LIFE SCIENCES PAYLOAD DEFINITION AND INTEGRATION STUDY

VOLUME III + APPENDICES
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LIFE SCIENCES PAYLOAD DEFINITION
AND INTEGRATION STUDY

VOLUME III + APPENDICES

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National Aeronautics and Space Administration
GEORGE C. MARSHALL SPACE FLIGHT CENTER
Huntsville, Alabama

Prepared by
CONVAIR AEROSPACE DIVISION OF GENERAL DYNAMICS
San Diego, California

Details of illustrations in
this document may be better
studied on microfiche
This report consists of Volume I-Management Summary, Volume II-Requirements and Design Studies, and Volume III-Appendices.

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R. Adachi
N. L. Bell
W. A. Dunlap
H. S. Ginoza
J. E. Greenleaf
T. H. Harmont
J. E. Hewitt
L. I. Hochstein
H. A. Leon
B. C. Look
J. Miquel
J. Oyama
L. J. Polaski
S. T. Taketa
J. W. Tremor
C. M. Winget
K. Yokoyama
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G. L. Drake (Contract Manager)
R. C. Armstrong (Convair Life Sciences Manager)
H. Gottschalk
G. R. Mabie
A. R. Perl
E. J. Russ
G. E. Taylor
R. L. Trussel
W. G. Thomson
D. W. Vorbeck
A. N. Wilson

Comments or requests for additional information should be directed to:

C. B. May
National Aeronautics and Space Administration
George C. Marshall Space Flight Center
Huntsville, Alabama 35812
Telephone: (205) 453-3431

-or-

G. L. Drake
Convair Aerospace Division of
General Dynamics
P. O. Box 1128, Mail Zone 663-00
San Diego, California 92112
Telephone: (714) 277-8900, Ext. 1881
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APPENDIX I
CONFIGURATION STUDIES DATA

This appendix contains detail design information on the following:

a. Equipment modules/equipment item lists
b. Weight and volume breakdown by payload and equipment units (EUs)
c. Layouts made for first generation designs
d. External centrifuge for Maxi Max laboratory
e. The Midi-30 payload definition
f. Longitudinal floor arrangement configuration
g. Non baseline second generation layouts.

I. 1 EQUIPMENT MODULES

Figures I-1 through I-22 depict the equipment racks (ERs); equipment consoles (ECs); and special equipment modules (SEMs) developed for the second generation layouts. These equipment modules were used in the development of the baseline payloads.

In determining the number of modules required to hold the equipment items (EIs) a sizing study was performed on the pertinent CORE equipment units. Figures I-1 through I-6 indicate the results of a preliminary EI placement activity. The EI placement within the equipment unit (EU) is noted by the EI identification number. The EI placement activity had two purposes: (1) to represent a first-cut functional placement relationship of equipment; and (2) to provide equipment module sizing and volume requirements for the payload layout design task.

The figures illustrate the size and shape of the various equipment modules for the various baseline payloads. The accompanying tables itemize the individual equipment items contained within each equipment module.

The standard module has a 0.61 m by 0.61 m base and is 2.0 meters high. Two exceptions are the cage module holding units and the internal centrifuge.

The BLH units (SEMs) are descrete designs whose configuration was dictated by the various functions (i.e., bicycle ergometer, rotating litter chair, etc.).
Figure I–1. Equipment Unit EU 001 Visual Records and Microscopy Unit (Sheet 1)
<table>
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<th>MAXI NOM</th>
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<td>41</td>
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Figure I-1. Equipment Unit EU 001 Visual Records and Microscopy Unit (Sheet 2)
Figure I-2. Equipment Unit EU-002-Data Management Unit (Sheet 1)
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Figure I-2. Equipment Unit EU-002-Data Management Unit (Sheet 2)
Figure I-3. Equipment Unit EU 003 Life Sciences Experiment Support Unit (Sheet 1)
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Figure I-4. Equipment Unit EU 004 Preparation and Preservation Unit (Sheet 1)
Figure I-4. Equipment Unit EU004 Preparation and Preservation Unit (Sheet 2)
Figure I-4. Equipment Unit EU 004 Preparation and Preservation Unit (Sheet 3)
PREPARATION AND PRESERVATION UNIT

Figure I-4. Equipment Unit EU 004 Preparation and Preservation Unit (Sheet 4)
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<td>Phototransistor (Cplr)</td>
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<td>50</td>
<td>12</td>
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<td>(Distribution throughout laboratory)</td>
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<td>153B</td>
<td>Sensors, Assorted</td>
<td>24</td>
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<td>162</td>
<td>Sterilzr, Autoclv, Stm</td>
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<td>165</td>
<td>Sterilzr, Tool</td>
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<td>Tags, Io, Organizm</td>
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<td>288</td>
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<td>181D</td>
<td>Transducer, Pressure</td>
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<td>35</td>
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<td>185</td>
<td>Voltmtr (VOM)</td>
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Figure I-6. Equipment Unit EU 006 Maintenance Repair and Fabrication Unit (Sheet 2)
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<td>167B</td>
<td>Storage, General</td>
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<td>167C</td>
<td>Storage, Film</td>
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Figure I-7. Equipment Unit EU 997, Ancillary Storage
Figure I-8. Equipment Unit EU 011 Remote Manipulator (Part of EU-011 Airlock/EUA Capability (Sheet 1))
<table>
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<th>REMARKS</th>
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<td>1</td>
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<td>(Part of space station)</td>
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<td>119</td>
<td>Maintenance Task Simu</td>
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<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>(Exterior to laboratory)</td>
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<tr>
<td>119A</td>
<td>Manipulator, Remote</td>
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<td>1</td>
<td>1</td>
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<td>1</td>
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<td>143H</td>
<td>Pressure Suit Connectr</td>
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<tr>
<td>143I</td>
<td>Pressure Suit Manipulator</td>
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<td>1</td>
<td>1</td>
<td>1</td>
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<td>172</td>
<td>Space Suit + 50 Ft Umbilical</td>
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<td>4</td>
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<td>(Stored in Space Station)</td>
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<td>(Experimental Suit Provisions Stored in EU 080-1 &amp; -2 Consoles) (6 Ft²)</td>
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Figure I-8. Equipment Unit EU 011 Remote Manipulator (Part of EU-011 Airlock/EUA Capability (Sheet 2)
Figure I-9. Equipment Unit EU 012 Rotating Litter Chair and Body Mass Measurements (Sheet 1)
<table>
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<tr>
<td>019D</td>
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<td>153A</td>
<td>Rotating Litter Chair</td>
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Figure I-9. Equipment Unit EU 012 Rotating Litter Chair and Body Mass Measurements (Sheet 2)
Figure I-10. Equipment Unit EU 012/031 Bio-Medical Man-System Integration Research Support Unit (Sheet 1)
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Figure I-10. Equipment Unit EU 012/031 Bio-Medical Man-System Integration Research Support (Sheet 2)
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Figure I-10. Equipment Unit EU 012/031 Bio-Medical Man-System Integration Research Support (Sheet 3)
Figure I-11. Equipment Unit EU 021/023 Internal Centrifuge (Sheet 1)
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<td>043D</td>
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Figure I-11. Equipment Unit EU 021/023 Internal Centrifuge (Sheet 2)
Figure I-12. Internal Bio-Research Centrifuge (Sheet 1)
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Figure I-12. Internal Bio-Research Centrifuge (Sheet 2)
Figure I-13. Equipment Unit EU 025/026 Radiation Exposure Unit (Sheet 1)
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<td>152</td>
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<td>52</td>
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<td>150</td>
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</tbody>
</table>

| EU026  | Reference                      |     |     |      |      |      |         |
| 076D   | Film Table, X-rays            | 1   | -   | -    | -    | -    |         |
| 147C   | Radiatn Room Rack Sys        | 1   | -   | -    | -    | -    |         |
| 149F   | Radiatn Srce, Isotope        | 1   | -   | -    | -    | -    |         |
| 149G   | Radiatn Source, Prepkgd      | 1   | 1   | 1    | 1    | -    |         |
| 149H   | Radiation Whole Body Scan    | 1   | 1   | 1    | 1    | -    |         |

Figure I-13. Equipment Unit EU 025/026 Radiation Exposure Unit (Sheet 2)
Figure I-14. Equipment Unit EU 030 Bicycle Ergometer, Lower Body Negative Pressure, Exergenie (Sheet 1)
<table>
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<td>104E</td>
<td>Coupler, Impedance Cardiogram</td>
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<td>104F</td>
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Figure I-14. Equipment Unit EU 030 Bicycle Ergometer, Lower Body Negative Pressure, Exergenie (Sheet 1)
Figure I-15. Equipment Unit EU 040-050-060-070 Cage Module (Sheet 1)
<table>
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Note: Cages, feces management system, feeding and watering systems, and urine collector systems are provided in above cages and cage modules as required.

Figure I-15. Equipment Unit EU 040-050-060-070 Cage Module (Sheet 2)
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|--------|----------------------------|      |      |      |      |      |         |
| 026B   | Cage MMB, Plant            | 32   | 16   | 16   | 2    | 1    |         |
| 029    | Cage, Plnt, Pot            | 8    | 4    | 4    | 1    | 1    |         |
| 101    | Hldg Unit, Plant           | 18   | 8    | 8    | 2    | 1    |         |

Figure I-15. Equipment Unit EU 040-050-060-070 Cage Module (Sheet 3)
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Figure I-15. Equipment Unit EU 040-050-060-070 Cage Module (Sheet 4)
Figure I-16. Equipment Unit EU 041 Primate Holding Facility (Sheet 1)
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Figure I-16. Equipment Unit EU 041 Primate Holding Facility (Sheet 2)
Figure I-17. Equipment Unit EU-042/071 Holding Unit Support (Sheet 1)
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Figure I-17. Equipment Unit EU-042/071 Holding Unit Support (Sheet 2)
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Figure I-17. Equipment Unit EU-042/071 Holding Unit Support (Sheet 3)
Figure I-18. Equipment Unit EU080/081 Life Support Subsystem Test Unit (Sheet 1)
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Figure I-18. Equipment Unit EU080/081 Life Support Subsystem Test Unit (Sheet 2)
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Figure I-20. Equipment Unit EU091 Behavioral Measurements Unit (Sheet 1)
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(Distributed through Laboratory)

Figure I-20. Equipment Unit EU091 Behavioral Measurements Unit (Sheet 2)
Figure I-21. Equipment Unit EU093 Mobility Unit - Damage Proof (Sheet 1)
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Figure I-21. Equipment Unit EU093 Mobility Unit - Damage Proof (Sheet 2)
Figure I-22. Equipment Unit EU110 Animal Environmental Control System (Sheet 1)
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Weight power and volume of all these items are different - For example
1 Bosch for Maxi-Maxi
1 Bosch for Maxi-Norm

Figure I-22. Equipment Unit EU110 Animal Environmental Control System (Sheet 2)
I.2 WEIGHT AND VOLUME BREAKDOWN BY EQUIPMENT UNIT (EU)

The weight and volume for the baseline payload equipment units have been summarized in Tables I-1 through I-4.

Column 4 (titled manual) indicates an input requirement for the design sensitive equipment items.
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<th>VOLUME FT³</th>
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<td>6.65 x 3 = 20</td>
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*489 lb will be changed to 289 lb on the next tab run.
Table I-1. Weight and Volume Breakdown - Maxi-Max Payload Based on 9-27-71 Tab Run, Contd

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<th>EQUIP, RACK</th>
<th>＝TOTAL</th>
<th>RACK DIMENSIONS FT.</th>
<th>VOLUME FT&lt;sup&gt;3&lt;/sup&gt;</th>
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<td>4.82 x 6.56 x 14.75 (Deployed)</td>
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<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>lb</td>
<td>(24,166)</td>
<td>(2,135)</td>
<td>(26,301)</td>
<td>(5,391)</td>
<td>(28,692)</td>
<td></td>
<td>2,043 FT&lt;sup&gt;3&lt;/sup&gt;</td>
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<tr>
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<td>970</td>
<td>11,955</td>
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<td>57.8 M&lt;sup&gt;3&lt;/sup&gt;</td>
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RESEARCH CENTRIFUGE PORTION OF MAXI (MAX) PAYLOAD

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<th>＝TOTAL</th>
<th>RACK DIMENSIONS FT.</th>
<th>VOLUME FT&lt;sup&gt;3&lt;/sup&gt;</th>
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<td></td>
<td>-</td>
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<td>153</td>
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*489 lb will be changed to 289 lb on the next tab run.
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<th>MANUAL =</th>
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<th>VOLUME FT³</th>
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<td>500</td>
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Table I-2. Weight and Volume Breakdown Maxi-Nom Payload 9-28-71 Tab Run

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<th>EQUIP. RACK</th>
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<th>RACK DIMENSIONS FT</th>
<th>VOLUME FT³</th>
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<td>1,048</td>
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**Post run update
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<th>VOLUME FT³</th>
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Table I-3. Weight and Volume Breakdown Mini-30 Payload 9-27-71 Tab Run, Contd

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**Post run update
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I. 3 FIRST GENERATION LAYOUT DATA

This section documents the first generation payload layouts for the following payloads (see Figures I-23 through I-37):

Maxi Max
Midi-56
Mini-56
Midi-30
Mini-30
Mini-7

Figure I-38 shows a special case (data point) BLH Module layout depicting a maximum volume configuration to minimize experiment envelope overlap. Figure I-39 shows the case where all the CORE units are placed in the BLH module. The Maxi Max external centrifuges, and the human centrifuge are shown in Figures I-40, I-41, and I-42 respectively.

I. 3.1 FIRST GENERATION PAYLOAD LAYOUTS. The first generation payload layouts are accompanied by a table describing module size, required Shuttle launches, costs, and total facility weights and volumes.
Figure I-23. Concept No. 1, BLH Module - Sheet 1
Figure I-23. Concept No. 1, F Module - Sheet 2
Figure I-23. Concept No. 1, Module Cluster - Sheet 3
Figure I-24. Concept No. 2, BLH Module - Sheet 1
Figure I-24. Concept No. 2, F Module - Sheet 2
Figure I-24. Concept No. 2, Module Cluster - Sheet 4
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Figure I-25. Concept No. 3, F Module, Sheet 2
Figure I-25. Concept No. 3, Module Cluster - Sheet 3

ALTERNATES:
COG-1
COG-2
COG-3
COG-4
COG-5
COG-7

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WAFFER FLOORS
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*Based on inside usable diameter, excludes common subsystems, compartment, airlock.

**Figure I-25. Concept No. 3, Sheet 4**
Figure I-26. Concept No. 4, BLH Module - Sheet 1
Figure I-26. Concept No. 4, F Module - Sheet 2
Figure I-26. Concept No. 4, Module Cluster - Sheet 3
FIRST GENERATION CONCEPT NO. 4

**DEG.** | **MODULE** | **SIZE OF MODULE REQUIRED** | **SCIENTIFIC * SUPPORT EQUIPMENT PAYLOAD** | **SHUTTLE LAUNCHES REQUIRED** | **COSTS** | **TOTAL** |
---|---|---|---|---|---|---|
| CON. | TYPE | FF | LENGTH | VOLUME | WEIGHT, LESS KILOGRAMS | VOLUME | WEIGHT, LESS KILOGRAMS | SCIENCE | SUPPORT | Manned | CARGO | TOTAL |
|        |        |      | (ft²) | (ft³) | (lbs.) | (ft³) | (lbs.) | PAYLOAD | EQUIPMENT | Launches | PAYLOAD | (lbs.) | (ft³) | PAYLOAD | EQUIPMENT | MOD. | CARGO | TOTAL |

**4** | F | 2 | 35.9 | 329 | 4.1 | 2.7 | 2.7 | 3.0 | 3.0 | 26.0 | 9.6 | 50.0 | 95.0 | 40.0 | 15.0 | 31.0 | 31.0 | 40.0 | 40.0 |
|    |     | | | | | | | | | | | | | | | | | | | |
| BLH | 1 | 43.7 | 408.6 | 10.1 | 0.5 | 2.7 | 2.7 | 2.7 | 2.7 | 26.0 | 9.6 | 50.0 | 95.0 | 40.0 | 15.0 | 31.0 | 31.0 | 40.0 | 40.0 |
|    |     | | | | | | | | | | | | | | | | | | | |
| FC | 1 | 60.0 | 536.4 | 10.1 | 1.5 | 3.1 | 3.1 | 3.1 | 3.1 | 26.0 | 9.6 | 50.0 | 95.0 | 40.0 | 15.0 | 31.0 | 31.0 | 40.0 | 40.0 |
| RC | 1 | 20.45 | 2.37 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 26.0 | 9.6 | 50.0 | 95.0 | 40.0 | 15.0 | 31.0 | 31.0 | 40.0 | 40.0 |
| TOTAL | 5 | 17.62 | 28.67 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 26.0 | 9.6 | 50.0 | 95.0 | 40.0 | 15.0 | 31.0 | 31.0 | 40.0 | 40.0 |

**4A** | F | 2 | SAME AS CONCEPT 4 | SAME AS CONCEPT 4 | SAME AS CONCEPT 4 | SAME AS CONCEPT 4 | SAME AS CONCEPT 4 | SAME AS CONCEPT 4 | SAME AS CONCEPT 4 | SAME AS CONCEPT 4 | SAME AS CONCEPT 4 | SAME AS CONCEPT 4 | SAME AS CONCEPT 4 | SAME AS CONCEPT 4 | SAME AS CONCEPT 4 | SAME AS CONCEPT 4 | SAME AS CONCEPT 4 | SAME AS CONCEPT 4 | SAME AS CONCEPT 4 |
|    | | | | | | | | | | | | | | | | | | | | |
| BLH | 1 | 60.0 | 536.4 | 10.1 | 1.5 | 3.1 | 3.1 | 3.1 | 3.1 | 26.0 | 9.6 | 50.0 | 95.0 | 40.0 | 15.0 | 31.0 | 31.0 | 40.0 | 40.0 |
| RC | 1 | 20.45 | 2.37 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 26.0 | 9.6 | 50.0 | 95.0 | 40.0 | 15.0 | 31.0 | 31.0 | 40.0 | 40.0 |
| TOTAL | 4 | 15.87 | 28.67 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 26.0 | 9.6 | 50.0 | 95.0 | 40.0 | 15.0 | 31.0 | 31.0 | 40.0 | 40.0 |

**4B** | F | 2 | SAME AS CONCEPT 4 | SAME AS CONCEPT 4 | SAME AS CONCEPT 4 | SAME AS CONCEPT 4 | SAME AS CONCEPT 4 | SAME AS CONCEPT 4 | SAME AS CONCEPT 4 | SAME AS CONCEPT 4 | SAME AS CONCEPT 4 | SAME AS CONCEPT 4 | SAME AS CONCEPT 4 | SAME AS CONCEPT 4 | SAME AS CONCEPT 4 | SAME AS CONCEPT 4 | SAME AS CONCEPT 4 | SAME AS CONCEPT 4 | SAME AS CONCEPT 4 |
|    | | | | | | | | | | | | | | | | | | | | |
| BLH | 1 | 60.0 | 536.4 | 10.1 | 1.5 | 3.1 | 3.1 | 3.1 | 3.1 | 26.0 | 9.6 | 50.0 | 95.0 | 40.0 | 15.0 | 31.0 | 31.0 | 40.0 | 40.0 |
| RC | 1 | 20.45 | 2.37 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 26.0 | 9.6 | 50.0 | 95.0 | 40.0 | 15.0 | 31.0 | 31.0 | 40.0 | 40.0 |
| TOTAL | 4 | 15.87 | 28.67 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 26.0 | 9.6 | 50.0 | 95.0 | 40.0 | 15.0 | 31.0 | 31.0 | 40.0 | 40.0 |

**4C** | F | 2 | SAME AS CONCEPT 4 | SAME AS CONCEPT 4 | SAME AS CONCEPT 4 | SAME AS CONCEPT 4 | SAME AS CONCEPT 4 | SAME AS CONCEPT 4 | SAME AS CONCEPT 4 | SAME AS CONCEPT 4 | SAME AS CONCEPT 4 | SAME AS CONCEPT 4 | SAME AS CONCEPT 4 | SAME AS CONCEPT 4 | SAME AS CONCEPT 4 | SAME AS CONCEPT 4 | SAME AS CONCEPT 4 | SAME AS CONCEPT 4 | SAME AS CONCEPT 4 |
|    | | | | | | | | | | | | | | | | | | | | |
| BLH | 1 | 60.0 | 536.4 | 10.1 | 1.5 | 3.1 | 3.1 | 3.1 | 3.1 | 26.0 | 9.6 | 50.0 | 95.0 | 40.0 | 15.0 | 31.0 | 31.0 | 40.0 | 40.0 |
| RC | 1 | 20.45 | 2.37 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 26.0 | 9.6 | 50.0 | 95.0 | 40.0 | 15.0 | 31.0 | 31.0 | 40.0 | 40.0 |
| TOTAL | 4 | 15.87 | 28.67 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 26.0 | 9.6 | 50.0 | 95.0 | 40.0 | 15.0 | 31.0 | 31.0 | 40.0 | 40.0 |

**4D** | F | 2 | SAME AS CONCEPT 4 | SAME AS CONCEPT 4 | SAME AS CONCEPT 4 | SAME AS CONCEPT 4 | SAME AS CONCEPT 4 | SAME AS CONCEPT 4 | SAME AS CONCEPT 4 | SAME AS CONCEPT 4 | SAME AS CONCEPT 4 | SAME AS CONCEPT 4 | SAME AS CONCEPT 4 | SAME AS CONCEPT 4 | SAME AS CONCEPT 4 | SAME AS CONCEPT 4 | SAME AS CONCEPT 4 | SAME AS CONCEPT 4 | SAME AS CONCEPT 4 |
|    | | | | | | | | | | | | | | | | | | | | |
| BLH | 1 | 60.0 | 536.4 | 10.1 | 1.5 | 3.1 | 3.1 | 3.1 | 3.1 | 26.0 | 9.6 | 50.0 | 95.0 | 40.0 | 15.0 | 31.0 | 31.0 | 40.0 | 40.0 |
| RC | 1 | 20.45 | 2.37 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 26.0 | 9.6 | 50.0 | 95.0 | 40.0 | 15.0 | 31.0 | 31.0 | 40.0 | 40.0 |
| TOTAL | 4 | 15.87 | 28.67 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 26.0 | 9.6 | 50.0 | 95.0 | 40.0 | 15.0 | 31.0 | 31.0 | 40.0 | 40.0 |

Based on inside usable diameter. Excludes common subsystems compartment. ARILOCK.

