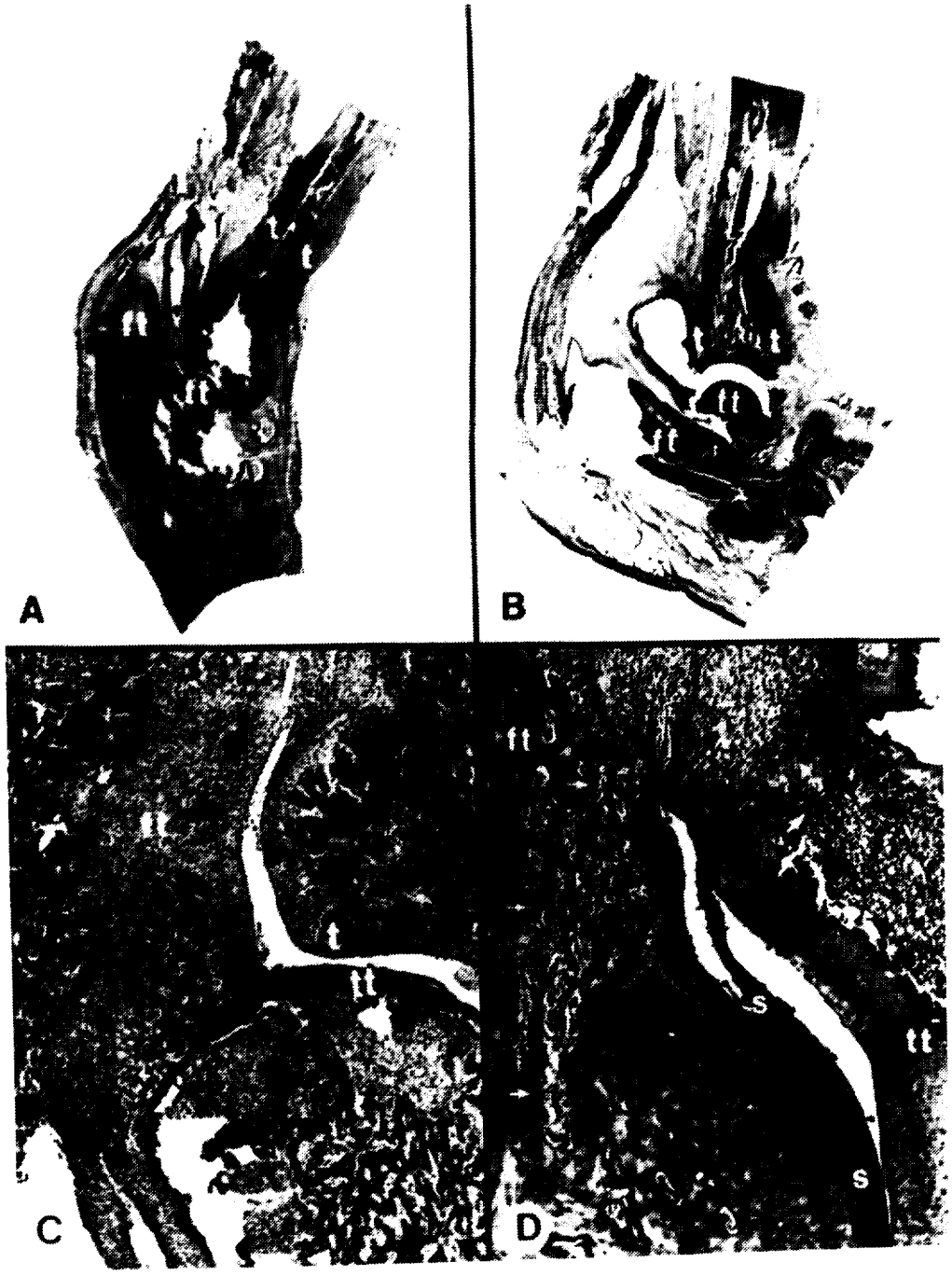
PLATE 14. Longitudinal sections of left distal tibia and tarsus. t = tibia,tt = tibio-tarsal bone, ft = fibular tarsal bone. A and C are flight animals. B and D are ground controls.