Figure I-26. Concept No. 4, Sheet 4
Figure I-27. Concept No. 5, F Module - Sheet 2
Figure I-27. Concept No. 5, Module Cluster - Sheet 3
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Figure I-28. Concept No. 6, Module Cluster - Sheet 3
**First Generation Concept A2G**

*Reproduced from best available copy.*

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*Based on inside usable diameter. Excludes common subsystems compartment.*

*Assumes 90-day resupply.

Figure I-28. Concept No. 6, Sheet 4
Figure I-29. Concept No. 7, BLH Module – Sheet 1
Figure I-29. Concept No. 7, F Module - Sheet 2
Figure I-29. Concept No. 7, Module Cluster - Sheet 3

ALTERNATES:
CAG-1  CAG-8
-3  -9
-4  -10
-5  -11
CAG-6  CAG-12

B + L + H and F

CORE IN ARTIFICIAL GRAVITY

SELF MOBILITY WITH CARGO ON RAILS

NO FLOORS

WALL MOUNTED EQUIPMENT
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Figure I-29. Concept No. 7, Sheet 4

*Based on inside usable diameter. Excludes common subsystems compartment, airlock. **Assumes 90-day resupply. †Excludes airlock.
Figure I-30. Concept No. 8, Module Cluster - Sheet 3
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**Figure I-30. Concept No. 8, Sheet 4**
Figure I-31. Concept No. 9, BLH Module - Sheet 1
Figure I-31. Concept No. 9, Module Cluster - Sheet 3
### First Generation Concept No. 9

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<th>SCIENTIFIC &amp; SUPPORT EQUIPMENT LOAD</th>
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<th>% L</th>
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**Note:**

1. Based on inside usable diameter. Excludes common subsystems compactness.
2. Assumes 90-day resupply.
3. Excludes airlock.

Figure I-31. Concept No. 9, Sheet 4
Figure I-32. Concept No. 10, BLH Module - Sheet 1
Figure I-32. Concept No. 10, CORE Module - Sheet 3
Figure I-32. Concept No. 10, Module Cluster - Sheet 4
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| 9A     | F           | SAME AS CONCEPT 10   |              |              |          |                            |                  | 25.7          | 100%        | 1.3         | 100%         | -       | -    | -       |
|        | BLH         | SAME AS CONCEPT 10   |              |              |          |                            |                  | 16.3          | 100%        | 1.0         | 100%         | -       | -    | -       |
|        | CORE/A/L    | SAME AS CONCEPT 10   |              |              |          |                            |                  | 13.0          | 100%        | 1.2         | 100%         | -       | -    | -       |
|        | RC           | 60.0 x 5364          | 10.1         | 1.5          | 3.1      | 0.7 (con)                 | 1.5              | 19.3          | 100%        | 2.5         | 100%         | -       | -    | -       |
|        | RC           | SAME AS CONCEPT 10   |              |              |          |                            |                  | 25.7          | 100%        | 1.3         | 100%         | -       | -    | -       |
| TOTAL  | 4           | 1664                 |              |              |          |                            |                  | 123.9         | 100%        | 2.7         | 100%         | -       | -    | -       |

| 10B    | F           | 31.7 x 2625          | 8.6          | 2.0          | 2.7      | 0.7 (con)                 | 1.1              | 17.6          | 60.7        | 13.4        | 100%         | -       | -    | -       |
|        | BLH         | SAME AS CONCEPT 10   |              |              |          |                            |                  | 16.3          | 100%        | 1.0         | 100%         | -       | -    | -       |
|        | CORE/A/L    | SAME AS CONCEPT 10   |              |              |          |                            |                  | 13.0          | 100%        | 1.2         | 100%         | -       | -    | -       |
|        | RC           | SAME AS CONCEPT 10A  |              |              |          |                            |                  | 25.0          | 100%        | 1.7         | 100%         | -       | -    | -       |
| TOTAL  | 4           | 12101                |              |              |          |                            |                  | 11201         | 100%        | 2.6         | 100%         | -       | -    | -       |

| 10C    | F           | 237 x 1670           | 7.6          | 2.5          | 2.7      | 0.8 (con)                 | 1.1              | 15.8          | 64.1        | 13.4        | 100%         | -       | -    | -       |
|        | BLH         | SAME AS CONCEPT 10   |              |              |          |                            |                  | 16.3          | 100%        | 1.0         | 100%         | -       | -    | -       |
|        | CORE/A/L    | SAME AS CONCEPT 10   |              |              |          |                            |                  | 13.0          | 100%        | 1.2         | 100%         | -       | -    | -       |
|        | A/L          | SAME AS CONCEPT 10A  |              |              |          |                            |                  | 25.0          | 100%        | 1.7         | 100%         | -       | -    | -       |
| TOTAL  | 4           | 7246                 |              |              |          |                            |                  | 113249        | 100%        | 2.7         | 100%         | -       | -    | -       |

Figure I-32. Concept No. 10, Sheet 5
Figure I-33. Midi-30 Payload Design Analysis (Shuttle)
Figure I-34. Midi-56 Payload Design Analysis (Skylab)
Figure I-35. Mini-56 Payload Design Analysis (Skylab)
Figure I-37. Mini-7 Payload Design Analysis (Shuttle)
I.4 EXTERNAL CENTRIFUGES FOR MAXI MAX

Figures I-40, I-41, and I-42 are layouts of the FC, HC, and RC centrifuges. As a result of NASA direction at the close of first generation layout studies, the FC and HC were combined into a single centrifuge and identified as the RC. This RC was used for the second generation layouts for Maxi Max.

The RC unit is 3.68 m (12.0 ft) outside diameter and 19.45 m (63.0 ft) in overall length. It houses biology and MSI research equipment. The biology equipment consists of 48 stationary cage modules, 2 mobile cage modules, 1 primate sphere, 2 macaque cylinders, and 3 EU 042/071-2 holding support units.

For MSI, habitability equipment (EU-120) is installed at section D-D to provide approximately 0.30 g acceleration. At section E-E are the Behavioral Measurements units, and a walking and experiment area within a one g field.
Figure I-38. BLH Module Long Floor Min. Time Share Layout (Data Point)
Figure I-40. FC Biology Research Centrifuge
Figure I-41. HC Human Research Centrifuge

I-122
Figure I-42. Research Centrifuge Module (R.C.) Maxi Max (Biology and Human)
1.5 MIDI-30 PAYLOAD

The contents of the Midi-30 payload are illustrated in Figures I-43 and I-44. All other payloads were selected as baselines and are presented in Volume II of this report.
I. 6 LONGITUDINAL FLOOR ARRANGEMENT

Equipment arrangements were studied for the "long floors" configurations and are shown in Views A through F of Figure I–45. Views B and C are configurations that were carried into the second generation layouts, and subsequently used in the baselines. Views A, D, E, and F are configurations which proved to be undesirable due to the restricted aisle space available for emergency egress or equipment transfer.
Figure I-43. Midi-30 Payload Contents
Figure I-44. Midi-30 Payload Equipment Layout
Figure I-45. Volumetric Efficiency Sensitivity vs General Arrangement (Sheet 1)
Figure I-45. Volumetric Efficiency Sensitivity vs General Arrangement (Sheet 2)
I. 7 NON-BASELINE SECOND GENERATION LAYOUTS

This section discusses the second generation payload layouts that were not selected as baselines.

I. 7. 1 MAXI MAX LAYOUT DESCRIPTIONS. Figure I-46 shows an F Module layout for Maxi Max utilizing the longitudinal floors concept. The equipment is arranged in a linear arrangement. The animal ECS modules are shown stored above the floor. Two macaque cylinders, the primate sphere, and the radiobiology unit are shown stowed below the floor. The module length required to house this configuration is approximately 11 meters (36-1/2 ft).

A companion module to the configuration shown in Figure I-46 is shown in Figure I-47. This is the BLH module Maxi Max no floors configuration. The overall usable space required is approximately 26 ft and, the design utilizes a 0.9 meter sliding hatch. Shown at the extreme top of the photo is the protective corridor (EU-093) in the stowed position. Other equipment shown in this layout is the rotating litter chair, the lower body negative pressure unit next, the bicycle ergometer, and the body mass measurement unit. The rectangular thin block to the right and above the two consoles is the life support and protective systems whole body shower unit in the stowed position. Just below it are the two life support and protective system consoles. Other modules shown are the biomedicine measurement units, and MSI behavioral measurement units. The module to the extreme right, with the plastic box above, is the remote manipulation unit, and the dark cylinder below, is the common subsystem portion of the CM-4. This unit would incorporate mobility aids in the form of porches below the two life support and protective systems consoles. In the biomedical area, small local floors would be installed for foot restraints for use by the test conductor. Man's orientation in this configuration, in the lower portion of the unit would be parallel to the axis, and in the upper portion for biomedical functions, man's body would be radial or normal to the axis of the LS-RAM.

Figures I-48 and I-49 show the Maxi Max payload BLH Module longitudinal floors configuration. The photographs are self-explanatory, they contain biomedical, MSI and LSPS research equipment. This is a long floors configuration, and the mobility system would be pressure walking or guided soaring. Figure I-49 shows the protective corridor in the deployed position.

A study was made to investigate placing the CORE in the BLH Module, the results are shown in Figures I-50 and I-51. Figure I-50 is the F Module without the CORE (i.e., CORE in the BLH Module). Figure I-51 shows the BLH Module with all the CORE units installed. This unit would require an overall length of 33 ft.
Figure I-46. F Module Maxi Max "Long Floors"
Figure I-47. BLH Module Maxi Max "No Floors"
Figure I-48. BLH Module Maxi Max "Long Floors"
Figure I-49. BLH Module Maxi Max "Long Floors"
Figure I-50. F Module Maxi Max "No Floors" CORE in BLH

NOTE: NO CORE UNITS INSTALLED

F MODULE
MAXI(MAX) "NO FLRS," CORE IN BLH
Figure I-51. BLH Module Maxi Max "No Floors" CORE in BLH

I-136
Figure I-52. FBLH Module Maxi Nom "No Floors - Wafer Floors"
I-137
I. 7.2 MAXI NOM LAYOUT DESCRIPTION. Figures I-52 and I-53 show the FBLH Module for the Maxi Nom payload utilizing the no-floor/wafer floor concept. The Maxi Nom payload is contained in this single module for attachment to the modular Space Station. The 20 cage modules are visible in an annular array, showing the laminar flow bench in position. The next level of equipment down, reading from left to right, is the life support and protective systems consoles, the data management consoles, the preparation/preservation units, the analysis units, and the maintenance, repair and fabrication units. The large unit just below the annular array, in the right-hand section of the photograph, shows the protective corridor in the stowed position setting on top of two MSI measurement units. The left portion of the photo shows the bicycle ergometer, the lower body negative pressure, the two biomedical measurement consoles, the rotating litter chair, and the body mass measurement unit.

The FBLH Module for Maxi Nom payload utilizing the longitudinal floors concept is shown in Figure I-54. The layout is approximately 15 meters (49 ft) in length.

I. 7.3 MIDI-30 LAYOUT DESCRIPTIONS. Figures I-55 and I-56 present the FBLH Module for the Midi-30 payload in a no floors/wafer floors configuration. This layout resulted in a module length of approximately 11 meters (36-1/2 ft). The unit was designed for use in the Shuttle Sortie mission and requires the research support module (RSM) rather than the normal common subsystem module portion of the CM-4. Figure I-57 is a photograph of a Midi-30 payload layout iteration. This second iteration eliminates the second wafer floor, and has only a wafer floor imposed by the bulkheads required for the internal centrifuge. An improvement in overall module length resulted with required length of only 10 meters (32-1/2 ft). Figure I-58 depicts a layout very similar to the one shown for the Maxi Nom (Figure I-54). The Midi-30, with its reduced number of CORE modules, can be packaged in a module of about 14 meters (46.5 ft). Figures I-59 and I-60 depict a configuration for the Midi-30 long floors concept, which is actually an iteration of Figure I-58. This iteration made better use of the volume above and below the floor. Better utilization of the volume above and below the floor was an evolutionary outgrowth of the layout developed. This approach led to the development of the Maxi Nom baseline shown in Section 3 of Volume II.

Figures I-61 and I-62 show the FBLH module for the Midi-30 payload incorporating the concept of long floors and no floors. These photographs show the advantage of the no floors concept in terms of volume utilization. Overall module length is approximately 12 meters (37-1/2 ft). However, there is a disadvantage in this concept in that two orientations are required for the man. He must operate basically normal and parallel to the centerline. This imposes problems when consideration is given to ground build-up, loading of the module and Shuttle, and boosting to orbit.

I. 7.4 MINI-30 LAYOUT DESCRIPTIONS. Figure I-63 shows the Mini-30 FBLH Module in the no floors/wafer floors configuration. This layout has characteristics similar to layouts previously described. There is 6.62 meters (21.72 ft) available for other disciplines in the unassigned area. This particular length is designed for a Shuttle Sortie mission.
I. 7. 5 MINI-7 LAYOUT DESCRIPTION. Figure I-64 shows this configuration designed for a Shuttle Sortie mission, with 8.7 meters (28.5 ft) available in the unassigned area.
Figure I-53. FBLH Module Maxi Nom "No Floors - Wafer Floors"

I-140
Figure I-54. FBLH Module Maxi Nom "Long Floors"
Figure I-55. FBLH Module Midi-30 "No Floors - Wafer Floors"

I-142
Figure I-56. FBLH Module Midi-30 "No Floors - Wafer Floors"
I-143
Figure I-57. FBLH Module Midi-30 "No Floors - Wafer Floors"
Figure I-59. FBLH Module Midi-30 "Long Floors" Iteration No. 2
Figure I-60. FBLH Module Midi-30 "Long Floors" Iteration No. 2
Figure I-61. FBLH Module Midi-30 "Long Floors - No Floors"
Figure I-62. FBLH Module Midi-30 "Long Floors - No Floors"
Figure I-63. FBLH Module Mini-30 "No Floors - Wafer Floors"

I-150
Figure I-64. FBLH Module Mini-7 "No Floors"

I-151
Figure I-65. FBLH Module Mini-7 "No Floors"

I-152
This appendix presents a conceptual design for a Data Management System (DMS). The requirement of the DMS is to aid experimenters with experiment management through control of equipment and data acquisition, processing, and disposition. The ground rules used are as follows:

a. The design will build upon the concept of the Data Management Unit of the Life Sciences Common Operations Research Equipment (CORE) as presented in the "Blue Book", Reference 1. (All references of this report are presented in Section 7.1 of Volume II).

b. The concept design will be based upon data requirements presented in the Blue Book, but modified as determined necessary by the results of this current study.

c. The concept design will be limited to the basic, general-purpose framework of the DMS. Experiment instrumentation and associated special data processing devices are not considered herein. However, the DMS will be designed to readily interface with all instrumentation and such devices.

d. All external communications will be conducted via the support modules for the Sortie and Space Station missions.

e. There will be no capability for independent, detached laboratory module operations. However, there will be a capability for automatic operations during short, unattended periods such as launch.

The general approach used to design the DMS was to classify the data handling requirements, and select the concepts to be used for each requirement. Next, the hardware needed to implement each technique was determined and assembled to form an integrated data management system.

II. 1 REQUIREMENTS AND SELECTION OF TECHNIQUE

Data handling requirements presented in the Blue Book were reviewed, and the kinds of data to be handled were broadly classified as: (1) sampled; (2) continuous; (3) video; (4) audio; (5) computer; (6) control; and (7) miscellaneous. In the discussion which follows, the above classifications are described, and basic handling techniques are selected. Worse case data loads were estimated
for the Maxi Max payload to insure that the selected techniques will readily provide the required capability.

### II.1.1 Sampled Data Requirements

Sampled data handling requirements can be typically characterized as summarized below:

**a. Acquisition** - Numerous sources, slow changing, and long duration.

**b. Processing** - Compress (use only significant samples such as changes, trends, etc.). Compute conversion to engineering units and other typically simple computer-type operations. Update displays or activate computer-controlled devices if data meets some predetermined criteria.

**c. Disposition** - Store all raw data until transferred to ground. Store selected, processed data for subsequent use on-board or transfer to ground.

Measurements in this classification are typically amperage, displacement, power, force, position, pressure, strain, temperature, and voltage. This classification of data is ideally suited for handling in a pulse code modulated (PCM) form. PCM data can be readily introduced into a computer for processing, and the total PCM data stream is in an organized format that can be efficiently stored on instrumentation tape and transmitted to ground.

Most sampled data originate from analog voltage sources which are periodically sampled and converted to PCM words. However, a PCM format is also ideal for handling source data originating in a digital form, such as time or bi-level states (discretes), which can be grouped and handled as a single PCM word.

Some PCM data sources will be located in a centrifuge where extension of a hard wire, common data bus is not practical. This condition will require an RF link between: each bus interface unit servicing a PCM data acquisition unit located in the centrifuge, and the common data bus located in the computer area.

The bit rate of the PCM system will vary according to detailed experiment requirements and scheduling, and is not expected to exceed 62,500 bits per second (bps) for the worst case. The anticipated bit rate will allow recording of the entire raw PCM data stream on tape using a low tape speed, for later playback at a much higher speed for transfer to ground.

### II.1.2 Continuous Data Requirements

Continuous data handling requirements can be typically characterized as follows:

**a. Acquisition** - Few sources, fast changing, and short duration.
b. Processing - Compress (use only significant intervals such as an anticipated event). Computer (special computer program which might require experimenter interaction through a graphic display console). Non Computer (special purpose analog data processing/display equipment).

c. Disposition - Temporarily store the most recent few minutes of all raw data. Store selected intervals of selected measurements in raw form until transferred to ground. Store selected, processed data for subsequent use on-board or transfer to ground.

Measurements in this classification are typically physiological signals, such as EGG, EEG, and EMG. Most experiments require some measurements in this classification. These signals originate in analog form from numerous sources, and a variety of special equipment is required for processing and display. Usually, only a few signals are processed at any one time. Typically, the experimenter must make some special setup of equipment to select, process, display, or store the signals desired for an experiment. For these reasons, a flexible analog data handling system is required. Basically, this system should be a network of analog data signal trunk lines, that interconnect equipment work areas and appropriate switching and signal conditioning. An RF link is required to extend trunk lines into the centrifuge.

Analog-to-digital (A/D) conversion, and computer entry of data must be provided for those signal sources and experiments that require computer support, such as waveform analysis of ECG signals. Selected analog signals must also be temporarily incorporated into the PCM format. This could be done by using a PCM data cycle format with unused time slots dedicated to this purpose. The sources of data using these time slots may often change; however, the basic PCM format will not.

A continuous data storage system will be required. Conventionally, high frequency analog signals are stored on instrumentation tape. This appears to be a desirable method since several data channels can be frequency multiplexed and stored on one track at a slow tape speed. The worse-case data storage load is estimated to be 24 channels continuously recorded.

A loop tape recorder and reproducer will be required to continuously record the most recent few minutes of selected analog channels. This will be required for experiments that produce long-time insignificant data between significant events. Occurrence of a significant event typically cannot be detected until after it has passed, at which time it is usually desirable to immediately replay the event for processing, or transfer to the main instrumentation tape for storage or transfer to ground.
There are many possible analog signal sources and destinations. The number of channels active at critical functional locations in the analog data handling system at any one time, will vary according to detailed experiment requirements and scheduling. Critical locations are expected to be computer entry, and instrumentation tape recording and playback. For computer entry, the worst case is anticipated to be equivalent to 12 channels digitized at a rate of 1000 samples per second per channel for a period of 10 seconds, with the next data interval delayed until disposition of the current data.

II. 1.3 VIDEO DATA REQUIREMENTS. Television capability will be required at all principal activity areas, such as the Visual Records and Microscopy Unit, Plant Research Support Unit, and the Research Centrifuge. Other areas, such as the Plant Research Support Unit, or Holding Units may require coverage of many image sources during a single experiment. These areas could be instrumented with several cameras which time share a signal video channel, or, with a single camera that periodically scans the many sources.

Television data handling requirements can be met with a switchable network of video signal trunk lines that interconnect cameras, monitors, and video tape machines as required. There are several possible sources and users for video signals, it is estimated that not more than three channels will be active at any one time. Two video data trunk lines will require extension by RF link into a centrifuge. Television data will be stored on video tape for later review onboard, or transfer to ground via a support module. Storage and transfer requirements are not defined at this time. However, it appears that the system should provide the capability to record and/or transfer at least one channel continuously.

II. 1.4 AUDIO DATA REQUIREMENTS. There are no unusual audio data requirements. A handling system using conventional techniques will be suitable. The proposed handling system is basically a switchable network of audio signal trunk lines that interconnect microphones, speakers, audio tape recorders, and signal conditioners. An audio signal could be switched to an analog signal trunk, and treated as an analog signal to record on tape. It is estimated that not more than three audio channels will be required to be active at any one time.

Audio communication between portable equipment where hard wire links would be impractical, or between main laboratory and a centrifuge, will require RF links.

At least two multichannel voice tape recorders will be required. One permanently located recorder to continuously record all active audio channels and an analog time code. One audio channel will be permanently assigned to the support module. The other tape machine would be portable, and used to both record and reproduce modes as required by various experiments. Any of the audio
signal trunk lines would be selectable to either tape machine, recording, or playback of audio data.

II. 1.5 COMPUTER DATA REQUIREMENTS. The data management computer will be required to handle many kinds of data from several sources, and perform a variety of computer operations. Computer data sources and users are summarized as follows:

a. Sources:
   1. PCM data
   2. Digitized analog data
   3. Time from time code generator
   4. Storage data from quick access computer storage
   5. Storage data from computer tapes
   6. Transferred computer data from service module
   7. Interactive graphics data, both control and display

b. Users:
   1. Control data to external devices
   2. Storage data to quick access computer storage
   3. Storage data to computer tape machines
   4. Transferred computer data to service module
   5. Digital-to-analog converted data
   6. Interactive graphics data, both control and display

Each of these data links with the computer will require a hardware interface to condition the data and manage the transfer from one medium to another. In some cases the interfaces require conventional capabilities, such as those for the quick-access storage of computer tapes. However, in most cases the interfaces will require unusual functional capabilities. An important consideration is to relieve the computer of high-rate repetitive functions that are most efficiently accomplished externally.

Input/output requirements for some classifications of data that the computer must handle (sampled, continuous and control) have been discussed in the requirement sections dealing with these classifications. Very little information covering requirements for computer data storage size, and processing rate is
available. However, an estimate of worse-case, quick-access storage requirements are summarized below. The unit of storage is assumed to be a 16-bit word. ((TOTAL) 1,667,296 words (approximately 30 \times 10^6 bits)).

a. PCM data request file - 128 words per frame, 32 frames per data cycle: 4096 words.
b. Device control request file - 240 words per frame, 30 frames per control cycle: 7200 words.
c. Instruction file - 5000 measurements, 300 characters (150 words) per measurement: 750,000 words.
d. Computer data file inventory file - 200 files, 60 characters (30 words) per file: 6000 words.
e. Computer data file storage - 100 files, 5000 words per file: 500,000 words.
f. Graphic frame file storage - 50 files, 500 words per file: 25,000 words.
g. Graphic display format files - 20 files, 250 words per file: 5,000 words.
h. Current experiment procedure file - 10 experiments, 5,000 words per experiment: 50,000 words.
i. System and utility program library - 20 programs, 4000 words per program: 80,000 words.
j. Application program library - 40 programs, 4000 words per program: 160,000 words.
k. Working buffer area - 40 buffers, 2000 words per buffer: 80,000 words.

The above assumes that long intervals of a raw data stream entering the computer are to be stored on computer tape. In addition, large files of data seldom used, will be stored on computer tape.

Experiments using the Biomedical Measurement Unit of the Medical Research Facility, that originate ECG type signals will impose the worse-case processing load on the computer. These will require wave-form analysis. This processing must be accomplished without disrupting the ever-present handling of PCM data, and control of devices. These experiments may require management by an experimenter interacting through a computer graphics display/control console. This would impose an additional load on the computer. It was previously stated that 12 ECG-type signals, digitized at a rate of 1000 samples per second for 10 seconds, is estimated to be the worse-case load. This acquired data must be analyzed, the results stored, and the experiment setup modified before the next interval of data are acquired.
Transfer of computer data between the data management computer and the service module, or storage devices does not impose a significant load on the data management computer, because transfer links are managed by automatic devices peripheral to the computer.

The computer requirements to service interactive graphics data are difficult to estimate. Graphics will impose severe short-term loads if this technique is often used as the primary experiment management and analysis tool. If more detailed experiment plans and requirements reveal this to be the case; then, all computer graphics functions possible should be incorporated in specific purpose graphics equipment peripheral to the computer. This would reduce the load on the computer.

II. 1.6 DEVICE CONTROL DATA REQUIREMENTS. Equipment operations in the laboratory must be automated by computer control, where practical, in order to minimize experimenter attention, and to insure reliable operation. Most of these operations are simple, low rate, and long term. Typically, a sensor is sampled by the PCM system and a status display is updated, and if the condition is out of some predetermined tolerance, an equipment operation is automatically initiated by the computer which restores the sensed condition to an acceptable state. An example of this kind of operation is the monitoring and control of an environmental control parameter.

Certain equipment must be operated in some prescribed sequence in order to support an experiment. An example of this is the control of a light, by computer programmed light/dark cyclic series. Some equipment operations are under control of an experimenter via the computer. This kind of operation usually supports an experiment where human judgment must direct the computer to one of several possible, programmed courses of action.

Another mode of control is required for the situation where an externally sensed condition might occur at an unpredictable time, and then needs the immediate attention of some process program in the computer. Conventional computer interrupt signals could be used for this situation. The interrupt capability could be inhibited during periods when action is not necessary. Many interrupts will be required at various work stations. For example, a computer graphics console, for human control of experiments.

There will be many kinds of devices using control data from the computer. Some of these devices are special-purpose instrumentation, and must incorporate specially designed interfaces to the general-purpose framework of the data management system. Device control data can be broadly separated into two classes; scheduled, and unscheduled. The worse-case control word output rate required of the computer is estimated to be less than 240 words per second for scheduled control. The unscheduled rate is less. The total rate imposes an insignificant load on the computer.
II. 1. 7 **MISCELLANEOUS DATA REQUIREMENTS.** This classification includes general-purpose film using equipment, and signal conditioners not included elsewhere.

II. 2 **DATA MANAGEMENT SYSTEM FUNCTIONAL DESCRIPTION**

The Data Management System functional capabilities are illustrated in Figure II-1. Its functional capabilities are most conveniently described by considering each of its major functions separately. These are presented in the following sections, along with block diagrams illustrating the equipment and functional inter-relationships. The software functional blocks shown are not intended to illustrate all software functions, rather, only those necessary to describe how the computer functions with its associated peripheral equipment. The quantity of equipment units required will vary according to overall data management requirements. However, the functional design of the system is intended to be independent of load, within anticipated bounds.

A summary of data management equipment is shown in Table II-1. The weight, power, and volume requirements for the smaller payloads shown in the table appear unreasonably high. This is due to the assumption that all basic DMS capabilities would be included for the smaller Life Sciences payloads, and the DMS would be shared by other FPE payloads.

II. 2. 1 **PCM DATA HANDLING.** Functional capabilities for handling PCM data are illustrated by the PCM Data Control Unit shown in Figure II-2 and the PCM Data Acquisition Unit shown in Figure II-3. PCM data acquisition is controlled by the data management computer, by execution of the data acquisition program. Modification and initial execution of this program is by operator control. During initial execution, direct-memory-access (DMA) channels of the computer and a peripheral PCM data formatter are "setup". Thereafter, all PCM data acquisition operations proceed automatically under control of the DMA channels and PCM data formatter.

During normal operation, the formatter issues a word transfer request (at a rate specified during setup) to the data request output DMA channel. The DMA channel accesses the data request buffer (in computer core storage) for the next data request and outputs it to the formatter and the common data bus, via a bus interface unit. The data request is actually a function code, and the address of a PCM data acquisition unit and one of its multiplexer channels. In other words, the address of the data source. The multiplexer channel is sampled, and the resultant data word is sent to the formatter via the common data bus. The formatter holds the address and data word for a length of time sufficient to maintain the constant word rate specified during the setup. The formatter then issues a word transfer request to the computer data input DMA channel. The DMA channel inputs the data word and stores it in the PCM data input table (in
Figure II-1. Data Management System Function Block Diagram
Table II-1. Data Management System Equipment Summary

<table>
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<th>Equipment Group</th>
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Figure II-2. PCM Data Control Unit - DMS
Figure II-3. PCM Data Acquisition Unit – DMS
computer core storage) at a location derived from the address. Note that the address serves as a unique number to identify each measurement, its source, and its location in the PCM data input table.

Two data request buffers are used. The buffers are alternately emptied by the data request DMA channel, and alternately filled by the request file DMA channel which transfers requests from the quick-access storage. The size of a data request buffer is defined as a data frame. The size of the data request file is a multiple of the data request buffer size, and is defined as a data cycle.

There are no hardware limitations as to how often one multiplexer channel is sampled relative to another, or in the order that they are sampled. These are software functions, and are determined solely by how often and in what sequence the data requests appear in the data request file. Intermittent, high sampling rate acquisition of a few sources is accommodated without modifying the basic data cycle. This is done by initially formatting the data request file with unused time slots dedicated to this purpose.

When the last data request of a frame in the data request buffer has been transferred out, the DMA channel issues an end-of-range interrupt to the computer. The computer then directs the DMA channel to the other buffer and initiates updating of the recently completed buffer. Data requests at the start of each frame are assigned addresses by the formatter. The formatter uses these time slots to merge frame sync code, frame number, format number, and time with the data word stream.

The PCM formatter also generates, and outputs a PCM bit stream in Miller code for recording on instrumentation tape and subsequent transfer to ground. As an example; current techniques allow a PCM Miller code at a rate of 62,500 bps to be recorded at a tape speed of 4.8 CM per second (1-7/8 inches per second). One track of a tape, 1463 meters (4800 ft) in length, would store over 8 hours of data. The tape is played back at a speed of 304.8 CM per second (120 ips), requiring less than 8 minutes, and would produce a transfer rate of $4 \times 10^8$ bps. One track of the tape could store almost $2 \times 10^9$ bits. A 14-track tape could store over 112 hours of data (over $2 \times 10^{10}$ bits). Storage density would be over 12,990 bits per CM (33,000 bits per inch) per track.

The PCM data input table is the interface with all data user computer programs. The table is being constantly updated independently of process programs that use the data. Several processing programs can time-share the computer, each selecting only those measurements required, and at whatever rate they choose. A PCM data handling equipment list is shown in Table II-2.
<table>
<thead>
<tr>
<th>Equipment Item</th>
<th>Weight kg (lbs)</th>
<th>Volume m³ (ft³)</th>
<th>Power Watts</th>
<th>Quantity Per Payload</th>
</tr>
</thead>
<tbody>
<tr>
<td>PCM Data Formatter</td>
<td>6.8</td>
<td>.011</td>
<td>15</td>
<td>MINI-7: 1, MINI-30: 1, Maxi-Nom: 1, Maxi-Max: 1</td>
</tr>
<tr>
<td>PCM Data Acquisition Unit</td>
<td>2.2</td>
<td>.003</td>
<td>10</td>
<td>MINI-7: 4, MINI-30: 6, Maxi-Nom: 8, Maxi-Max: 18</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Total Weight: 15.6, 20.0, 24.4, 46.4</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Total Volume: .023, .029, .035, .065</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Total Power: 55, 75, 95, 195</td>
</tr>
</tbody>
</table>
II. 2.2 ANALOG DATA HANDLING. Capabilities for handling analog data are illustrated by the Analog Data Handling Unit in Figure II-4, the Analog Data Interface Unit in Figure II-5, and the Wide-band Data Acquisition Unit in Figure II-6. The analog data handling system is a group of analog data acquisition, processing, signal conditioning, switching, and storage equipment interconnected by a network of wide-band data trunk lines.

Wide-band data acquisition units are used at remote locations where analog data sources, and users are concentrated. A selector unit at each acquisition unit is used by the experimenters to connect selected signal sources and users, in the vicinity, to the trunk lines. The trunk lines terminate at a switching matrix in an analog data handling unit. This analog data switching matrix is used by the experimenters to route signals between acquisition units, or between trunk lines and nearby, commonly used analog data handling equipment.

Most elements of the analog data handling system can be operated simultaneously, and independently of the others. Analog data may be handled independently of the data management computer, and the other data handling systems (PCM, video, audio, computer, and device control). However, three analog data links to the computer are provided for those operations that require computer support. One link is provided by signal lines from the analog data switching matrix to multiplexer channels of a PCM data acquisition unit. The PCM acquisition unit used would be one located near the switching matrix, and some of its multiplexer channels would be reserved for this purpose. The resultant acquired data would be incorporated into the PCM data stream. Another link is provided by signal lines from the switching matrix to an analog-to-digital converter that inputs data into the computer. The third link is provided by digital-to-analog converters for data from the computer to the analog data switching matrix.

Selector units of the wide-band data acquisition units are remotely controlled by a switching keyboard adjacent to the analog data switching matrix. This allows one experimenter, at a central location, to interconnect analog equipment to any configuration. All switching functions could readily be designed to operate under computer control, if more detailed requirements show this to be desirable. All commonly used analog data handling equipment (tape machines, oscilloscopes, strip-chart recorder, etc.) would be located near the analog data switching matrix for convenience of interconnection, and to minimize signal line lengths. A list of analog data handling equipment is shown in Table II-3. Trunk lines in the main laboratory, and the centrifuge are interfaced with RF links.

High frequency analog data are stored on instrumentation tape. The analog signals are converted to frequency modulated, constant bandwidth data. Several subcarriers are multiplexed together and recorded on a single track. During
Figure II-4. Analog Data Handling Unit - DMS
Figure II-5. Analog Data Interface Unit - DMS
Figure II-6. Wide-Band Data Acquisition Unit - DMS
<table>
<thead>
<tr>
<th>EQUIPMENT ITEM</th>
<th>Weight kg (lbs.)</th>
<th>Volume m³ (ft³)</th>
<th>Power Watts</th>
<th>MINI-7</th>
<th>MINI-30</th>
<th>MAXI-NOM</th>
<th>MAXI-MAX</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multiplexer and A/D converter (24)</td>
<td>3.6</td>
<td>.005</td>
<td>10</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Digital to Analog Converter (12)</td>
<td>1.4</td>
<td>.001</td>
<td>10</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Analog Data Switching Matrix</td>
<td>4.0</td>
<td>.005</td>
<td>30</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Analog Data Trunk Lines (12)</td>
<td>5.0</td>
<td>.005</td>
<td>-</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Analog Tape Signal Conditioner (12)</td>
<td>4.0</td>
<td>.002</td>
<td>30</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Analog Tape Machine (2)</td>
<td>36.4</td>
<td>.113</td>
<td>400</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Loop Tape Machine</td>
<td>10.0</td>
<td>.030</td>
<td>100</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Oscilloscope-Standard</td>
<td>12.0</td>
<td>.030</td>
<td>50</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Oscilloscope-Persistent</td>
<td>12.0</td>
<td>.030</td>
<td>50</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Strip-Chart Recorder-Low Freq.</td>
<td>10.0</td>
<td>.020</td>
<td>100</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Strip-Chart Recorder-High Freq.</td>
<td>15.0</td>
<td>.020</td>
<td>200</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Analog Time Code Translator</td>
<td>2.0</td>
<td>.002</td>
<td>5</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Time Display</td>
<td>1.0</td>
<td>.002</td>
<td>5</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Wide-band Data Acquisition Unit</td>
<td>5.0</td>
<td>.002</td>
<td>10</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>Switching Keyboard</td>
<td>2.0</td>
<td>.002</td>
<td>20</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Total Weight</th>
<th>MINI-7</th>
<th>MINI-30</th>
<th>MAXI-NOM</th>
<th>MAXI-MAX</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight (lbs.)</td>
<td>132.4 (290)</td>
<td>132.4</td>
<td>143.8</td>
<td>197.8</td>
<td></td>
</tr>
<tr>
<td>Volume (ft³)</td>
<td>.273 (9.6)</td>
<td>.273</td>
<td>.282</td>
<td>.345</td>
<td></td>
</tr>
<tr>
<td>Power</td>
<td>1020</td>
<td>1020</td>
<td>1040</td>
<td>1290</td>
<td></td>
</tr>
</tbody>
</table>
playback, the subcarriers are separated and frequency discriminated to reproduce the original analog signal. As an example, current techniques allow 12 analog signals, each with a frequency response of 500 Hz to be recorded on one track of tape. At a tape speed of 19.05 CM per second (7-1/2 inches per second), one track of a tape 1463 meters (4800 ft) in length could store more than 2 hours of data. A tape with 14 tracks could store more than a full day of continuous recording. A track of data could be played back at 304.8 CM per second (120 ips) and transmitted, using a 2 MHz bandwidth. This would require eight minutes of transmission.

II. 2.3 VIDEO DATA HANDLING. Functional capability for handling video data are illustrated by the Video Data Unit shown in Figure II-7, and the Wide-Band Data Acquisition Unit shown in Figure II-6. The video data handling system is a group of video equipment; such as cameras, camera commutators, monitors, switching, and tape machines interconnected by a network of wide-band data trunk lines.

The equipment and functions for the analog, video and audio data handling systems are similar, and should be packaged together to save weight and space wherever possible. A video data handling equipment list is shown in Table II-4.