(A) There is extensive osteonecrosis of distal tibia, tt and ft and also of the remaining small tarsal bones.4.2X

(B) THe osteonecrosis of the tibia is less advanced than in A. 4.2X

(C) Most of the regional bone tissue in all bones (t,tt, and ft) has been destroyed and is replaced by reactive bone. 45X

(D) The articular cartilage of tt is well defined and appears normal. The bone of tt has been invaded and destroved by granulation tissue with a large amount of inflammatory cells. In the ft bone, the cartilage is well preserved but covered by a synovium (s) with a large amount of inflammatory cells. The underlying bone appears normal but is being invaded and destroyed by expanding granulation tissue (arrows). 60X



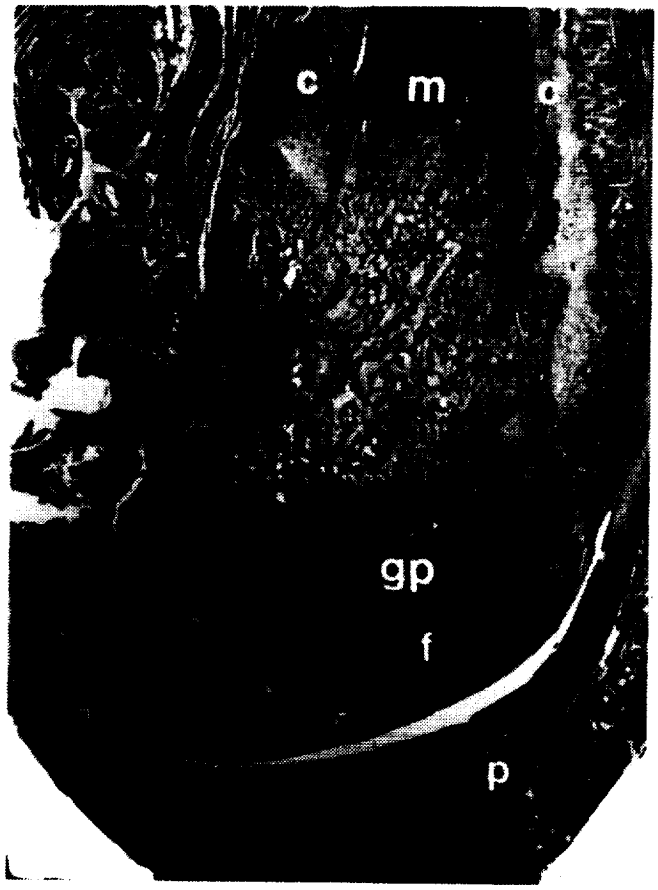


PLATE 15. Left hind leg of non-injected flight animal.
Femoro-patellar region. C = feroro cortex, m = bone marrow, gp = growth plate, f = femur, p = patellar
The cortices distal to C are mostly necrotic and replaced by proliferating reactive bone. The metaphyses between m and gp is devoid of normal trabeculae and marrow cells. The space is occupied by proliferating reactive bone. 10X

ADDENDUM A

THE ANIMAL ENCLOSURE MODULE: DESIGN, FABRICATION AND OPERATION

ANIMAL ENCLOSURE MODULE

DESIGN, FABRICATION AND OPERATION

The design effort on what was to become the Animal Enclosure Module (AEM) began in mid-1981 when General Dynamics joined the experiment team. A requirements analysis identified the key design drivers early on.

The experiment requirements, see Table 1, emphasized the desirability of on-orbit data collection. The first three of the proposed methods would have driven up the cost of the AEM substantially or imposed a contamination hazard on the crew. The use of a video camera was selected for this requirement and necessitated a clear Lexan ™ top to allow viewing. Other than that, the impact on the hardware or shuttle procedures was minimal.

The most obvious design requirements imposed by the Space Shuttle on the AEM are summarized in Table 2. Figure 1 illustrates the location of the Space Shuttle mid-deck and the stowage lockers for the AEM. The key design problem for any enclosure in space for animals is how to separate the waste products from the crew and still allow air interchange with the crew compartment. The AEM must get fresh air from the crew compartment, cycle it through the cage and then through substantial filtration before return to the cabin. The airflow is required to cool the animals, provide oxygen, and act as a transportation mechanism for waste. Previous work done in the area had established that an air flow of about 15-25 Ft/Min was sufficient to blow liquid and solid waste out of the animal cage and into a filter media. Since the animals were to be loaded up to 24 hours before flight, the filter must also be below the animals, between the cage and the door of the Shuttle Stowage Locker (which is oriented vertical at launch).