II. 2.4 AUDIO DATA HANDLING. Functional capabilities for handling audio data are illustrated by the Audio Data Handling Unit shown in Figure II-8, and the wide-band Data Acquisition Unit shown in Figure II-6. The audio data handling system is a group of audio equipment; such as communication on sets, and switching and tape machines interconnected by a network of wide-band data trunk lines.

Audio communication terminals will be connected to selector units of the nearest wide-band data acquisition unit. The selector units are used to connect terminals to audio data trunk lines that terminate at a switching matrix in an audio data handling unit. The audio data switching matrix is used to route signals between acquisition units, or between trunk lines and nearby, commonly used audio data handling equipment, such as the audio tape machines. An audio data handling equipment list is shown in Table II-5.

II. 2.5 COMPUTER DATA HANDLING. The computer is the heart of the Data Management System, and has many data and control links with peripheral equipment. These links are summarized as follows:

a. PCM Data Control Unit (Refer to Figure II-2).
   1. Direct Input/Output (DI/O) to PCM Data Formatter for setup and control to the formatter, and status to the computer.
Figure II-7. Video Data Handling Unit - DMS
<table>
<thead>
<tr>
<th>EQUIPMENT LIST</th>
<th>Weight kg (lbs.)</th>
<th>Volume m$^3$ (ft$^3$)</th>
<th>Power Watts</th>
<th>Quantity Per Payload</th>
</tr>
</thead>
<tbody>
<tr>
<td>Video Data Switching Matrix</td>
<td>2.0</td>
<td>.002</td>
<td>20</td>
<td>1/1/1</td>
</tr>
<tr>
<td>Video Tape Machine (2)</td>
<td>35.0</td>
<td>.113</td>
<td>400</td>
<td>1/1/1</td>
</tr>
<tr>
<td>Video Data Truck Lines (4)</td>
<td>4.0</td>
<td>.003</td>
<td>-</td>
<td>1/1/1</td>
</tr>
<tr>
<td>T.V. Camera - Color</td>
<td>20.0</td>
<td>.020</td>
<td>100</td>
<td>1/1/1</td>
</tr>
<tr>
<td>T.V. Camera - B &amp; W</td>
<td>3.0</td>
<td>.010</td>
<td>25</td>
<td>1/1/1</td>
</tr>
<tr>
<td>T.V. Monitor</td>
<td>15.0</td>
<td>.030</td>
<td>50</td>
<td>1/1/2</td>
</tr>
<tr>
<td>Camera Commutator</td>
<td>2.0</td>
<td>.001</td>
<td>10</td>
<td>1/1/2</td>
</tr>
<tr>
<td><strong>Total Weight</strong></td>
<td><strong>81.0 (178)</strong></td>
<td><strong>81.0 (178)</strong></td>
<td><strong>98.0 (216)</strong></td>
<td><strong>122.0 (268)</strong></td>
</tr>
<tr>
<td><strong>Total Volume</strong></td>
<td><strong>.179 (6.3)</strong></td>
<td><strong>.179 (6.3)</strong></td>
<td><strong>.210 (7.4)</strong></td>
<td><strong>.257 (9.1)</strong></td>
</tr>
<tr>
<td><strong>Total Power</strong></td>
<td><strong>605</strong></td>
<td><strong>605</strong></td>
<td><strong>665</strong></td>
<td><strong>780</strong></td>
</tr>
</tbody>
</table>
Figure II-8. Audio Data Handling Unit - DMS
<table>
<thead>
<tr>
<th>EQUIPMENT ITEM</th>
<th>Weight kg (lbs.)</th>
<th>Volume m³ (ft³)</th>
<th>Power Watts</th>
<th>Quantity Per Payload</th>
<th>Total</th>
<th>Total Volume</th>
<th>Total Power</th>
</tr>
</thead>
<tbody>
<tr>
<td>Audio Data Switching Matrix</td>
<td>1.0</td>
<td>.001</td>
<td>10</td>
<td>MINI-7 MINI-30 MAXI-NOM MAXI-MAX</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Continuous Voice Recorder</td>
<td>2.5</td>
<td>.005</td>
<td>50</td>
<td>1 1 1 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Portable Voice Recorder</td>
<td>2.5</td>
<td>.005</td>
<td>50</td>
<td>1 1 1 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Audio Data Trunk Lines (4)</td>
<td>4.0</td>
<td>.003</td>
<td>-</td>
<td>1 1 1 2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wireless Communication Set</td>
<td>1.0</td>
<td>.002</td>
<td>50</td>
<td>1 1 1 2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stationary Communication Set</td>
<td>1.0</td>
<td>.002</td>
<td>20</td>
<td>1 1 2 3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Total Weight</strong></td>
<td><strong>12.0 (26)</strong></td>
<td><strong>12.0 (26)</strong></td>
<td><strong>13.0 (29)</strong></td>
<td><strong>26.0 (57)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Total Volume</strong></td>
<td><strong>.018 (.6)</strong></td>
<td><strong>.018 (.6)</strong></td>
<td><strong>.020 (.7)</strong></td>
<td><strong>.039 (1.4)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Total Power</strong></td>
<td><strong>180</strong></td>
<td><strong>180</strong></td>
<td><strong>200</strong></td>
<td><strong>390</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
2. Direct Memory Access (DMA) to PCM Data Formatter and Common Data Bus Interface Unit, for PCM data requests to the formatter and common data bus.

3. DMA to PCM Data Formatter for PCM data to computer.

4. DI/O to Time Code Translator for time words and clocks to computer.

b. Analog Data Interface Unit (Refer to Figure II-5).

1. DI/O to Analog-to-Digital Multiplexer Programmer for setup and control to the programmer, and status to the computer.

2. DMA to Analog-to-Digital Converter for digitized analog data to computer.

3. DI/O to Digital-to-Analog Converter for computer data and control to the converter, and status to the computer.

c. Computer Data Transfer and Storage Unit (Figure II-9).

1. DI/O to Computer Data Transfer Controller for setup and control to the controller, and status to the computer.

2. DMA to Computer Data Transfer Controller for data transfer to and from controller.

3. DI/O to Computer Tape Controller for setup and control to controller, and status to computer.

4. DMA to Computer Tape Controller for data transfer to and from controller.

5. DI/O to Quick-Access Storage Controller for setup and control to controller and status to computer.

6. DMA to Quick-Access Storage Controller for data transfer to and from controller.

d. Computer Graphics Control Unit (Figure II-10).

1. DI/O to Control/Display Bus Interface for setup, control and display data to interface; and status and data to computer.

2. DMA to Control/Display Bus Interface for display data from computer.

e. External Control Unit (Figure II-11).

1. DI/O to External Control Unit for setup, control and unscheduled control requests; and status to computer.
Figure II-9. Computer Data Transfer and Storage Unit - DMS
Figure II-10. Computer Graphics Control Unit - DMS
Figure II-11. External Control Unit - DMS
2. DMA to External Control Unit for scheduled control requests.

f. Other Links

1. Interrupts from above interfaced equipment, and miscellaneous other sources.

The functions of the computer when operating with the PCM Data Control Unit, Analog Data Interface Unit, and the External Control Unit are described in other sections of this report dealing with these units.

A hypothetical application for the Computer Data Graphics Control Unit is discussed below, and describe this systems' capabilities. Assume an experimenter wants to:

a. Monitor incoming ECG data during an experiment;

b. extract only the data during a representative interval;

c. perform a computer programmed waveform analysis on the extracted ECG data;

d. display results of the analysis in graphic form on a CRT;

e. add annotation to the CRT display;

f. store the CRT display on film;

g. store the raw data interval on tape as a computer data file; and

h. store the ECG analysis results in the quick-access storage as a computer data file.

The incoming data could enter the computer as part of the PCM data stream, or enter through the A/D converter, if acquired by the analog data handling system. The data could enter by both. Since ECG data are typically handled by the analog data handling system, it would be available at the analog data switching matrix. It is directed into the computer by using the Graphics Control Unit to setup the A/D multiplexer programmer and its associated DMA channel to the computer.

A graphics executive program is always resident in the computer to service the graphics control unit. To setup the analog data link to the computer, the experimenter gains the attention of this program by depressing a function key on the function keyboard. The executive program responds by displaying a
menu of available programs on an alphanumeric CRT. The experimenter points to the analog data acquisition program (included in the menu) with the light pen, and depresses its associated switch. The executive program then transfers the analog data acquisition program from the quick-access storage, and executes it. The acquisition program displays a menu of setup alternatives on the CRT. These include multiplexer channels to digitize, rate to digitize, and size of the analog data input buffer. The experimenter indicates his choice for these parameter using the light pen and switch. He then depresses a function key to start the operation. Thereafter the incoming digitized data stream repeatedly fills the analog data input buffer from top to bottom, automatically, under control of the A/D programmer and DMS channel.

The next step is to transfer the special process program into the computer, to be used to process the data. This is done in the same manner as was used for the analog data acquisition program. The special process program will display a menu of setup alternatives on the CRT. Generally, the setup specifies the software linkages between the analog data input buffer, the special process program, and the graphics display program. Some setup parameters cannot be specified by selection from a predetermined menu. In this case the alphanumeric keyboard is enabled when the light pen indicates what parameter is to be setup. The information is entered from the keyboard, and displayed on the CRT. All selections made with the light pen are displayed. After he is satisfied that the setup is correct, the experimenter depresses a function key to start the operation.

The next step is to call the graphics display program, and specify its setup. This is done in the same manner as above. Many setup specifications are required. A basic graphic display format is chosen from a file of standard formats, and the keyboard is used to add annotations to the format. The format chosen is probably one to display a graphical time history. The time length of the displayed interval, the display scales, and the method used for "paging" the display frame are chosen. After he is satisfied that the setup is correct, the experimenter depresses a function key to start the operation. The incoming data are displayed on the CRT in real-time. Time is always available to the computer, and the time scale is updated for each new page.

The graphic display program enables, and is able to service, most of the control equipment of the computer graphics control unit. The experimenter is able to apply human judgments to the process by using the control equipment, primarily the function keys. In this example he monitors the incoming data being displayed on the CRT until he is ready to select a representative interval. Several methods are available to do this. One way is to depress a function key at the beginning, and at the end of the interval. Another way is to enter the start and stop time through the keyboard. The graphic display program automatically extracts this interval if a function key has "armed" this function of
the program. Another way is to enter the interval length and arm a function key that is depressed by the experimenter whenever he chooses to designate the start of an interval. A waveform analysis is performed on the extracted data by the special process program, the results of the analysis are displayed on the CRT, and both the raw data and results are temporarily stored until disposition is made by function key action. The experimenter probably would choose a display mode that would hold the extracted interval of raw data on the CRT. The results would be added to that display.

A function key is used to couple a slave CRT to the graphic CRT. The copied image on the slave CRT is recorded on film, by a camera fixed to the slave CRT for this purpose. Other function keys direct the data intervals to be stored in the medium specified.

Another example of the use of the graphics control unit is described below. In this example the experimenter wishes to review information previously stored by the computer. The file maintenance program is used.

This program maintains a complete file of all computer data files and has the subroutines to retrieve, display, modify, and store entries of most of these files. A typical use of the file maintenance program might be to replace an existing transducer calibration in the instrumentation file with a new entry. The station operator, using the function keyboard, initiates this action by requesting the graphics executive to display a menu of application programs on the alphanumeric CRT. The light pen is then positioned on the face of the CRT to select the file maintenance program.

The executive transfers the file maintenance program to CORE, and initiates its execution. The file maintenance program displays a menu of files on the CRT. The operator selects the instrumentation file as described above. The file maintenance program transfers the instrumentation file to CORE, displays the index or first page of the file on the CRT, and enables certain function keys. In general, the function keys are assigned general-purpose functions, which are used with many different application programs. All keys have status lights to indicate "enabled" or "active" status. In this example, the first desired function would possibly be to locate and display the current transducer calibration entry. This could be done in several ways. If the file is indexed, the entry could be selected using the light pen. Or, the file could be scanned a page (CRT display frame) at a time using the "page advance" function key. After the desired page is displayed, other function keys allow a light pen indicated entry on the page to be deleted, or another entry created on the alphanumeric keyboard to be inserted.

A computer data handling equipment list is shown in Table II-6.
<table>
<thead>
<tr>
<th>EQUIPMENT ITEM</th>
<th>Weight (kg)</th>
<th>Volume (\text{m}^3) (ft(^3))</th>
<th>Power Watts</th>
<th>Quantity Per Payload</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computer Central Processing Unit</td>
<td>25.0</td>
<td>0.025</td>
<td>60</td>
<td>1</td>
</tr>
<tr>
<td>Computer Core Storage, 32 K</td>
<td>15.0</td>
<td>0.015</td>
<td>40</td>
<td>1</td>
</tr>
<tr>
<td>Computer Tape Machines (2)</td>
<td>35.0</td>
<td>0.150</td>
<td>400</td>
<td>1</td>
</tr>
<tr>
<td>Quick-Access Storage (1 M words)</td>
<td>50.0</td>
<td>0.150</td>
<td>600</td>
<td>1</td>
</tr>
<tr>
<td>Computer Data Transfer Unit</td>
<td>1.0</td>
<td>0.002</td>
<td>20</td>
<td>1</td>
</tr>
<tr>
<td>Time Code Generator/Translator</td>
<td>2.5</td>
<td>0.002</td>
<td>7</td>
<td>1</td>
</tr>
<tr>
<td>Common Data Bus. &amp; Control</td>
<td>8.0</td>
<td>0.010</td>
<td>30</td>
<td>1</td>
</tr>
<tr>
<td>Control/Display Bus. &amp; Control</td>
<td>5.0</td>
<td>0.004</td>
<td>30</td>
<td>1</td>
</tr>
<tr>
<td>Graphics Controller</td>
<td>8.0</td>
<td>0.015</td>
<td>30</td>
<td>1</td>
</tr>
<tr>
<td>Alphanumeric Keyboard</td>
<td>1.0</td>
<td>0.003</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Function Keyboard</td>
<td>1.0</td>
<td>0.003</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Cursor and Light Pen</td>
<td>0.5</td>
<td>0.001</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Graphic CRT</td>
<td>15.0</td>
<td>0.070</td>
<td>50</td>
<td>1</td>
</tr>
<tr>
<td>Alphanumeric CRT</td>
<td>12.0</td>
<td>0.050</td>
<td>40</td>
<td>1</td>
</tr>
<tr>
<td>Status Light Display (80)</td>
<td>1.5</td>
<td>0.003</td>
<td>10</td>
<td>1</td>
</tr>
<tr>
<td>Numeric Display (5×10)</td>
<td>1.5</td>
<td>0.003</td>
<td>10</td>
<td>1</td>
</tr>
<tr>
<td>Slave CRT and Camera</td>
<td>15.0</td>
<td>0.070</td>
<td>50</td>
<td>1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>MINI-7</th>
<th>MINI-30</th>
<th>MAXI-NOM</th>
<th>MAXI-MAX</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Weight</strong></td>
<td>195.0</td>
<td>195.0</td>
<td>211.5</td>
<td>307.0</td>
</tr>
<tr>
<td><strong>Volume</strong></td>
<td>.476</td>
<td>.476</td>
<td>.494</td>
<td>.829</td>
</tr>
<tr>
<td><strong>Power</strong></td>
<td>1385</td>
<td>1385</td>
<td>1435</td>
<td>2201</td>
</tr>
</tbody>
</table>
II. 2.6 MISCELLANEOUS DATA HANDLING. A list of miscellaneous data handling equipment is shown in Table II-7. Most of items in the list are general purpose cameras.

II. 3 COMPUTER CONTROL OF DEVICES

Capabilities of the computer to control devices are illustrated by the External Control Unit shown in Figure II-11. The Device Control Unit is shown in Figure II-12. Computer control of equipment is provided by a device control program executed in the computer, and an associated external control unit peripheral to the computer. Modification, and initial execution of this program is by operator control. During initial execution, a DMA channel of the computer and the external control unit are "setup". Thereafter all device control operations proceed automatically, under control of the DMA channels and external control unit.

During initial execution of the device control program, the first device control request is transferred from the computer to the device control unit. A device control request is actually a function code, an address of a device control unit and one of its associated demultiplexer channels, and time. In other words, the address of the device, and the time when the control is to be executed. During normal operation, the device control unit holds the next control request to be executed. It continuously compares current time with the time specified in the request. When these match, the control request is outputed to the common data bus, via a bus interface unit, and is received by the addressed device via its device control unit.

After the external control unit disposes of its current request, it issues a transfer request to the control request output DMA channel. The DMA channel accesses the control request buffer (in computer core storage) for the next control request, and outputs it to the external control unit. Two control request buffers are used. The buffers are alternately emptied by the control request DMA channel, and alternately filled by the control file DMA channel. The size of a request buffer is defined as a control frame. The size of the control request file is a multiple of the request buffer size, and is defined as a control cycle. There are no hardware limitation, as to how often one device is activated relative to another, or in the order that they are activated. These are software functions, and are determined solely by how often and in what sequence the control requests appear in the request file.

When the last control request of a frame in the control request buffer has been transferred out, the DMA channel issues an end-of-range interrupt to the computer. The computer then directs the DMA channel to the other buffer and initiates updating of the recently completed buffer.
Table II-7. Miscellaneous Data Equipment List – DMS

<table>
<thead>
<tr>
<th>EQUIPMENT ITEM</th>
<th>Weight</th>
<th>Volume</th>
<th>Power Watts</th>
<th>Quantity Per Payload</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>kg</td>
<td>m³</td>
<td></td>
<td>MINI-7</td>
</tr>
<tr>
<td>Polaroid Camera</td>
<td>1.3</td>
<td>.001</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Roll Film Camera</td>
<td>2.3</td>
<td>.003</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Movie Camera</td>
<td>.5</td>
<td>.008</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Plate Film Camera</td>
<td>1.3</td>
<td>.002</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Misc. Signal Conditioners</td>
<td>1.3</td>
<td>.002</td>
<td>5</td>
<td>1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Total Weight</th>
<th>MINI-7</th>
<th>MINI-30</th>
<th>MAXI-NOM</th>
<th>MAXI-MAX</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(Total)</td>
<td>(15)</td>
<td>(15)</td>
<td>(15)</td>
<td>(26)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Total Volume</th>
<th>MINI-7</th>
<th>MINI-30</th>
<th>MAXI-NOM</th>
<th>MAXI-MAX</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(.53)</td>
<td>(.53)</td>
<td>(.53)</td>
<td>(.53)</td>
<td>(.71)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Total Power</th>
<th>MINI-7</th>
<th>MINI-30</th>
<th>MAXI-NOM</th>
<th>MAXI-MAX</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>10</td>
<td></td>
</tr>
</tbody>
</table>
Figure II-12. Device Control Unit - DMS
The above described operation serves to control devices on a time-scheduled basis only. This is useful for experiments that are well planned in advance, and require a scheduled cyclic operation of equipment. However, equipment control for many applications cannot be scheduled. When a device is to be activated, will depend upon some predetermined criteria being met, which might be sensed by a processing program from incoming data. Or, the pace of equipment operation must be under control of an experimenter. For this reason, the external control unit has the capability to issue unscheduled control requests. These requests are transferred directly to the external control unit by any processing program. These requests are acted upon immediately, but do not disrupt the scheduled operations. Several processing programs can time-share the computer, each issuing control requests independently of the others. A computer device control equipment list is shown in Table II-8.