TABLE 1. EXPERIMENT REQUIREMENTS

- KEEP TEST ANIMALS HEALTHY AND AS UN-STRESSED AS POSSIBLE.
- EXCEPT FOR ZERO-G, A NEAR 'NORMAL' ENVIRONMENT SHOULD BE MAINTAINED.
- CONDUCT PRE AND POST ANALYSES OF TEST AND CONTROL ANIMALS TO EXAMINE GROSS CHANGES IN THE DISEASE CHARACTERISTICS AS A RESULT OF THE EXPOSURE TO WEIGHTLESSNESS.
- CONDUCT SOME SORT OF ONBOARD, INFLIGHT MONITORING OF THE TEST ANIMALS IN ORDER TO GATHER MORE SUBSTANTIVE DATA ABOUT THE DEVELOPMENT OF THE DISEASE. PROPOSED PROCEDURES HAVE INCLUDED:
  - IMPLANTING SENSORS IN THE ANIMALS AND RECORDING BODY PARAMETERS WITH AN ONBOARD COMPUTER.
  - EQUIPING ANIMAL CAGES WITH MOTION SENSORS WIRED TO AN ONBOARD COMPUTER.
  - HAVING THE ASTRONAUTS REMOVE THE ANIMALS FROM THEIR ENCLOSURE AND, WITH SPECIAL INSTRUMENTS, MEASURE THE THICKNESS OF THE ANIMALS' JOINTS.
  - RIGGING THE CAGE FOR EITHER MANUAL OR AUTOMATIC SEQUENCE OR MOTION PICTURE PHOTOGRAPHY.
- PROVIDE ANIMALS WITH RELATIVELY LARGE ENCLOSURES TO MAXIMIZE THEIR POSSIBILITIES FOR MOVEMENT. SEPARATE ARTHRITIC FROM CONTROL ANIMALS TO AID IDENTIFICATION.

TABLE 2. GENERAL SPACE SHUTTLE MIDDECK HARDWARE REQUIREMENTS

- AEM MUST FIT STANDARD STOWAGE LOCKER TRAY ON SPACE SHUTTLE MIDDECK, PREFERABLY ON FORWARD WALL WHERE MOST OF THESE LOCKERS ARE LOCATED.
- THE FULL DEPTH STOWAGE LOCKER TRAY IS ABOUT 9½" DEEP, 17" WIDE AND 19½" DEEP.
- THE AEM MUST NOT EXCEED 60 LBS. AND IDEALLY SHOULD BE 40 LBS. OR LESS.
- AIR FOR THE ANIMALS CAN ONLY BE DRAWN INTO AND EXHAUSTED FROM THE AEM THRU THE STOWAGE LOCKER TRAY DOOR.
- SPACE SHUTTLE WILL IMPOSE APPROXIMATELY 3.3 G'S AGAINST DOOR OF LOCKER AT TAKEOFF AND ABOUT 1.5 G'S THRU FLOOR OF TRAY AT LANDING.
- ON ORBIT AEM WILL BE IN 'ZERO' GRAVITY WITH NO SETTLING FORCE FOR WASTE PRODUCTS.
- NO WASTE PRODUCTS MAY ESCAPE THE AEM INTO THE CREW CABIN.