II.4 ALTERNATIVE APPROACHES

Many trade-offs must be considered, and resolved before a firm configuration can be selected for the Data Management System. During this contract, the approach used was to define the independent equipment necessary to satisfy the Life Sciences payload with minimum constraints imposed by the supporting vehicle and mission. This was discussed in Appendix, where it was pointed out that the next recommended follow-on phase to this study would investigate the interface and integration aspects of the preliminary designs presented herein. It is anticipated that the Data Management System penalties presented in the preceding section could be substantially reduced as a result of such studies. Several aspects of such integration are as follows:

a. Share a Data Management System with other payloads. The DMS sized for the Maxi Nom payload could provide data management services to other FPE payloads similar to the Life Sciences Mini-7. Figure II-13 shows curves (solid lines) for weight, volume, and power required for data management equipment listed for each of the four payloads as a function of the length of the module required. The lists were compiled under the assumption that all basic DMS capabilities would be included for small payloads. The solid curves indicate unrealistically high DMS loads for the small payloads. The dotted curves have the shape one would expect, and are probably reasonable estimates to use for DMS properties, assuming a DMS shared by other than Life Science payloads.

b. Use some data management functions available on board the support modules. The weight, volume, and power requirements of the DMS presented herein could be considerably reduced if some of its functions are provided by the support module. The data storage function (for data never, or seldom, retrieved for on-board use) could be moved to the support module. This would move two instrumentation tape machines, two video tape
Table II-8. Computer Device Control Equipment List - DMS

<table>
<thead>
<tr>
<th>EQUIPMENT ITEM</th>
<th>Weight kg (lbs.)</th>
<th>Volume m³ (ft.³)</th>
<th>Power Watts</th>
<th>Quantity Per Payload</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>MINI-7</td>
<td>MINI-30</td>
</tr>
<tr>
<td>External Control Unit</td>
<td>4.0</td>
<td>.005</td>
<td>20</td>
<td>1</td>
</tr>
<tr>
<td>Device Control Unit</td>
<td>2.0</td>
<td>.003</td>
<td>10</td>
<td>3</td>
</tr>
</tbody>
</table>

|                        | Total Weight     |                  |             |         |          |          |
|                        | 10.0             | (22)             | 12.0        | (26)    | 16.0     | (35)     |
|                        | 28.0             | (62)             |             |          |          |

|                        | Total Volume     |                  |             |         |          |          |
|                        | .014             | (.49)            | .017        | (.60)   | .023     | (.81)    |
|                        | .041             | (1.45)           |             |          |          |

|                        | Total Power      |                  |             |         |          |          |
|                        | 50               |                  | 60          |          | 80       | 140      |
Figure II-13. Data Management System Requirements - Weight, Volume, Power
machines, two computer tape machines, and one audio tape machine to the support module. The portable audio tape machine, and the loop analog tape machine would not be moved. The DMS weight would be reduced by 129 Kg, volume by 0.346 m$^3$, and power by 1250 watts. This represents a more than one-third reduction in the case of the Mini-7 payload, and almost one-fourth for Maxi Max.

It appears unlikely that the data management computer could be moved to the support module and still retain the flexibility that a dedicated computer would also have to be moved, or their interfaces designed to operate through a common data bus. Some equipment, such as the computer graphics control unit, must be located in the experimenter work area.

c. Provide experiment setup, monitoring, control, data processing, and analysis using ground facilities. The DMS presented herein provides audio, analog, video, and computer data links to the support module that can be used for real-time data, or command transmission. Command and control data are transferred from the support module as computer data files. However, if the function of experiment setup, monitoring, control, data processing, and data analysis are to be handled primarily by ground facilities continuously in real-time (or nearly so), then; the DMS should be tailored for this mode of operation. This mode would require more automation of such functions as signal switching. A communication system might have to be added. Data storage requirements would probably be reduced. However, an automatic, short-term, continuous "fill and dump" capability might be required. Much of the signal monitoring and computer graphics capability would not be required. Communication satellites would probably have to be used.

d. Use of the same common data bus system for the Life Science DMS, RAM, SS, and Shuttle, was not discussed in detail in the functional description of the DMS. Candidate common data bus systems are being studied under other current contracts for RAM and Shuttle. For the sake of commonality, the system chosen for these vehicles should be used. The DMS organization presented herein is intended to be independent of the bus system used.
This appendix contains the operations model (Section III-1) and the equipment operations analysis (Section III-2), which are the basis for the crew and equipment research analyses discussed in Section 2.3, Volume II.

III.1 OPERATIONS MODEL

The Life Sciences payloads are based on the "Facility Approach", and consequently there are no specific experiments scheduled to be conducted within the laboratory. In order to make preliminary estimates of experiment/schedule-dependent factors; such as average power requirements, crew size and skill requirements, passageway/work-space volume requirements, and ECS requirements, it is necessary to develop an operations model upon which these estimates can be based. This model consists of each of the functions to be performed within the laboratory, and an estimate of the frequency of occurrence of each. These frequencies are considered to be reasonable estimates of the character of the operations within the Maxi Max laboratory. Average frequencies have been assumed for sporadic functions; that is, functions that occur quite frequently for a period, then not at all for a subsequent period.

The functions and their assumed frequencies are grouped in the following categories and presented in Table III-1.

a. Experiment Measurements and Analysis
b. Support Operations
c. Speciment Maintenance
d. Equipment Maintenance.

The types of operations associated with the above categories are manual, semiautomatic, and automatic.

freq = expected frequency
hr (hrs) = hour(s)
dy (dys) = day(s)
wk (wks) = week(s)
mo = month
c = continuous operation
as re'q = as required
Table III-1. Operations Model Maxi Max Payload

1. EXPERIMENT MEASUREMENTS AND ANALYSIS

MANUAL AND SEMIAUTOMATIC

9 1 ORGANISM MASS MEASUREMENTS
9  FREQ = 30/90 DYS

17 11 MONITOR ECG (FOR BIORESEARCH - ECG SIGNAL MGMT FROM CAGE TO CAGE
17 21 MOD TO DATA MGMT)
17B  FREQ = 3/WK - HARDWIRE MULTIPLEX DATA TO DM (CREW CK FREQ)
17C  FREQ = 2/WK - XMTR ON ORGANISM/RECVR AT CG MOD
17F  FREQ = 6/WK - ELECTROPHYSIOLOGY BACKPACK=MAN

18 11 MONITOR EEG (FOR BIORESEARCH - EEG SIGNAL MGMT FROM CAGE TO CAGE
18 21 MOD TO DATA MGMT)
18B  FREQ = 3/WK - HARDWIRE MULTIPLEX DATA TO DM (CREW CK FREQ)
18C  FREQ = 2/WK - XMTR ON ORGANISM/RECVR AT CG MOD
18F  FREQ = 3/WK - ELECTROPHYSIOLOGY BACKPACK=MAN
18G  FREQ = 3/DY - DISCRETE MONITORING UNITS-MAN-PORTABLE
18H  FREQ = 2/WK - ELECTROPHYSIOLOGY CONSOLE-MAN-FIXED SYS

19 1 MONITOR EMG-EMG SIGNAL MGMT CAGE TO CAGE MOD TO DATA MGMT
<table>
<thead>
<tr>
<th>ID</th>
<th>Test Description</th>
<th>Frequency</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>19B</td>
<td>HARDWIRE MULTIPLEX DATA TO DM (CREW CK FREQ)</td>
<td>3/WK</td>
<td>HARDWIRE MULTIPLEX DATA TO DM (CREW CK FREQ)</td>
</tr>
<tr>
<td>19C</td>
<td>XMTR ON ORGANISM/RECVR AT CG MOD</td>
<td>2/WK</td>
<td>XMTR ON ORGANISM/RECVR AT CG MOD</td>
</tr>
<tr>
<td>19F</td>
<td>ELECTROPHYSIOLOGY BACKPACK-MAN</td>
<td>3/WK</td>
<td>ELECTROPHYSIOLOGY BACKPACK-MAN</td>
</tr>
<tr>
<td>20</td>
<td>RESPIRATORY RATE MONITORING- DOES NOT INCLUDE RESP VOLUME</td>
<td>12/WK</td>
<td>RESPIRATORY RATE MONITORING- DOES NOT INCLUDE RESP VOLUME</td>
</tr>
<tr>
<td>20B</td>
<td>PLYTHESMOMOGRAPH ON ORGANISM</td>
<td></td>
<td>PLYTHESMOMOGRAPH ON ORGANISM</td>
</tr>
<tr>
<td>21</td>
<td>CARDIAC OUTPUT- IMPLANTED FLOW XDCR=SIGNAL XFR TO DM AS FUNC 17</td>
<td>3/WK</td>
<td>CARDIAC OUTPUT- IMPLANTED FLOW XDCR=SIGNAL XFR TO DM AS FUNC 17</td>
</tr>
<tr>
<td>21A</td>
<td>CATHETERIZED SEMIRESTRAINED</td>
<td>2/WK</td>
<td>CATHETERIZED SEMIRESTRAINED</td>
</tr>
<tr>
<td>21B</td>
<td>ULTRASONIC FLOWMETER</td>
<td>2/WK</td>
<td>ULTRASONIC FLOWMETER</td>
</tr>
<tr>
<td>24</td>
<td>WATER CONSUMPTION -WATER CONSUMED OR WATER DELIVERED</td>
<td>10/WK</td>
<td>WATER CONSUMPTION -WATER CONSUMED OR WATER DELIVERED</td>
</tr>
<tr>
<td>24B</td>
<td>VOL OR MASS OF WATER BAG/BOT</td>
<td></td>
<td>VOL OR MASS OF WATER BAG/BOT</td>
</tr>
<tr>
<td>26</td>
<td>LIQUID VOLUME MSMTS- MICRO VOLUMES 0.001 ML TO 1 ML</td>
<td>3/DY</td>
<td>LIQUID VOLUME MSMTS- MICRO VOLUMES 0.001 ML TO 1 ML</td>
</tr>
<tr>
<td>26A</td>
<td>MICROPETITES</td>
<td></td>
<td>MICROPETITES</td>
</tr>
<tr>
<td>26B</td>
<td>MICROSYRINGES</td>
<td></td>
<td>MICROSYRINGES</td>
</tr>
<tr>
<td>27</td>
<td>LIQUID VOLUME MSMTS- MACRO 1 ML TO 1000 ML</td>
<td>15/DY</td>
<td>LIQUID VOLUME MSMTS- MACRO 1 ML TO 1000 ML</td>
</tr>
<tr>
<td>28</td>
<td>MASS MEASUREMENTS OF CONTAINED LIQUIDS AND SOLIDS - 0.001-100 GRAMS</td>
<td>6/DY</td>
<td>MASS MEASUREMENTS OF CONTAINED LIQUIDS AND SOLIDS - 0.001-100 GRAMS</td>
</tr>
<tr>
<td>28B</td>
<td>MICROVOLUMES</td>
<td></td>
<td>MICROVOLUMES</td>
</tr>
<tr>
<td>29</td>
<td>MASS MEASUREMENTS- CONTAINED LIQUIDS AND SOLIDS - 10-1000 GRAMS</td>
<td>9/DY</td>
<td>MASS MEASUREMENTS- CONTAINED LIQUIDS AND SOLIDS - 10-1000 GRAMS</td>
</tr>
<tr>
<td>30</td>
<td>GROSS ANATOMIES-ASSESSMENT OF MAJOR ORGANS-SIZE SHAPE MASS COLOR</td>
<td>3/WK</td>
<td>GROSS ANATOMIES-ASSESSMENT OF MAJOR ORGANS-SIZE SHAPE MASS COLOR</td>
</tr>
<tr>
<td>34</td>
<td>BLOOD ELECTROLYTES</td>
<td></td>
<td>BLOOD ELECTROLYTES</td>
</tr>
<tr>
<td>34B</td>
<td>ATOMIC ABSORPTION</td>
<td></td>
<td>ATOMIC ABSORPTION</td>
</tr>
<tr>
<td>34C</td>
<td>PRESERVE FOR GROUND ANALYSIS</td>
<td></td>
<td>PRESERVE FOR GROUND ANALYSIS</td>
</tr>
<tr>
<td>35</td>
<td>BLOOD PH PC02 0.2 MSUR CONC OF DISSOLVED GS IN BLOOD</td>
<td>2/WK</td>
<td>BLOOD PH PC02 0.2 MSUR CONC OF DISSOLVED GS IN BLOOD</td>
</tr>
<tr>
<td>36</td>
<td>BLOOD TOTAL PROTEIN MSUR CONC IN SERUM OR WHOLE BLOOD</td>
<td>10/WK</td>
<td>BLOOD TOTAL PROTEIN MSUR CONC IN SERUM OR WHOLE BLOOD</td>
</tr>
<tr>
<td>36C</td>
<td>ELECTROPHORESIS</td>
<td></td>
<td>ELECTROPHORESIS</td>
</tr>
<tr>
<td>39</td>
<td>THYROID FUNCTION TESTS- SERUM STABLE WHEN IF ALL CELLS REMOVED</td>
<td>6/WK</td>
<td>THYROID FUNCTION TESTS- SERUM STABLE WHEN IF ALL CELLS REMOVED</td>
</tr>
<tr>
<td>40</td>
<td>BLOOD MORPHOLOGY AND CELL COUNTS</td>
<td>20/WK</td>
<td>BLOOD MORPHOLOGY AND CELL COUNTS</td>
</tr>
<tr>
<td>41</td>
<td>HEMATOCRIT MSUR OF PACKED CELL VOL TO TOTAL VOL</td>
<td>4/WK</td>
<td>HEMATOCRIT MSUR OF PACKED CELL VOL TO TOTAL VOL</td>
</tr>
<tr>
<td>42</td>
<td>MSUR CONC OXYHGB OR CARBOXYHGB</td>
<td>4/WK</td>
<td>MSUR CONC OXYHGB OR CARBOXYHGB</td>
</tr>
<tr>
<td>43</td>
<td>RBC OSMOTIC FRAGILITY- MSUR RUPTURE PRESSURE OF RBC</td>
<td>4/WK</td>
<td>RBC OSMOTIC FRAGILITY- MSUR RUPTURE PRESSURE OF RBC</td>
</tr>
<tr>
<td>44</td>
<td>IMMUNOGLOBIN ASSAY- MSUR ANTIBODY FORMATION</td>
<td>2/WK</td>
<td>IMMUNOGLOBIN ASSAY- MSUR ANTIBODY FORMATION</td>
</tr>
<tr>
<td>44C</td>
<td>DISC GEL ELECTROPHORESIS</td>
<td></td>
<td>DISC GEL ELECTROPHORESIS</td>
</tr>
<tr>
<td>45</td>
<td>RBC OSMOTIC FRAGILITY- MSUR RUPTURE PRESSURE OF RBC</td>
<td>4/WK</td>
<td>RBC OSMOTIC FRAGILITY- MSUR RUPTURE PRESSURE OF RBC</td>
</tr>
<tr>
<td>46</td>
<td>IMMUNOGLOBIN ASSAY- MSUR ANTIBODY FORMATION</td>
<td>2/WK</td>
<td>IMMUNOGLOBIN ASSAY- MSUR ANTIBODY FORMATION</td>
</tr>
<tr>
<td>46C</td>
<td>PRESERVE FOR GROUND ANALYSIS</td>
<td></td>
<td>PRESERVE FOR GROUND ANALYSIS</td>
</tr>
<tr>
<td>48</td>
<td>ANTIBODY TITRATION- DETERMINE ANTIBODY CONC TO SPECIFIC DISEASE</td>
<td></td>
<td>ANTIBODY TITRATION- DETERMINE ANTIBODY CONC TO SPECIFIC DISEASE</td>
</tr>
</tbody>
</table>
Table III-1. Operations Model Maxi Max Payload, Contd

<table>
<thead>
<tr>
<th>Operation</th>
<th>Frequency</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>48A</td>
<td>2/ wk</td>
<td>Interfacial test in agar</td>
</tr>
<tr>
<td>48B</td>
<td>2/ wk</td>
<td>Preserve for ground analysis</td>
</tr>
<tr>
<td>49</td>
<td></td>
<td>Pressure monitoring</td>
</tr>
<tr>
<td>49A</td>
<td></td>
<td>3/ dy - Meters visual readout</td>
</tr>
<tr>
<td>51</td>
<td></td>
<td>Trace gas analysis hydrocarbons - specific compound/predicted list</td>
</tr>
<tr>
<td>51A</td>
<td>20 min/ dy</td>
<td>Gas chromatography</td>
</tr>
<tr>
<td>51B</td>
<td>2/ dy</td>
<td>Mass spectroscopy</td>
</tr>
<tr>
<td>51C</td>
<td>2/ dy</td>
<td>Infrared absorption</td>
</tr>
<tr>
<td>53</td>
<td></td>
<td>Oxygen monitoring</td>
</tr>
<tr>
<td>53A</td>
<td></td>
<td>2/ dy - Polarographic sensor</td>
</tr>
<tr>
<td>57</td>
<td></td>
<td>Water vapor monitoring</td>
</tr>
<tr>
<td>57C</td>
<td></td>
<td>2/ dy - Specific sensors</td>
</tr>
<tr>
<td>63</td>
<td></td>
<td>Radiation monitoring</td>
</tr>
<tr>
<td>63A</td>
<td>1/ wk</td>
<td>For each of 110 badges - film sensors</td>
</tr>
<tr>
<td>63C</td>
<td>1/ mo</td>
<td>Rate monitoring</td>
</tr>
<tr>
<td>69</td>
<td></td>
<td>Carbohydrate analysis - soluble/insoluble</td>
</tr>
<tr>
<td>69</td>
<td></td>
<td>5/ wk</td>
</tr>
<tr>
<td>78</td>
<td></td>
<td>Invertebrate counting and sorting (insects)</td>
</tr>
<tr>
<td>78</td>
<td></td>
<td>30 min/ dy</td>
</tr>
<tr>
<td>85</td>
<td></td>
<td>Starch granule assay</td>
</tr>
<tr>
<td>85</td>
<td></td>
<td>2/ wk</td>
</tr>
<tr>
<td>86</td>
<td></td>
<td>Bacterial colony counting</td>
</tr>
<tr>
<td>86</td>
<td></td>
<td>10/ wk</td>
</tr>
<tr>
<td>87</td>
<td></td>
<td>Microorganism identification</td>
</tr>
<tr>
<td>87</td>
<td></td>
<td>15/ wk</td>
</tr>
<tr>
<td>91</td>
<td></td>
<td>Plant radiochemistries</td>
</tr>
<tr>
<td>91</td>
<td></td>
<td>16/2 wks</td>
</tr>
<tr>
<td>92</td>
<td></td>
<td>Vertebrate radiochemistries</td>
</tr>
<tr>
<td>92</td>
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<td>Invertebrate radiochemistries</td>
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<td>94</td>
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<td>Cells and tissue radiochemistries</td>
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<td>94</td>
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<td>16/2 wks</td>
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<td>108</td>
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<td>Bacterial cell counting</td>
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<tr>
<td>108A</td>
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<td>Automatic cell counters</td>
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<td>108B</td>
<td>2/ wk</td>
<td>Hematocrit</td>
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<td>108C</td>
<td>3/ mo</td>
<td>Vital staining</td>
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<td>141</td>
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<td>Airparticulate sampling and analysis</td>
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<tr>
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<td></td>
<td>2/ dy</td>
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<tr>
<td>149</td>
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<td>Urine analysis</td>
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<td>1/ wk (set up)</td>
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<tr>
<td>149C</td>
<td>5/ wk</td>
<td>Preserve for ground analysis</td>
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<td>155</td>
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<td>Urinary phosphates</td>
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<td>Frequency</td>
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<tr>
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<tr>
<td>155</td>
<td>FREQ - 16/WK</td>
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<tr>
<td>156</td>
<td>1 URINE CREATININE AND CREATINE</td>
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<td>161</td>
<td>1 ARTERIAL BLOOD PRESSURE</td>
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<td>162</td>
<td>1 X-RAY DIAGNOSTIC</td>
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<td>1 PERIPHERAL VENOUS BLOOD PRESSURE</td>
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<td>1 TV MONITORING AD HOC - COMMERCIAL GRADF. COLOR</td>
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<td>173</td>
<td>1 PLANT LIPIDS</td>
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<td>174</td>
<td>11 ENZYME ASSAY - RECOMMEND ASSAYS POSSIBLE ON CRUDE HEMOGENATES AND</td>
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<td>174</td>
<td>21 ONE STEP PARTIAL PURIFICATION ONLY FOR SPACE ANAL</td>
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<td>175</td>
<td>1 AMINO ACIDS ASSAY</td>
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<tr>
<td>175A</td>
<td>FREQ - 15 MIN/MO - AUTOMATIC ANALYSIS</td>
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<td>175B</td>
<td>FREQ - 5/MO - PRESERVE FOR GROUND ANALYSIS</td>
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<tr>
<td>177</td>
<td>1 PROTEIN ASSAY</td>
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<tr>
<td>177B</td>
<td>FREQ - 5/WK - PRESERVE FOR GROUND ANALYSIS</td>
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<td>177D</td>
<td>FREQ - 3/WK - AUTOMATIC BIOCHEMICAL ANALYZER</td>
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<td>180A</td>
<td>FREQ - 3/2 WKS - CHROMATOGRAPHY</td>
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<td>FREQ - 5/2 WKS - PRESERVE FOR GROUND ANALYSIS</td>
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<td>226</td>
<td>1 CELLS AND TISSUE POPULATION DENSITY</td>
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<td>1 LOWER BODY NEGATIVE PRESSURE (LBNP)</td>
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<td>1 EAR CANAL CALORIC STIMULATION</td>
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<td>1 SPATIAL LOCALIZATION</td>
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<td>308</td>
<td>1 ELECTRO-OCULOGRAM (EOG) 0.14-100Hz A-D AT LEAST 500 SAMP/SEC</td>
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<td>315</td>
<td>1 TOTAL BODY WATER</td>
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<td>316</td>
<td>1 AGRAVIC PERCEPTION</td>
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<td>1 OCULAR COUNTER-ROLLING</td>
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<tr>
<td>317</td>
<td>FREQ = 3/WK</td>
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<td>1 OCULOGLYRAL ILLUSION</td>
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<td>319</td>
<td>1 VECTORCARDIOGRAM (VCG) 0.05-500Hz A-D AT LEAST 2500 SAMPLE/SEC</td>
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<tr>
<td>319A</td>
<td>FREQ = 3/3 DYS - DISCRETE MONITORING UNITS-MAN</td>
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<td>319B</td>
<td>FREQ = 3/3 DYS - ELECTROPHYSIOLOGY BACKPACK-MAN</td>
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<td>320</td>
<td>1 PHONO/VIBROCARDIOGRAM (PCG/VBCG) 0.1-20Hz 10-30Hz 30-500Hz A-D</td>
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<td>320A</td>
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<td>321</td>
<td>1 IMPEDANCE CARDIOGRAPHY (ZCG) A-D 100 SAMPLES/SEC</td>
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<td>FREQ = 3/3 DYS - ELECTROPHYSIOLOGY BACKPACK-MAN</td>
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<td>322</td>
<td>1 VENOUS BLOOD PRESSURE -INVASIVE DURING VENIPUNCTURE</td>
<td>6/2 WKS</td>
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<td>324</td>
<td>1 PULSE WAVE VELOCITY</td>
<td>4/2 WKS</td>
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<td>325</td>
<td>1 PULSE WAVE CONTOUR</td>
<td>2/WK</td>
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<td>326</td>
<td>1 BALLISTOCARDIOGRAPHY (BCG) AT LEAST 800 SAMPLES PER SEC</td>
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<td>326A</td>
<td>FREQ = 3/WK - DISCRETE MONITORING UNITS-MAN</td>
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<td>FREQ = 3/WK - ELECTROPHYSIOLOGY BACKPACK-MAN</td>
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<td>327</td>
<td>1 RESPIRATORY VITAL CAPACITY (VC); TIMED VITAL CAPACITY (VC1,VC3)</td>
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<td>327A</td>
<td>FREQ = 6/2 WKS - DISCRETE MONITORING UNITS MAN</td>
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<td>FREQ = 6/2 WKS - ELECTROPHYSIOLOGY BACKPACK-MAN</td>
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<td>328</td>
<td>1 ALVEOLAR PO2</td>
<td>6/2 WKS</td>
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<td>329</td>
<td>FREQ = 6/2 WKS</td>
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<td>330</td>
<td>1 RESPIRATORY DEAD SPACE (VD) ALVEOLAR VENTILATION (VA) RESIDUAL VOL (VR)</td>
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<td>1 RESPIRATORY AIRWAY RESISTANCE (RA)</td>
<td>6/2 WKS</td>
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<td>332</td>
<td>1 LUNG COMPLIANCE</td>
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<td>333</td>
<td>1 BLEEDING TIME</td>
<td>2/2 WKS</td>
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<td>334</td>
<td>1 CLOTTING TIME</td>
<td>2/2 WKS</td>
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<td>335</td>
<td>1 ERYTHROCYTE SURVIVAL</td>
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<tr>
<td>335</td>
<td>FREQ - 6/MO</td>
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<td>336</td>
<td>PLASMA GLUCOSE</td>
<td>6/WK</td>
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<td>337</td>
<td>PLASMA PHOSPHATE</td>
<td>6/WK</td>
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<td>338</td>
<td>PLASMA ALKALINE PHOSPHATASE</td>
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<td>339</td>
<td>PLASMA BILIURUBIN</td>
<td>6/WK</td>
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<td>340</td>
<td>PLASMA GLOBULINS</td>
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<td>342</td>
<td>PLASMA COAGULATION</td>
<td>6/WK</td>
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<td>343</td>
<td>BODY MASS MEASUREMENT DEVICE (BMMD) FOR MAN</td>
<td>6/DY</td>
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<td>344</td>
<td>ELECTRONYSTAGMOGRAM (ENG)</td>
<td>3X10 MIN/3 DYS - ELECTROPHYSIOLOGY BACKPACK-MAN</td>
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<tr>
<td>345</td>
<td>ANGULAR ACCELERATION THRESHOLD</td>
<td>3/WK</td>
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<td>346</td>
<td>SUBJECT HISTORIES</td>
<td>12X1 MIN/DY - VOICE RECORDING</td>
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<td>INTRAOCULAR PRESSURES</td>
<td>6/2 WKS</td>
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<td>GONAD HISTOPATHOLOGY</td>
<td>6/2 WKS</td>
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<td>CREW METABOLIC RECORDS - FOOD/WATER CONSUMPTION - URINE/FECES PRODUCTION</td>
<td>6/3 WKS</td>
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<td>351</td>
<td>BONE DENSITOMETRY - PHOTON ABSORPTION</td>
<td>3/2 WKS</td>
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<td>352</td>
<td>RADIOISOTOPE COUNTING - WHOLE BODY</td>
<td>3/2 WKS</td>
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<td>353</td>
<td>CULTURE/SENSITIVITY - MICROORGANISM GROWTH CAPABILITY IN PRESENCE OF VARIOUS ANTIBIOTICS</td>
<td>6/3 WKS</td>
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<td>354</td>
<td>EAR CANAL TEMPERATURE</td>
<td>6/3 WKS</td>
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<td>355</td>
<td>MUSCLE STRENGTH AND SIZE</td>
<td>6/3 WKS</td>
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<td>357</td>
<td>GASTRIC PRESSURE AND PH</td>
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Table III-1. Operations Model Maxi Max Payload, Contd
Table III-1. Operations Model Maxi Max Payload, Contd

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<tr>
<th>Operation</th>
<th>Frequency</th>
<th>Description</th>
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<tbody>
<tr>
<td>Heart Rate</td>
<td>5 min/dy</td>
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<td>Urine Serotonin and Aldosterone</td>
<td>6/wk</td>
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<td>Visual Task with Head Rotation</td>
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<td>Venous Compliance (LVMS)</td>
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<td>Arteriolar Reactivity</td>
<td>30 min/wk</td>
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<tr>
<td>Viral Culturing</td>
<td>6/2 wks</td>
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<tr>
<td>Viral Identification</td>
<td>6/2 wks</td>
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<tr>
<td>Fungal Culturing</td>
<td>6/2 wks</td>
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<tr>
<td>Fungal Identification</td>
<td>6/2 wks</td>
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<tr>
<td>Analysis of Gas Mixtures</td>
<td>2/dy</td>
<td>Chromatography</td>
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<tr>
<td>Mass Spectroscopy</td>
<td>2/dy</td>
<td>Individual Constituent Sensors</td>
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<tr>
<td>IR Absorption</td>
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<td>Water Analysis - Conductivity</td>
<td>1/4 hrs</td>
<td>Measurement</td>
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<td>Water Analysis - pH Measurement</td>
<td>1/4 hrs</td>
<td>(H₂ Ion Concentration)</td>
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<td>Water Analysis - Total Solids</td>
<td>1/dy</td>
<td>Content</td>
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<td>Water Analysis - Bacteriological</td>
<td>1/dy</td>
<td>Assay</td>
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<td>Electrical Continuity and Voltage</td>
<td>3 min/wk</td>
<td>Measurements</td>
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<td>Electrical Amperage Measurements</td>
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<td>Variation and Measurement of</td>
<td>3/wk</td>
<td>Metabolic Rate of Suited Crewman</td>
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<td>Visual Acuity, Static - Near and</td>
<td>3/wk</td>
<td>BEIH</td>
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<tr>
<td>Far</td>
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<tr>
<td>Visual Acuity, Dynamic</td>
<td>3/wk</td>
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</table>

III-8
# Table III-1. Operations Model Maxi Max Payload, Contd

| 702 | 1 VISUAL - STEREOPSIS (DEPTH PERCEPTION): STATIC | BEIH |
| 702 | FREQ = 3/WK |
| 703 | 1 VISUAL - STEREOPSIS (DEPTH PERCEPTION): DYNAMIC | H |
| 703 | FREQ = 3/WK |
| 704 | 1 VISUAL - BRIGHTNESS THRESHOLD; ABSOLUTE | BEI |
| 704 | FREQ = 3/WK |
| 705 | 1 VISUAL - BRIGHTNESS DISCRIMINATION | H |
| 705 | FREQ = 3/WK |
| 706 | 1 VISUAL - COLOR PERCEPTION | BEIH |
| 706 | FREQ = 3/WK |
| 707 | 1 VISUAL - CRITICAL FLICKER FUSION FREQUENCY | BEI |
| 707 | FREQ = 3/WK |
| 708 | 1 VISUAL - PHORIAS; LATERAL AND VERTICAL - NEAR AND FAR | BEI |
| 708 | FREQ = 3/WK |
| 709 | 1 VISUAL - GLARE RECOVERY (PHOTO STRESS) | BEI |
| 709 | FREQ = 3/WK |
| 710 | 1 VISUAL - DARK ADAPTATION | BEI |
| 710 | FREQ = 3/WK |
| 713 | 1 VISUAL - PERIPHERAL FIELD | BEI |
| 713 | FREQ = 3/WK |
| 714 | 1 VISUAL - ACCOMMODATION RANGE | BE |
| 714 | FREQ = 3/WK |
| 715 | 1 AUDITORY - ABSOLUTE THRESHOLD | BEI |
| 715 | FREQ = 3/WK |
| 716 | 1 AUDITORY - PITCH DISCRIMINATION | BEIH |
| 716 | FREQ = 3/WK |
| 717 | 1 AUDITORY - TEMPORAL ACUITY | BEI |
| 717 | FREQ = 3/WK |
| 719 | 1 AUDITORY - SOUND LOCALIZATION | BE |
| 719 | FREQ = 3/WK |
| 720 | 1 AUDITORY - DETECTION OF MOTION | BE |
| 720 | FREQ = 3/WK |
| 721 | 1 CUTANEOUS - PRESSURE THRESHOLD | I |
| 721 | FREQ = 3/WK |
| 722 | 1 KINESTHETIC - SENSING LIMB MOVEMENT | BE |
| 722 | FREQ = 3/WK |
| 723 | 1 KINESTHETIC - SENSING LIMB POSITION | BE |
| 723 | FREQ = 3/WK |
| 730 | 1 COGNITIVE/COMPLEX PERCEPTUAL - SPEECH INTELLIGIBILITY | BE |
| 730 | FREQ = 3/WK |
Table III-1. Operations Model Maxi Max Payload, Contd

|   | COGNITIVE/COMPLEX PERCEPTUAL | FREQ |   |   | COGNITIVE/COMPLEX PERCEPTUAL | FREQ |   |   | COGNITIVE/COMPLEX PERCEPTUAL | FREQ |   |   | COGNITIVE/COMPLEX PERCEPTUAL | FREQ |   |   |   |   |   |   |   |   |   |   |
|---|-------------------------------|------|---|---|-------------------------------|------|---|---|-------------------------------|------|---|---|-------------------------------|------|---|---|   |   |   |   |   |   |   |   |   |   |
| 732 |                               |      |   |   |                               |      |   |   |                               |      |   |   |                               |      |   |   |                               |      |   |   |   |   |   |   |   |   |   |   |   |
| 733 |                               |      |   |   |                               |      |   |   |                               |      |   |   |                               |      |   |   |                               |      |   |   |   |   |   |   |   |   |   |   |   |
| 734 |                               |      |   |   |                               |      |   |   |                               |      |   |   |                               |      |   |   |                               |      |   |   |   |   |   |   |   |   |   |   |   |
| 735 |                               |      |   |   |                               |      |   |   |                               |      |   |   |                               |      |   |   |                               |      |   |   |   |   |   |   |   |   |   |   |   |
| 736 |                               |      |   |   |                               |      |   |   |                               |      |   |   |                               |      |   |   |                               |      |   |   |   |   |   |   |   |   |   |   |   |
| 737 |                               |      |   |   |                               |      |   |   |                               |      |   |   |                               |      |   |   |                               |      |   |   |   |   |   |   |   |   |   |   |   |
| 738 |                               |      |   |   |                               |      |   |   |                               |      |   |   |                               |      |   |   |                               |      |   |   |   |   |   |   |   |   |   |   |   |
| 739 |                               |      |   |   |                               |      |   |   |                               |      |   |   |                               |      |   |   |                               |      |   |   |   |   |   |   |   |   |   |   |   |
| 740 |                               |      |   |   |                               |      |   |   |                               |      |   |   |                               |      |   |   |                               |      |   |   |   |   |   |   |   |   |   |   |   |
| 741 |                               |      |   |   |                               |      |   |   |                               |      |   |   |                               |      |   |   |                               |      |   |   |   |   |   |   |   |   |   |   |   |
| 742 |                               |      |   |   |                               |      |   |   |                               |      |   |   |                               |      |   |   |                               |      |   |   |   |   |   |   |   |   |   |   |   |
| 743 |                               |      |   |   |                               |      |   |   |                               |      |   |   |                               |      |   |   |                               |      |   |   |   |   |   |   |   |   |   |   |   |
| 744 |                               |      |   |   |                               |      |   |   |                               |      |   |   |                               |      |   |   |                               |      |   |   |   |   |   |   |   |   |   |   |   |
| 745 |                               |      |   |   |                               |      |   |   |                               |      |   |   |                               |      |   |   |                               |      |   |   |   |   |   |   |   |   |   |   |   |
| 746 |                               |      |   |   |                               |      |   |   |                               |      |   |   |                               |      |   |   |                               |      |   |   |   |   |   |   |   |   |   |   |   |
| 747 |                               |      |   |   |                               |      |   |   |                               |      |   |   |                               |      |   |   |                               |      |   |   |   |   |   |   |   |   |   |   |   |
| 748 |                               |      |   |   |                               |      |   |   |                               |      |   |   |                               |      |   |   |                               |      |   |   |   |   |   |   |   |   |   |   |   |
| 749 |                               |      |   |   |                               |      |   |   |                               |      |   |   |                               |      |   |   |                               |      |   |   |   |   |   |   |   |   |   |   |   |
| 750 |                               |      |   |   |                               |      |   |   |                               |      |   |   |                               |      |   |   |                               |      |   |   |   |   |   |   |   |   |   |   |   |
| 751 |                               |      |   |   |                               |      |   |   |                               |      |   |   |                               |      |   |   |                               |      |   |   |   |   |   |   |   |   |   |   |   |
| 752 |                               |      |   |   |                               |      |   |   |                               |      |   |   |                               |      |   |   |                               |      |   |   |   |   |   |   |   |   |   |   |   |
| 753 |                               |      |   |   |                               |      |   |   |                               |      |   |   |                               |      |   |   |                               |      |   |   |   |   |   |   |   |   |   |   |   |
| 754 |                               |      |   |   |                               |      |   |   |                               |      |   |   |                               |      |   |   |                               |      |   |   |   |   |   |   |   |   |   |   |   |
| 755 |                               |      |   |   |                               |      |   |   |                               |      |   |   |                               |      |   |   |                               |      |   |   |   |   |   |   |   |   |   |   |   |
| 756 |                               |      |   |   |                               |      |   |   |                               |      |   |   |                               |      |   |   |                               |      |   |   |   |   |   |   |   |   |   |   |   |
| 757 |                               |      |   |   |                               |      |   |   |                               |      |   |   |                               |      |   |   |                               |      |   |   |   |   |   |   |   |   |   |   |   |
| 758 |                               |      |   |   |                               |      |   |   |                               |      |   |   |                               |      |   |   |                               |      |   |   |   |   |   |   |   |   |   |   |   |
| 759 |                               |      |   |   |                               |      |   |   |                               |      |   |   |                               |      |   |   |                               |      |   |   |   |   |   |   |   |   |   |   |   |
| 760 |                               |      |   |   |                               |      |   |   |                               |      |   |   |                               |      |   |   |                               |      |   |   |   |   |   |   |   |   |   |   |   |
| 761 |                               |      |   |   |                               |      |   |   |                               |      |   |   |                               |      |   |   |                               |      |   |   |   |   |   |   |   |   |   |   |   |
| 762 |                               |      |   |   |                               |      |   |   |                               |      |   |   |                               |      |   |   |                               |      |   |   |   |   |   |   |   |   |   |   |   |
| 763 |                               |      |   |   |                               |      |   |   |                               |      |   |   |                               |      |   |   |                               |      |   |   |   |   |   |   |   |   |   |   |   |
| 764 |                               |      |   |   |                               |      |   |   |                               |      |   |   |                               |      |   |   |                               |      |   |   |   |   |   |   |   |   |   |   |   |
| 765 |                               |      |   |   |                               |      |   |   |                               |      |   |   |                               |      |   |   |                               |      |   |   |   |   |   |   |   |   |   |   |   |
| 766 |                               |      |   |   |                               |      |   |   |                               |      |   |   |                               |      |   |   |                               |      |   |   |   |   |   |   |   |   |   |   |   |
| 767 |                               |      |   |   |                               |      |   |   |                               |      |   |   |                               |      |   |   |                               |      |   |   |   |   |   |   |   |   |   |   |   |
| 768 |                               |      |   |   |                               |      |   |   |                               |      |   |   |                               |      |   |   |                               |      |   |   |   |   |   |   |   |   |   |   |   |