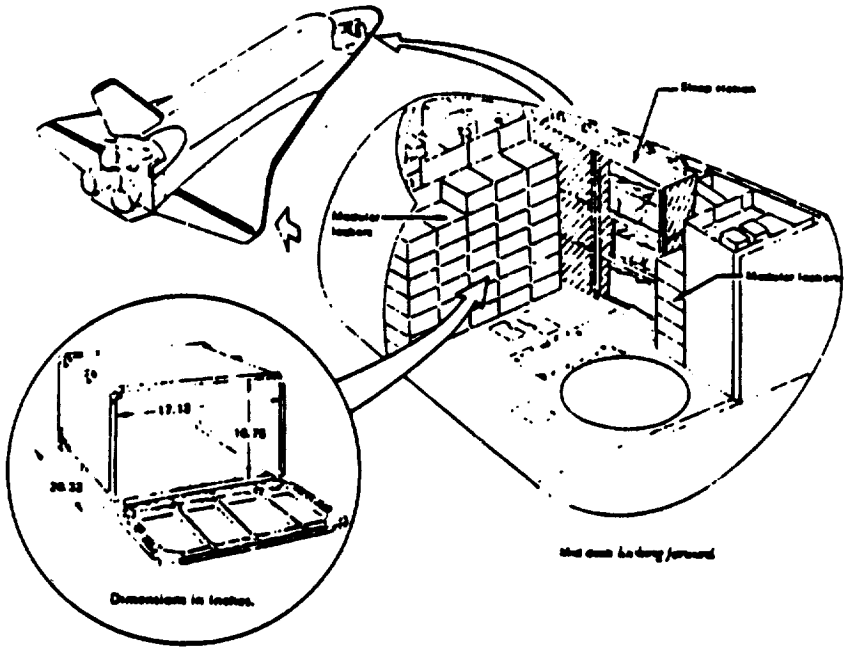


Figure 1. Space Shuttle Middeck and Stowage Locker Locations

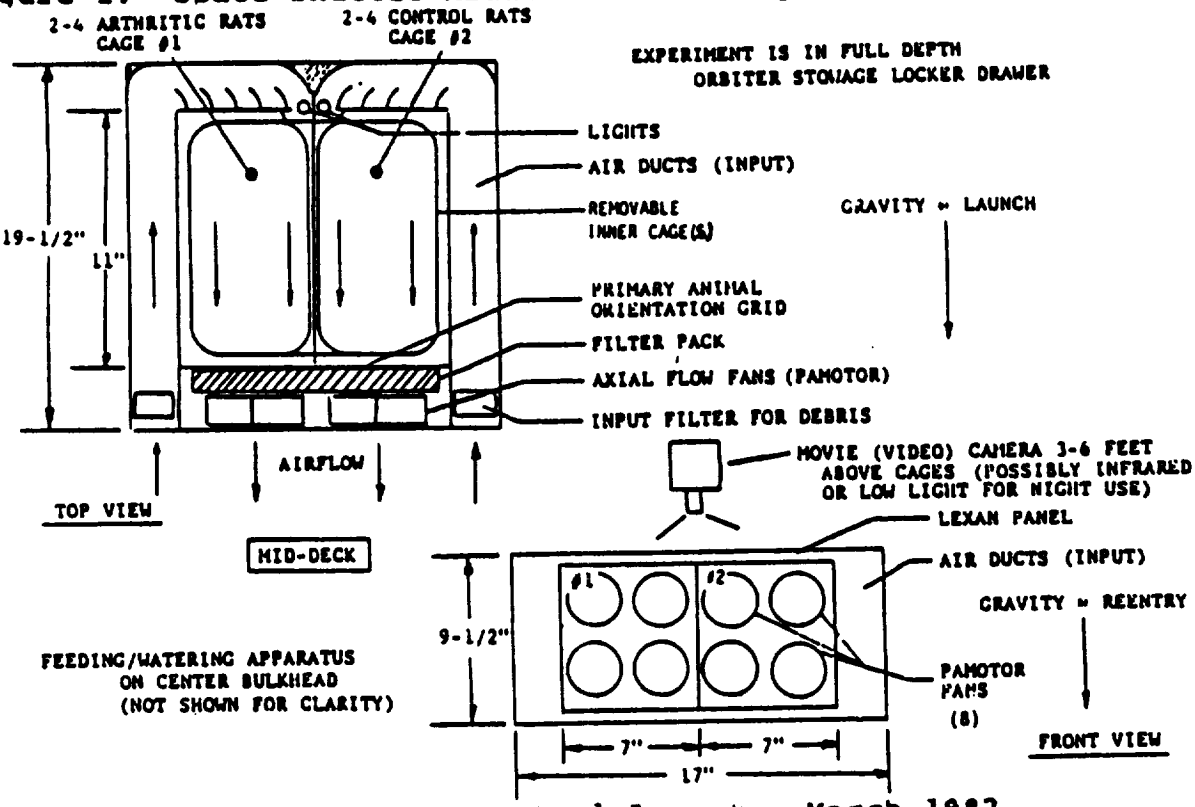


Figure 2. AEM Conceptual Layout - March 1982

Table 3 identifies the key features of the orbiter environment. Temperature and pressure are very important to the health and vitality of the animals.

This early requirements analysis established the basic design of the AEM and a sketch was prepared in early 1982, see Figure 2. The Top View looks into the stowage locker tray as the observer or video camera would see it. All air interchange occurs at the bottom, through the stowage locker door (which has three removable panels). Air is drawn in through channels on the side to the extreme rear of the unit where it turns 180° and enters the cages for the animals. It flows from top to bottom, blowing waste against the filter pack in the same direction that gravity and launch forces do. This provides a constant orientation for the animals until reentry of the Space Shuttle when an unavoidable 90° shift of direction occurs and a wall (the "bottom" of the locker tray) becomes the floor. The filter pack below the animals was assumed to be some package of charcoal and fiberglass. The air is pulled through the filter by eight small fans and exhausted to the mid-deck again.

The Front View identifies the eight fans, the side air ducts and the location of the video camera.

This early concept was presented to NASA management at the Johnson Space Center and at the Ames Research Center in March 1982. A number of key design issues were raised in several very productive sessions and in subsequent phone conversations. ARC was particularly helpful in passing on some of the design lessons learned in their own work on the Research Animal Holding Facility (RAHF). JSC identified many specific design requirements that the AEM must meet.

TABLE 3. ORBITER MID-DECK GENERAL ENVIRONMENT

	Nominal	Range
Temperature	75°F (24°C)	55 to 95°F (13 to 35°C)
Humidity	50%	25 to 75%
Pressure	14.7 psi (1.0 bar)	8 to 18.1 psi (0.54 to 1.23 bar)
Acceleration		
Launch	Maximum loading 3.3g. Down orbiter main axis.	
On-orbit	For normal crew motion activity, accelerations may vary from 6×10^{-4}g (worst case) to less than 2×10^{-4}g for periods of quiescent crew activity.	
	The minimum attainable acceleration level is 10^{-5}g. This level precludes any crew activity or firing of attitude control thrusters.	
Landing	Maximum loading 6.8g. Perpendicular to orbiter main axis.	

The wealth of design data from ARC helped in the detailed design of the AEM from its conceptual form in Figure 2 to its final design as manufactured in Figure 3. The lessons learned are summarized in Table 4.

Table 5 identifies the key areas of concern by both NASA Headquarters (first bullet) and the Johnson Space Center (second and third bullets). NASA management was particularly concerned that the welfare of the animal be carefully considered in the design, second only to crew safety. Adverse publicity as a result of a crude cage design injuring or killing the flight animals was to be avoided at all costs because it could impact the main life science program already underway. JSC concerns were much more specific and primarily addressed crew safety issues.

The detailed design of the AEM, including about 40 major layout drawings started in April 1982 and finished in June. The end result, incorporating all the inputs from NASA ARC and JSC is shown in Figure 3. Three clear Lexan™ panels cover, from front to rear, the inlet filter, the cage and the exhaust filter including an electrostatic 0.3 micron biological filter at the very end. Rubber gaskets seal these covers. The fiberglass-charcoal-fiberglass filter "sandwiches" are contained with stainless steel screens which slide in on guides machined in the aluminum side walls. The cage is a single welded unit which also slides in (on teflon guides) and has a removable divider to which the food bars were to be glued (a practice which was not used in flight because of flexure of the divider). Power for the four fans and four cage lights (located in the corners of the cage adjacent to the inlet filter) enters the cage on the left side and goes to two switches. Two rheostats control the fan speed (a concept which was dropped for the second flight) and are cooled by air exhausting from the four radial blowers mounted on the front.

The basic characteristics of the AEM are summarized in Figure 4.