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<th>Test Code</th>
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<td>769</td>
<td><strong>FINE PSYCHOMOTOR - GROSS POSITION ABILITY</strong> - POSITION REPRODCT BEH</td>
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<td>770</td>
<td><strong>FINE PSYCHOMOTOR - REACTION TIME</strong> - SIMPLE</td>
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<td><strong>FINE PSYCHOMOTOR - REACTION TIME</strong> - COMPLEX (RESP ORIENTATN)</td>
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<td><strong>GROSS PSYCHOMOTOR - GROSS BODY EQUILIBRIUM</strong></td>
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<td>780</td>
<td><strong>GROSS PSYCHOMOTOR - GROSS BODY COORDINATION</strong></td>
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<td>782</td>
<td><strong>GROSS PSYCHOMOTOR - SPEED OF LIMB MOVEMENT</strong> - LEGS</td>
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<td><strong>SLEEP BEHAVIOR - LENGTH AND DEPTH OF SLEEP</strong></td>
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<tr>
<td>790A</td>
<td>FREQ - COVERED BY F18 - MONITOR SLEEPING PATTERNS-EEG</td>
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<td>790B</td>
<td>FREQ - CREW RECORDS</td>
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<td><strong>SLEEP BEHAVIOR - ABILITY TO AWAKEN AND RESPOND TO EMERGENCY</strong></td>
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<td><strong>INDIVIDUAL BEHAVIOR - CLOSENESS OF INTERACTIONS (FRIENDLINESS; ALOOFNESS; SOPHISTICATION)</strong></td>
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<td>FREQ - CRT DISPLAYED TESTS-QUESTNNRS-KYBRD RESP</td>
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<td>FREQ - INTERVIEWS BY GRND COUNSELORS FOR BEHAV ANL</td>
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<tr>
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<td><strong>INDIVIDUAL BEHAVIOR - AMOUNT OF INTERACTION (INTRO-VS EXTROVERSION)</strong></td>
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<td>FREQ - CRT DISPLAYED TESTS-QUESTNNRS-KYBRD RESP</td>
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<td><strong>INDIVIDUAL BEHAVIOR - STRENGTH OF INTERACTION (ASSERTIVENESS)</strong></td>
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<tr>
<td>794B</td>
<td>FREQ - CRT DISPLAYED TESTS-QUESTNNRS-KYBRD RESP</td>
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<td>794D</td>
<td>FREQ - INTERVIEWS BY GRND COUNSELORS FOR BEHAV ANL</td>
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<tr>
<td>795</td>
<td><strong>INDIVIDUAL BEHAVIOR - AGGRESSION REACTION</strong></td>
<td>3/WK</td>
</tr>
<tr>
<td>795B</td>
<td>FREQ - CRT DISPLAYED TESTS-QUESTNNRS-KYBRD RESP</td>
<td>3/WK</td>
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<td>795D</td>
<td>FREQ - INTERVIEWS BY GRND COUNSELORS FOR BEHAV ANL</td>
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<td>796</td>
<td><strong>INDIVIDUAL BEHAVIOR - CONFORMITY AND/OR CONTROL REACTION (DEPENDENCY; AUTHORITARIANISM; COMFORMITY)</strong></td>
<td>3/WK</td>
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<tr>
<td>796B</td>
<td>FREQ - CRT DISPLAYED TESTS-QUESTNNRS-KYBRD RESP</td>
<td>3/WK</td>
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<td>796D</td>
<td>FREQ - INTERVIEWS BY GRND COUNSELORS FOR BEHAV ANL</td>
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<td>797</td>
<td><strong>INDIVIDUAL BEHAVIOR - FLEXIBILITY/RIGIDITY REACTION</strong></td>
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<tr>
<td>797B</td>
<td>FREQ - CRT DISPLAYED TESTS-QUESTNNRS-KYBRD RESP</td>
<td>3/WK</td>
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<td>FREQ - INTERVIEWS BY GRND COUNSELORS FOR BEHAV ANL</td>
<td>3/WK</td>
</tr>
<tr>
<td>798</td>
<td><strong>INDIVIDUAL BEHAVIOR - SELF CONTROL REACTION</strong></td>
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</tr>
<tr>
<td>798B</td>
<td>FREQ - CRT DISPLAYED TESTS-QUESTNNRS-KYBRD RESP</td>
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<tr>
<td>798D</td>
<td>FREQ - INTERVIEWS BY GRND COUNSELORS FOR BEHAV ANL</td>
<td>3/WK</td>
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Table III-1. Operations Model Maxi Max Payload, Contd

| INDIVIDUAL BEHAVIOR - SUBJECTIVITY/OBJECTIVITY REACTION (SELF CENTEREDNESS VS OBJECTIVITY) |
| FREQ - 3/WK | CRT DISPLAYED TESTS-QUESTNRS-KYBRD RESP |
| FREQ - 3/WK | INTERVIEWS BY GRND COUNSELORS FOR BEHAV ANL |

| INDIVIDUAL BEHAVIOR - EMOTIONALITY; SENSITIVITY OF REACTION |
| FREQ - 3/WK | CRT DISPLAYED TESTS-QUESTNRS-KYBRD RESP |
| FREQ - 3/WK | INTERVIEWS BY GRND COUNSELORS FOR BEHAV ANL |

| INDIVIDUAL BEHAVIOR - DESIRED OUTPUT LEVEL (MOTIVATION; ASPIRATION) |
| FREQ - 3/WK | CRT DISPLAYED TESTS-QUESTNRS-KYBRD RESP |
| FREQ - 3/WK | INTERVIEWS BY GRND COUNSELORS FOR BEHAV ANL |

| INDIVIDUAL BEHAVIOR - DESIRED OUTPUT TYPE (CONSCIENTIOUS VS EXPEDITIOUS; ETC.) |
| FREQ - 3/WK | CRT DISPLAYED TESTS-QUESTNRS-KYBRD RESP |
| FREQ - 3/WK | INTERVIEWS BY GRND COUNSELORS FOR BEHAV ANL |

| GROUP BEHAVIOR - GROUP COMPATIBILITY |
| FREQ - 3/WK | CREW MOOD |

| GROUP BEHAVIOR - GROUP COHESIVENESS |
| FREQ - 3/WK | CREW MOOD |

| GROUP BEHAVIOR - GROUP LEADERSHIP |
| FREQ - 3/WK | CREW MOOD |

| GROUP BEHAVIOR - GROUP SIMILARITY; PERCEIVED |
| FREQ - 3/WK | CREW MOOD |

| TASK COMPLETION TIMES (E.G., TIME TO COMPLETE A SPECIFIED MAINTENANCE TASK TO ASSEMBLE AN ANTENNA RIB, TO MOVE FROM POINT A TO B BY A MANEUVERING UNIT, TO ALIGN AN OBJECT WITH A REMOTE MANIPULATION, ETC.) |
| FREQ - 10 MIN/DY | SUBJECT OR EXPERIMTR-ACTUATED TIMER |
| FREQ - COVERED BY 10 MIN/DY UNDER FB20A | INTEGRAL EQUIPMENT TIMERS |
| FREQ - COVERED BY 10 MIN/DY UNDER FB20A | VIDEO COVERAGE |

| CREW BODY POSITION MEASUREMENTS |
| FREQ - 30 MIN/DY |

| CREW BODY MOTION MEASUREMENTS |
| FREQ - 30 MIN/DY | MOTION PICTURE PHOTOGRAPHY |
| FREQ - 5 MIN/DY | BODY MOUNTED SENSORS |

| FORCES, PRESSURES AND TORQUES EXERTED ON EQUIPMENT |
| FREQ - 5 MIN/DY |

| EYE MOVEMENT MEASUREMENTS - OPTICAL |
| FREQ - 30 MIN/DY |

| FREQUENCY OF EQUIPMENT/FACILITY UTILIZATION |
| FREQ - 5 MIN/DY | VIDEO COVERAGE |
| FREQ - 5 MIN/DY | BUILT-IN EQUIPMENT TIMERS |

| LENGTH OF USE OF EQUIPMENT/FACILITY |
| FREQ - 5 MIN/DY | VIDEO COVERAGE |
| FREQ - 5 MIN/DY | BUILT-IN EQUIPMENT TIMERS |

III-12
Table III-1. Operations Model Maxi Max Payload, Contd

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<tbody>
<tr>
<td>832</td>
<td>1 SEQUENCE OF USE OF EQUIPMENT/FACILITIES</td>
<td>FREQ - 5 MIN/DY</td>
</tr>
<tr>
<td>833</td>
<td>1 CREW SUBJECTIVE COMMENTS ON EQUIPMENT/FACILITY/PROCEDURES/SCHED &amp; SPECIFIC QUESTIONNAIRES - STRUCTURED</td>
<td>CREW LOGS - UNSTRUCTURED RESPONSE</td>
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<tr>
<td>834</td>
<td>1 FACILITY TRAFFIC PATTERNS</td>
<td>FREQ - 5 MIN/WK</td>
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<tr>
<td>840</td>
<td>1 MAX MASS TRANSPORTABLE FUNCTION OF TYPE OF MOBILITY AID, ONE</td>
<td>FREQ - COVERED BY THE 3X30 MIN/WK UNDER F840A - SS</td>
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<tr>
<td>844</td>
<td>1 MAX VOLUME ALIGNABLE FUNCTION OF TYPE OF RESTRAINT, ONE</td>
<td>FREQ - COVERED BY THE 3X30 MIN/WK UNDER F843A - SS</td>
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<tr>
<td>845</td>
<td>1 MAX ALIGNABLE MOI ABOUT CARRYING HANDLE FUNCTION OF RESTRAINT, ONE</td>
<td>FREQ - COVERED BY THE 3X30 MIN/WK UNDER F843A - SS</td>
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<tr>
<td>846</td>
<td>1 REMOTE MANIPULATION</td>
<td>FREQ - 3X30 MIN/WK</td>
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AUTOMATIC

************

11 17 MONITOR ECG (FOR BIORESEARCH - ECG SIGNAL MGMT FROM CAGE TO CAGE MOD TO DATA MGMT *)
11 17E FREQ - AS REQ'D - A-D CONVERTER AT CG MOD - WIRE TO DM

11 18 MONITOR EEG (FOR BIORESEARCH - EEG SIGNAL MGMT FROM CAGE TO CAGE MOD TO DATA MGMT *)
11 18E FREQ - AS REQ'D - A-D CONVERTER AT CG MOD - WIRE TO DM

11 19 MONITOR EMG - EMG SIGNAL MGMT CAGE TO CAGE MOD TO DATA MGMT
11 19E FREQ - AS REQ'D - A-D CONVERTER AT CG MOD - WIRE TO DM

20 1 RESPIRATORY RATE MONITORING - DOES NOT INCLUDE RESP VOLUME
20 20A FREQ - AS REQ'D - EXTRACT FROM RESP CO2 DATA

21 22 TEMPERATURE MSMTS
21 22A FREQ - AS REQ'D - THERMOCOUPLES
21 22B FREQ - AS REQ'D - THERMISTERS

23 1 NUTRIENT CONSUMPTION - A COUNT OF THE NUMBER OF PELLETS CONSUMED
23 23 FREQ - AS REQ'D
Table III-1. Operations Model Maxi Max Payload, Contd

24 1 WATER CONSUMPTION - WATER CONSUMED OR WATER DELIVERED
24A FREQ = AS REQ'D - FLOWMTR IN MANIFOLD

49 1 PRESSURE MONITORING
49B FREQ = C - PRESSURE XDCR ELECTRONIC SIG

52 1 TRACE GAS ANALYSIS INORGANICS
52 FREQ = 1/HR

53 1 OXYGEN MONITORING
53B FREQ = 1/HR - MASS SPECTROMETRY

54 1 CARBON DIOXIDE MONITORING
54 FREQ = 1/HR

55 1 NITROGEN MONITORING
55A FREQ = 30 MIN/DY - GAS CHROMATOGRAPHY
55B FREQ = 2/DY - MASS SPECTROMETRY

56 1 CARBON MONOXIDE MONITORING
56B FREQ = 30 MIN/DY - GAS CHROMATOGRAPHY
56C FREQ = 2/DY - MASS SPECTROMETRY

57 1 WATER VAPOR MONITORING
57A FREQ = 1/HR - MASS SPECTROMETRY
57D FREQ = 2/DY - DEW POINT SYS

58 1 AMMONIA MONITORING
58A FREQ = 1/HR - INFRARED SPECTROPHOTOMETRY
58C FREQ = 2/DY - MASS SPECTROMETRY

59 1 ATMOSPHERIC ETHYLENE MONITORING SENS TO SOPPB
59 FREQ = 30 MIN/DY

61 1 VIBRATION MONITORING
61 FREQ = C

62 1 ACCELERATION MONITORING 10-5 TO 1G 0-100HZ
62 FREQ = C

64 1 NOISE MONITORING
64 FREQ = C

65 1 PLANT ACTIVITY- MSUR GROWTH AND MOVEMENT OF PLANTS
65A FREQ = 1/HR FOR EA PLANT CM - TIME LAPSE VIDEO - SHORT STORAGE
65B FREQ = 1/HR FOR EA PLANT CM - TIME LAPSE PHOTOGRAPHY
65D FREQ = AS REQ'D - MAKE/BREAK INCREMENTAL MOTOR

66 1 ANIMAL ACTIVITY- MSUR ANIMAL ACTIVITY IN STD AND MMB CAGES
66A FREQ = C - VIDEO - TIME LAPSE
66C FREQ = C - ACTIVITY WHEEL MONITORING

70 1 AIR MOVEMENT
70 FREQ = C

71 1 LIGHT MONITORING-ON/OFF AND INTENSITY - ASSUME NO FREQ DATA REQ
71 FREQ = C

112 1 OXYGEN MSMTS MMB
112 FREQ = C
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<th>Table III-1. Operations Model Maxi Max Payload, Contd</th>
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<tr>
<td>113 1 CARBON DIOXIDE MSMTS MMB</td>
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<td>115 1 ELECTROMAGNETIC ASSAY</td>
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<td>165 1 EVENT MONITORING</td>
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<tr>
<td>165A</td>
</tr>
<tr>
<td>165B</td>
</tr>
<tr>
<td>169 1 TELEVISION MONITORING ROUTINE AND FOR DATA B/W HIGH RESOLUTION</td>
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<tr>
<td>218 1 DEEP BODY TEMPERATURE - IMPLANTABLE SENSOR</td>
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<td>792 11 INDIVIDUAL BEHAVIOR - CLOSERNESS OF INTERACTIONS (FRIENDLINESS, ALOOFNESS, SOPHISTICATION)</td>
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<td>793 11 INDIVIDUAL BEHAVIOR - AMOUNT OF INTERACTION (INTRO- VS EXTROVERSION, WITHDRAWAL)</td>
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<tr>
<td>794 1 INDIVIDUAL BEHAVIOR - STRENGTH OF INTERACTION (ASSERTIVENESS)</td>
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<td>795 1 INDIVIDUAL BEHAVIOR - AGGRESSION REACTION</td>
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<td>798 1 INDIVIDUAL BEHAVIOR - SELF CONTROL REACTION</td>
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<td>799 11 INDIVIDUAL BEHAVIOR - SUBJECTIVITY/OBJECTIVITY REACTION (SELF CENTEREDNESS VS OBJECTIVITY)</td>
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<td>802 11 INDIVIDUAL BEHAVIOR - DESIRED OUTPUT TYPE (CONSCIENTIOUS VS EXPEDITIOUS)</td>
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<tr>
<td>805 1 GROUP BEHAVIOR - GROUP COMPATIBILITY</td>
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III-15
Table III-1. Operations Model Maxi Max Payload, Cont'd

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<td>Crew Productivity Measurements</td>
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<td>Verbal Interaction Measurements</td>
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<td>Physical Interaction</td>
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<td>Verbal Interaction Measurements</td>
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<td>807B</td>
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<td>Physical Interaction</td>
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<tr>
<td>808</td>
<td>Group Similarity, Perceived</td>
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<td>Crew Productivity Measurements</td>
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<td>Verbal Interaction Measurements</td>
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<td>Physical Interaction</td>
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2 Support Operations

Manual and Semi-Automatic

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<tr>
<td>1</td>
<td>Organism Recvng - Shipping Orgs in Cage vs Shipping Container, IF</td>
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<td>Material Recvng - Same Technique and Tradeoff as Func No. 1</td>
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<td>Freq = 30/90 DYS - Materials Moved in LFB</td>
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<td>Freq = 30/90 DYS - Other</td>
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<tr>
<td>14</td>
<td>Bioelectic XDCR Installation and Setup - Beware EMI</td>
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<td>Freq = 2/DY</td>
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<td>CRT Check Manual Calib</td>
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<td>CRT Check/PreCalib CompTr Cal</td>
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<table>
<thead>
<tr>
<th>Task</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>15</td>
<td>Camera Setup</td>
</tr>
<tr>
<td></td>
<td>Freq = 30/90 DYS(F)</td>
</tr>
<tr>
<td></td>
<td>Freq = 1/DY(B/LH)</td>
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<thead>
<tr>
<th>Task</th>
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<tbody>
<tr>
<td>16</td>
<td>Setup Camera Optical Commutation - Organism to Organism</td>
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<tr>
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<td>Freq = 30/90 DYS</td>
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<thead>
<tr>
<th>Task</th>
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<tbody>
<tr>
<td>31</td>
<td>Biosampling - Obtaining Blood Whole Organism Leaves Etc for Analysis</td>
</tr>
<tr>
<td></td>
<td>Freq = 13/DY</td>
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<thead>
<tr>
<th>Task</th>
<th>Description</th>
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<tbody>
<tr>
<td>33</td>
<td>Blood Preparation - Syringe-Tube/Capillary with NAF EDTA Etc</td>
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<tr>
<td></td>
<td>Freq = 13/DY</td>
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<thead>
<tr>
<th>Task</th>
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<tbody>
<tr>
<td>50A</td>
<td>Gas Sampling - Obtain Gas from Site Xfer to Instmt</td>
</tr>
<tr>
<td></td>
<td>2/DY - Manual Syringe Samples</td>
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<thead>
<tr>
<th>Task</th>
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<tbody>
<tr>
<td>75</td>
<td>Crew Guidance - Provide Desired Information to Crew on Demand</td>
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<tr>
<td></td>
<td>Freq = 60 Min/DY</td>
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<thead>
<tr>
<th>Task</th>
<th>Description</th>
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<tbody>
<tr>
<td>88</td>
<td>Bacterial Smear Staining</td>
</tr>
<tr>
<td></td>
<td>Freq = 50/WK</td>
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<tr>
<th>Task</th>
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<tbody>
<tr>
<td>89</td>
<td>Histological Sectioning - Wax and Plastic Embedment</td>
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<tr>
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<td>Freq = 5/WK</td>
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III-16
Table III-1. Operations Model Maxi Max Payload, Contd

<table>
<thead>
<tr>
<th></th>
<th>90</th>
<th>1 HISTOLOGICAL STAINING</th>
<th>FREQ - 5/WK</th>
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<tbody>
<tr>
<td></td>
<td>95</td>
<td>1 RADIO ISOTOPE METHODOLOGY-PREPARATION AND MGMT</td>
<td>FREQ - 15 MIN/2 WKS</td>
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<tr>
<td></td>
<td>96</td>
<td>1 RADIOCHEM WASTE MGMT- RADIOCHEM, ORGNS, AND PARTS</td>
<td>FREQ - 15 MIN/2 WKS</td>
</tr>
<tr>
<td></td>
<td>97</td>
<td>1 EXPERIMENT WASTE MGMT</td>
<td>FREQ - 30 MIN/DY</td>
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<tr>
<td></td>
<td>105</td>
<td>1 ORGANISM OR SAMPLE PRESVN WITH GAS OR LIQUID CHEMICALS</td>
<td>FREQ - 4/DY</td>
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<tr>
<td></td>
<td>106</td>
<td>1 ORGANISM/SAMPLE PRES THERMAL</td>
<td>FREQ - 8/DY</td>
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<tr>
<td></td>
<td>107</td>
<td>1 ORGANISM/SAMPLE PRESVN LYOPHIL</td>
<td>FREQ - 8/DY</td>
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<tr>
<td></td>
<td>124</td>
<td>1 CREW/ORGANISM ISOLATION- REQMT TBD</td>
<td>FREQ - 5/DY (OTHER USAGE COVERED UNDER OTHER FUNCTIONS)</td>
</tr>
<tr>
<td></td>
<td>125</td>
<td>1 CREW/CHEMICAL ISOLATION</td>
<td>FREQ - 3/DY - LFB</td>
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<tr>
<td></td>
<td>125A</td>
<td>FREQ - 2/DY - GLOVE BOX, STD</td>
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<td></td>
<td>126</td>
<td>1 CREW RADIATION ISOLATION</td>
<td>FREQ - 4 HRS/2 WKS</td>
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<tr>
<td></td>
<td>127</td>
<td>1 CREW MOBILITY/TRANSFER - CREW ACCESS TO ANY LAB AREA, WALLS, ETC</td>
<td>FREQ - 4 PERCENT OF EACH CREWMAN'S TIME</td>
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<tr>
<td></td>
<td>128</td>
<td>1 MATERIALS TRANSFER - MOVE CARGO, TOOLS, SPECIMEN IN/OUT AROUND LAB</td>
<td>FREQ - 6 PERCENT OF EACH CREWMAN'S TIME</td>
</tr>
<tr>
<td></td>
<td>142</td>
<td>1 MICROBIOLOGICAL SAMPLING - AIR, SURFACES AND LARGE ORGANISMS</td>
<td>FREQ - 1/DY - AIR SAMPLING</td>
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<tr>
<td></td>
<td>142A</td>
<td>FREQ - 3/DY - SURFACE AND WOUND SAMPLING</td>
<td></td>
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<tr>
<td></td>
<td>143</td>
<td>1 PLANT HOMOGENATION</td>
<td>FREQ - 8/WK</td>
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<tr>
<td></td>
<td>144</td>
<td>1 EXPERIMENT STATUS MONITORING - CREW OBSERVATION</td>
<td>FREQ - 10/TWICE DAILY (EXPERIMENTS)</td>
</tr>
<tr>
<td></td>
<td>145</td>
<td>1 CENTRIFUGATION</td>
<td>FREQ - 3 HRS/WK</td>
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<tr>
<td></td>
<td>148</td>
<td>1 THERMAL CONTROL OF CHEMICAL PREPARATIONS - WATER BATH SUBSTITUTE</td>
<td>FREQ - 5 MIN/DY</td>
</tr>
<tr>
<td></td>
<td>163</td>
<td>1 RADIATION EXPOSURE</td>
<td>FREQ - 4 HRS/2 WKS</td>
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<tr>
<td></td>
<td>167</td>
<td>1 ANAESTHESIOLOGY - VERTEBRATES</td>
<td>FREQ - 5/WK</td>
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<tr>
<td></td>
<td>168</td>
<td>1 ANAESTHESIOLOGY - INVERTEBRATES</td>
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</table>
Table III-1. Operations Model Maxi Max Payload, Contd