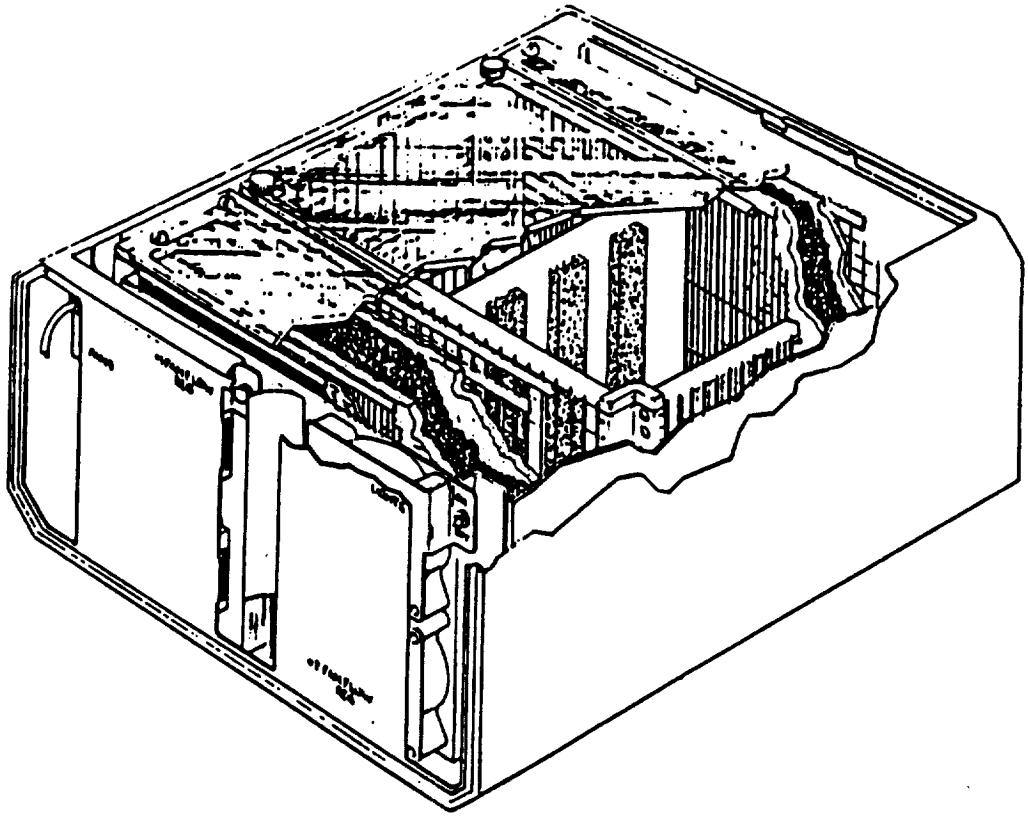


Figure 3. Animal Enclosure Module

TABLE 4. MAJOR AMES RESEARCH CENTER INPUT TO AEM CONCEPTUAL DESIGN

- USE STAINLESS STEEL FOR ANIMAL CAGE AND FILTER GRIDS
- USE HEAVY ANODIZED ALUMINUM ON MAJOR STRUCTURE TO REDUCE CORROSION
- USE 4 PAMOTOR RL-90 BLOWERS; SPACE SHUTTLE APPROVED ON THE RAHF
- USE LEXAN™ FOR TOP COVERS; SPACE SHUTTLE APPROVED ON RAHF
- TREAT FIBERGLASS AND CHARCOAL WITH PHOSPHORIC ACID TO IMPROVE ABSORBTION CAPABILITY
- 0.3 MICRON BIOLOGICAL FILTER REQUIRED TO TRAP BACTERIA
- SECOND AIR FILTER IN FRONT OF ANIMAL CAGE REQUIRED IN CASE OF FAN FAILURE
- USE ANIMAL FOOD BARS DEVELOPED FOR THE RAHF
- USE POTATOES AS A SOURCE OF WATER; ANIMAL SUPPLIERS SHIP ANIMALS WITH POTATOES

TABLE 5. NASA REQUIREMENTS SUMMARY

- THIS WILL BE THE FIRST NASA EXPERIMENT TO CARRY RATS INTO SPACE.

  THE SSIP IS A HIGHLY VISIBLE PROGRAM.

  THE POWERFUL ANTI-VIVISECTIONISTS LOBBY IS WATCHING NASA LIFE SCIENCE EXPERIMENTS CLOSELY.

  - ENSURE THAT THE ANIMALS ARE ALIVE AND WELL CARED FOR WHILE IN THE SHUTTLE.

- MEET ALL RELEVANT STS PAYLOAD REQUIREMENTS FOR EXPERIMENTS CARRIED ON THE MIDDECK OF THE ORBITER. CONCERNS INCLUDE:

  - FLAMMABILITY
  - OFF GASING
  - TOXIC SUBSTANCES, INCLUDING BACTERIA AND VIRUSES
  - CORROSIVE SUBSTANCES
  - ELECTRICAL LOADING (AND HAZARDS)
  - ACOUSTICAL LOADING
  - THERMAL LOADING
  - ASTRONAUT TIME REQUIREMENTS (BOTH PRIOR TO AND DURING MISSION)
  - WEIGHT & VOLUME
  - ANIMALS DYING OR GETTING LOOSE IN THE CREW COMPARTMENT
  - IDENTIFICATION AND CONSIDERATION OF ALL POSSIBLE FAILURE MODES/PATHS

- IN PARTICULAR, ENSURE THAT NO SIGNIFICANT ODORS ARE DETECTABLE OUTSIDE THE ENCLOSURE.

Specifications:

- **Fits standard STS stowage locker**
- **Air flow**
  - 4 Pamoter RL-90 radial blowers
  - Continuous 20 CFM, adjustable
- **Filtration**
  - 3-layer inlet, 4-layer exhaust filters
  - Phosphoric acid treated fiberglass bats & activated charcoal
  - 3M Filtrete™ electrostatic filters
  - 0.3μ with >97% DOP efficiency
- **Animal cage**
  - Volume — 1,200 in.^{3}
  - Floor space — 125 in.^{2}
  - Grid — 1/2 in. sq welded plain weave
- **Materials**
  - All Shuttle approved
  - 304 Stainless — Cage, all inner grill & support work
  - Hard anodized 6061 Al — Outer frame assembly
  - Lexan — Covers outer stowage tray
- **Electrical**
  - 11-27W at 28 VDC
  - Blowers individually fuzed, LEDs indicate fuze condition
  - 4 interior cage lamps
- **Weight with filters loaded**
  - ~39 lb (No animals or food)

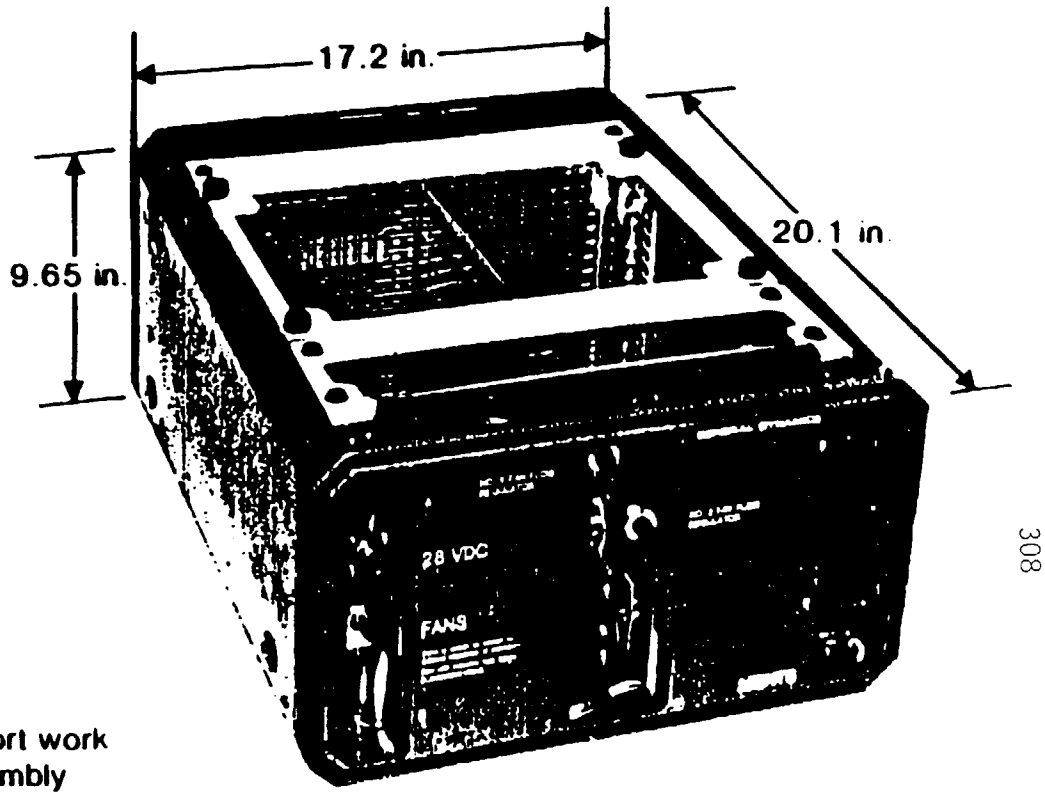


Figure 4. Animal Enclosure Module

The AEM was built in a seven week period concluding in July 1982. The major machining for the job was performed by a small local machine shop and a variety of components were obtained from outside vendors, see Table 6. The electrical work, all integration and final assembly, as well as preshipment testing, was conducted at General Dynamics' Lindbergh Field Plant.

In late July the AEM was shipped to Pfizer for preliminary live animal testing. Results of these tests led to several minor modifications to the hardware, mainly to improve the rubber gaskets, which were accomplished in September-November 1982.

Further testing by NASA JSC in March-April 1983 verified the ability of the cage to contain the odors of six dead animals for up to ten days before any trace of odor was detectable. Tape was added as a final seal of the covers to the sides of the AEM. The worst case scenario was performed as a final verification that the crew would not have to open the cage and access the animals under any contingency. Worry about contamination was the over-riding concern.

The AEM carried six healthy animals on STS-8 in August 1983 for a very successful eight day flight test of the system. The hardware performed well and only a few minor modifications were required. More rubber gasket material was added to further improve the sealing of the cage. Also, temperatures in the cage had risen into the mid-high eighties during the flight which led to concerns that the airflow rate was insufficient. In order to improve this, the fan rheostats (which cut the fan voltage by about 2 volts) were removed and the 3M G-0125 electrostatic filter was replaced with a slightly thinner G-0115 filter which reduced the pressure drop. These changes improved the flow velocity by about 20-30%.

TABLE 6. MAJOR COMPONENT SUPPLIERS FOR THE AEM

PAMOTOR - RL90-18/24 DC BLOWERS

770 Airport Blvd
Burlingame, Calif. 94010

(415) 347-1203

3M OCCUPATIONAL HEALTH & SAFETY PRODUCTS DIV - FILTRETE™ MICROBIOL FILTER MEDIA

3M Center, 230B
St. Paul, Minnesota 55144

(800) 328-1300 or (612) 733-9279

AMERICAN AIR FILTER - ACTIVATED CHARCOAL INFORMATION

Replacement Filter Division
18856 San Jose Avenue
City of Industry, California 91478

(213) 965-0805

HI-TEMP INS - UNBONDED MICROLITE-B FILTER FIBERGLASS

4700 Calle Alto Road
Camarillo, Calif. 93010

(213) 889-4101

CHARCOAL FILTRATION MEDIA CO - COCONUT SHELL ACTIVATED CHARCOAL

734 East Hyde Park Blvd.
Inglewood, CA

(213) 673-5194

CITY WIRE CLOTH, INC. - FILTER & CAGE CRES SCREEN

13900 Orange Ave
Paramount, CA 90723

(213) 630-8050

The AEM was returned to JSC in early December 1983. The successful flight of the AEM on STS-11 in early 1984 marked the end of this 2-¼ year development. It is hoped that these first two flights of this compact animal enclosure will be followed by many more as interest in space conducted life science research increases.

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E. R. Morey-Holton, P. D. Sebesta, A. M. Ladwig,*
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*NASA Headquarters, Washington, DC
**Johnson Space Center, Houston, Texas
†Kennedy Space Center, Florida
Point of Contact: E. R. Morey-Holton, Ames Research Center, MS 236-7, Moffett Field, CA 94035, (415) 694-5471 or FTS 464-5471

16. Abstract

This document contains biweekly reports generated for the Weber Student Shuttle Involvement Project (SSIP). The reports document the evolution of science, hardware, and logistics for this Shuttle project aboard the eleventh flight of the Space Transportation System (STS-41B) which was launched from Kennedy Space Center on February 3, 1984, and returned to KSC 8 days later. The reports were intended to keep all members of the team aware of progress in the project and to avoid redundancy and misunderstanding. Since the Weber SSIP was NASA's first orbital rat project, documentation of all actions was essential to assure the success of this complex project. Eleven reports were generated: on October 3, 17, and 31; November 14 and 28; and December 12 and 17, 1983; and January 3, 16, and 23; and May 1, 1984. A subject index of the reports is included. The final report of the project, written by Dan Weber, is included as the appendix.

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