168  FREQ = 10/DY (BOTTLES)

184 1 CLINOSTAT ENVIRONMENT  
184  FREQ = 1 HR/WK

185 1 CYTOCHEMICAL STAINING PLANTS  
185  FREQ = 16X10 MIN/WK

186 1 CYTOCHEMICAL STAINING -ANIMAL SYSTEMS - HEMATOXALIN/EOSIN  
186  FREQ = 16X10 MIN/WK

201 1 CREW RESTRAINT - STABILIZE THE CREW FOR MAX SAFETY AND EFFICIENCY  
201  FREQ = 1 PERCENT OF EACH CREWMAN'S TIME

222 1 VERTEBRATE EXPERIMENT INITIATION  
222  FREQ = 10/90 DYS

223 1 PLANT EXPERIMENT INITIATION  
223  FREQ = 5/90 DYS

224 1 INVERTEBRATE EXPERIMENT INITIATION  
224  FREQ = 5/90 DYS

225 1 CELLS AND TISSUE EXPERIMENT SETUP  
225  FREQ = 5/90 DYS

300 1 VOMITUS COLLECTION  
300  FREQ = NON-SCHEDULED

301 1 VOMITUS PRESERVATION AND STORAGE  
301  FREQ = NON-SCHEDULED

302 1 SWEAT SAMPLE COLLECTION  
302  FREQ = 6-WK

303 1 SWEAT PRESERVATION AND STORAGE  
303  FREQ = 6-WK

305 1 SPACE SUIT SUPPLY AND CONTROL FOR EXPERIMENTAL SETUPS  
305  FREQ = 1/HR

310 1 IN FLIGHT EXERCISE (ERGOMETER OUTPUT)  
310  FREQ = 7/WK

311 1 BODY RESTRAINT/MOTION DEVICE  
311  FREQ = 5 MIN/WK

356 1 SUBJECT INSTRUMENTATION AND CLEANUP  
356  FREQ = 30 MIN/DY

368 1 STOOL PRESERVATION  
368  FREQ = 6/WK

369 1 URINE PRESERVATION  
369  FREQ = 6/WK

507 1 LIQUID TRANSFER  
507A  FREQ = 5/DY = SYRINGE TRANSFER
507C  FREQ = 5/DY = COLLAPSIBLE BLADDER TRANSFER

516 1 ATMOSPHERIC GAS ISOLATION
Table III-1. Operations Model Maxi Max Payload, Contd

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Frequency</th>
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<tbody>
<tr>
<td>516</td>
<td>FREO - 1/WK</td>
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<tr>
<td>520</td>
<td>PRESSURE SUIT DONNING AND DOFFING (EXPERIMENTAL)</td>
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<tr>
<td>521</td>
<td>PRESSURE SUIT VENTILATION AND COOLING (EXPERIMENTAL)</td>
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</tr>
<tr>
<td>521A</td>
<td>FREO - 3/2 WKS - UMBILICAL</td>
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<tr>
<td>521B</td>
<td>FREO - 3/2 WKS - PLSS (PORTABLE LIFE SUPPORT SYS)</td>
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<tr>
<td>523</td>
<td>INGRESS/EGRESS (LABORATORY TO EVA)</td>
<td></td>
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<tr>
<td>524</td>
<td>EVA MAINTENANCE TASK SIMULATION</td>
<td></td>
</tr>
<tr>
<td></td>
<td>AUTOMATIC</td>
<td></td>
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<tr>
<td>10</td>
<td>HOLDING PRIMATES MMB -MEASURES BASIC METABOLISM AT WORK/REST</td>
<td>AS REQ'D</td>
</tr>
<tr>
<td>11</td>
<td>HOLDING RAT AND RAT SIZE ANIMALS FOR METABOLIC MSMTS</td>
<td>AS REQ'D</td>
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<tr>
<td>12</td>
<td>HOLDING MOUSE MMB-SAME AS FOR RAT</td>
<td>AS REQ'D</td>
</tr>
<tr>
<td>13</td>
<td>HOLDING CAGE MMB-RABBITS/MARMOTS ETC</td>
<td>AS REQ'D</td>
</tr>
<tr>
<td>43</td>
<td>DIGITAL RECORDS-RECORDING OF INSTRUMENT DATA</td>
<td>AS REQ'D</td>
</tr>
<tr>
<td>44</td>
<td>ANALOG RECORDS- RECORDING OF INST DATA</td>
<td>AS REQ'D</td>
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<tr>
<td>50</td>
<td>GAS SAMPLING- OBTAIN GAS FROM SITE XFER TO INSTMT</td>
<td>C - MICROMANIFOLD SYSTEM</td>
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<tr>
<td>50B</td>
<td>FREQ - AS REQ'D</td>
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<tr>
<td>68</td>
<td>ORGANISM IDENTIFICATION FILM</td>
<td>AS REQ'D</td>
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<tr>
<td>72</td>
<td>ORGANISM IDENTIFICATION VIDEO RECORDS</td>
<td>AS REQ'D</td>
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<td>73</td>
<td>DATA STORAGE</td>
<td>AS REQ'D</td>
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<tr>
<td>73A</td>
<td>FREQ - AS REQ'D - COMPUTER=MAG TAPE OR DISC</td>
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</tr>
<tr>
<td>73B</td>
<td>FREQ - AS REQ'D - COMPUTER=MEMORY CORE</td>
<td></td>
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<tr>
<td>76</td>
<td>EXPERIMENT MANAGEMENT SYSTEM</td>
<td>AS REQ'D</td>
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<tr>
<td>98</td>
<td>DISTILLED/STERILE WATER PREPARATION</td>
<td>C</td>
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<tr>
<td>195</td>
<td>ARTIFICIAL GRAVITY -APPROX 50 PERCENT OF HOLDING CAPACITY</td>
<td>C</td>
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<tr>
<td>195A</td>
<td>FREQ - C - CENTRIFUGE;MANNED DYNAMIC(BC)</td>
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<tr>
<td>195F</td>
<td>FREQ - C - CENTRIFUGE;MANNED DYNAMIC(HC)</td>
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<tr>
<td>508</td>
<td>VACUUM SUPPLY</td>
<td>AS REQ'D</td>
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Table III-1. Operations Model Maxi Max Payload, Contd

3 SPECIMEN MAINTENANCE

MANUAL AND SEMIAUTOMATIC

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<tr>
<th>STEP</th>
<th>DESCRIPTION</th>
<th>FREQUENCY</th>
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<tbody>
<tr>
<td>3</td>
<td>VERTEBRATE FEEDING - SOLID PELLETS ARE SUPPLIED ADLIB OR REGULATED</td>
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</tr>
<tr>
<td>3A</td>
<td>FREQ = 259/WK - PELLETS ATTACHED TO BELT</td>
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</tr>
<tr>
<td>3C</td>
<td>FREQ = 128/WK - LIQUID DIET SUPPLY</td>
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</tr>
<tr>
<td>3E</td>
<td>FREQ = 131/WK - EXTRUDED PASTE FEEDER</td>
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</tr>
<tr>
<td>8</td>
<td>FECES MGMT - CAGE TO DISPOSAL LIQUID TO SOLID CONSISTANCY</td>
<td>FREQ = 518/WK</td>
</tr>
<tr>
<td>32</td>
<td>SPECIMEN STATUS OBSERVATION - PERIODIC LOOK AT ORGANISMS IN CAGES</td>
<td>FREQ = 102/DY</td>
</tr>
<tr>
<td>79</td>
<td>ORGANISM SUBCULTURE - SUBSTRATE PREPARATION</td>
<td>FREQ = 2/WK (BATCHES)</td>
</tr>
<tr>
<td>80</td>
<td>ORGANISM SUBCULTURE - PLANTS</td>
<td>FREQ = 5/DY</td>
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<tr>
<td>81</td>
<td>MEDIA PREPARATION - CELLS AND TISSUE</td>
<td>FREQ = 60 MIN/WK</td>
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<tr>
<td>84</td>
<td>ORGANISM SUBCULTURING - CELLS AND TISSUE</td>
<td>FREQ = 32/DY</td>
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<tr>
<td>100</td>
<td>STERILIZN OF MEDIA - NOT REQD IF PREPKGD</td>
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<tr>
<td>100A</td>
<td>FREQ = 3/WK - AUTOCLAVE</td>
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<tr>
<td>100C</td>
<td>FREQ = 3/WK - FILTRATION</td>
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<tr>
<td>196</td>
<td>PRIMATE CAGE PREPARATION - INSTALL INSERTS, FEEDERS, EXPERIMENT EQUIPMENT</td>
<td>FREQ = 2 HRS/CAGE WITH 2 CAGES/90 DYS</td>
</tr>
<tr>
<td>197</td>
<td>VERTEBRATE CAGE PREPARATION - SETUP CAGES AND HOLDING UNIT</td>
<td>FREQ = 15 MIN/CM WITH 18 CM/90 DAYS</td>
</tr>
<tr>
<td>198</td>
<td>PLANT HOLDING UNIT PREPARATION - INSTALL LIGHTS, WATER, EXPERIMENT EQUIPMENT</td>
<td>FREQ = 15 MIN/CM WITH 5 CM/90 DAYS</td>
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<td>199</td>
<td>INVERTEBRATE CAGE AND HOLDING UNIT SETUP</td>
<td>FREQ = 15 MIN/CM WITH 2 CM/90 DAYS</td>
</tr>
<tr>
<td>200</td>
<td>CELLS AND TISSUE HOLDING UNIT SETUP/PREPARATION</td>
<td>FREQ = 15 MIN/CM WITH 3 CM/90 DAYS</td>
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AUTOMATIC

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<tr>
<td>4</td>
<td>VERTEBRATE WATERING - REQ DRIPLESS ANIMAL ACTUATED DISPENSER TIPS</td>
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<td>FREQ = AS REQ'D</td>
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<tr>
<td>5</td>
<td>URINE MGMT AT CAGE - URINE MUST BE REMOVED QUICKLY (MINUTES)</td>
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<tr>
<td>5</td>
<td>AIR FLOW THRU CAGE MOVES URINE TO COLLECTION PAD; URINE MUST</td>
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Table III-1. Operations Model Maxi Max Payload, Contd

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<tr>
<td>5</td>
<td><strong>FREQ - AS REQ'D</strong></td>
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<tr>
<td>6</td>
<td>1 URINE MGMT FROM CAGE COLLECTOR TO STORAGE OR DISPOSAL</td>
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<td>7</td>
<td>1 FECES MGMT AT CAGE - FECES MUST BE MOVED FROM ANIMAL AND COLLECTD</td>
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</tr>
<tr>
<td>102</td>
<td>1 STERILIZN OF ATM GASES</td>
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<tr>
<td>102</td>
<td><strong>FREQ - C</strong></td>
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<tr>
<td>129</td>
<td>1 HOLDING-PRIMATES- LARGE MACAQUE TO CHIMPANZEES</td>
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<tr>
<td>129A</td>
<td><strong>FREQ - C</strong> - MODULE PRIMATE</td>
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<tr>
<td>129C</td>
<td><strong>FREQ - C</strong> - CYLINDERS</td>
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<tr>
<td>130</td>
<td>1 HOLDING-MICE AND MICE SIZE ANIMALS</td>
<td></td>
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<td>130</td>
<td><strong>FREQ - C</strong></td>
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<tr>
<td>131</td>
<td>1 HOLDING-RATS QUAIL ETC</td>
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<tr>
<td>131</td>
<td><strong>FREQ - C</strong></td>
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<tr>
<td>132</td>
<td>1 HOUSING-PLANT SEEDLINGS</td>
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<tr>
<td>132</td>
<td><strong>FREQ - C</strong></td>
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</tr>
<tr>
<td>133</td>
<td>1 HOLDING UNIT PLANTS</td>
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</tr>
<tr>
<td>133</td>
<td><strong>FREQ - C</strong></td>
<td></td>
</tr>
<tr>
<td>134</td>
<td>1 HOLDING-RABBITS CATS MARMOTS ETC</td>
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</tr>
<tr>
<td>134</td>
<td><strong>FREQ - C</strong></td>
<td></td>
</tr>
<tr>
<td>135</td>
<td>1 HOLDING-CELLS AND TISSUE</td>
<td></td>
</tr>
<tr>
<td>135</td>
<td><strong>FREQ - C</strong></td>
<td></td>
</tr>
<tr>
<td>136</td>
<td>1 HOLDING INVERTEBRATES</td>
<td></td>
</tr>
<tr>
<td>136</td>
<td><strong>FREQ - C</strong></td>
<td></td>
</tr>
<tr>
<td>137</td>
<td>1 HOLDING-COLONY MICE HAMSTERS ETC</td>
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</tr>
<tr>
<td>137</td>
<td><strong>FREQ - C</strong></td>
<td></td>
</tr>
<tr>
<td>138</td>
<td>1 HOLDING COLONY RATS</td>
<td></td>
</tr>
<tr>
<td>138</td>
<td><strong>FREQ - C</strong></td>
<td></td>
</tr>
<tr>
<td>139</td>
<td>1 HOLDING COLONY MARMOTS/RABBITS</td>
<td></td>
</tr>
<tr>
<td>139</td>
<td><strong>FREQ - C</strong></td>
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</table>

### 4 EQUIPMENT MAINTENANCE

**MANUAL AND SEMIAUTOMATIC**

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<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>82</td>
<td>11 WORK BENCH CLEANUP - DEACTIVAT EQUIP, RE Cage OR DISPOSE OF SPEC-</td>
<td></td>
</tr>
<tr>
<td>82</td>
<td>21 IMEN(S), CLEANUP AND STOW EQUIP, DISPOSE OF WASTE, CLEAN BENCH</td>
<td></td>
</tr>
<tr>
<td>82</td>
<td>31 SURFACE, STOW AND/OR DISPOSE OF CLEANING MATERIAL</td>
<td></td>
</tr>
<tr>
<td>82</td>
<td><strong>FREQ - 7/DY (BENCHES)</strong></td>
<td></td>
</tr>
<tr>
<td>83</td>
<td>1 WORKBENCH STERILIZATION</td>
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III-21
<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>83A</td>
<td>Freq - 1/DY (Benches) - Alcohol or Quad Ammonia Wash</td>
<td></td>
</tr>
<tr>
<td>83C</td>
<td>Freq - 10/DY (Liniers) - Work Bench Autoclavable Liners</td>
<td></td>
</tr>
<tr>
<td>99</td>
<td>Sterilization of Tool/Equip</td>
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</tr>
<tr>
<td>99A</td>
<td>Freq - 1/2 DYS (All Items at Once) - ETO or Pro Gas</td>
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<tr>
<td>99D</td>
<td>Freq - 10/2 DYS (Individually) - Alcohol or Quad Ammon (Bac)</td>
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<tr>
<td>101</td>
<td>Sterilzn of Holding Units</td>
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<tr>
<td>104</td>
<td>Holding Unit Manifold Cleanup</td>
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<td>103</td>
<td>Organism Holding Unit Cleanup</td>
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<tr>
<td>103A</td>
<td>Freq - 90/Wk (CM) - Scrapers/Brushes on Vac Tool</td>
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<tr>
<td>103C</td>
<td>Freq - 12/Wk (CM) - Remove Cages to Autowasher</td>
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<tr>
<td>312</td>
<td>Electronic Equipment Calibration</td>
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<tr>
<td>312A</td>
<td>Freq - 30 Min/Wk</td>
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<tr>
<td>312B</td>
<td>Freq - 30 Min/Wk</td>
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<tr>
<td>313</td>
<td>Atmospheric Monitor Calibration</td>
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<tr>
<td>313</td>
<td>Freq - 30 Min/Wk</td>
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<td>314</td>
<td>Biochemical Analytical Equipment Calibration</td>
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<td>314</td>
<td>Freq - 60 Min/Wk</td>
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<td>358</td>
<td>Biomedical Equipment Cleanup/Disposal</td>
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<tr>
<td>358</td>
<td>Freq - 15 Min/DY</td>
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<tr>
<td>513</td>
<td>Electrical Maintenance</td>
<td></td>
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<tr>
<td>513</td>
<td>Freq - 15 Min/Wk</td>
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<td>514</td>
<td>Mechanical Maintenance</td>
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<tr>
<td>514</td>
<td>Freq - 15 Min/Wk</td>
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<tr>
<td>517</td>
<td>Clean-up: Liquid and Solid</td>
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<tr>
<td>517</td>
<td>Freq - 1/DY</td>
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</tr>
<tr>
<td>518</td>
<td>Trash Disposal</td>
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<tr>
<td>518</td>
<td>Freq - 1/DY</td>
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</tr>
<tr>
<td>950</td>
<td>Routine Equipment Maintenance</td>
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</tr>
<tr>
<td>950</td>
<td>Freq - 30 Min/DY</td>
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III, 2. EQUIPMENT OPERATIONS ANALYSIS

The operation of the equipment in the Life Sciences payload was analyzed to determine average power consumption, equipment usage rates, the related workspace volume required, and to verify the initial estimates of the number of each equipment item required. The primary documentation of these analyses is presented in Table III-2, Equipment Operations Analysis. The table contains the reference number of each equipment item tabulated in the left-hand column, followed by the name of the item, the equipment unit to which it belongs, and its weight, rated power, and volume. Beneath the name of each piece of equipment are the functions that use the equipment identified by reference number and title. Directly opposite each using function are the number of that equipment item required for the function, an estimate of the length of time that the equipment is "on" (using power), and the power consumption as a 24 hour average. The number required column has been summed across the using functions to give the total number required of each piece of equipment. This number corresponds to the total appearing in the equipment inventories.
### Table III-2. Equipment Operations Analysis

**Maxi Max Payload**

<table>
<thead>
<tr>
<th>REF. NO.</th>
<th>EQUIPMENT ITEM (EU)/INVENTORY WT., PWR., VOL.</th>
<th>USE TIME, MIN/X</th>
<th>EQUIP2 TIME, PWR, WATTS</th>
<th>AVER3</th>
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<tbody>
<tr>
<td>001</td>
<td>Acceleromtr (activity) (3)/.2, 0, .036</td>
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<tr>
<td>001</td>
<td>Maxi Max Payload</td>
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<tr>
<td>001A</td>
<td>Acceleromtr coupler (3)/2, 0, 100</td>
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<tr>
<td>003B</td>
<td>Air lock, EVA (11)/ *</td>
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<td>006</td>
<td>Air particl ampl collect (61)/6, 0, .03</td>
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<tr>
<td>007</td>
<td>Autoanalyzer, multiple (5)/100, 150, 3.0</td>
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<tr>
<td>008</td>
<td>Anlizr, amino acid (5)/88, 700, 3.9</td>
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<tr>
<td>008A</td>
<td>Anlizr, atom ads sptrph (5)/80, 110, 4</td>
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<td>008B</td>
<td>Anlizr, carbohydrate (5)/75, 100, 2</td>
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<tr>
<td>009</td>
<td>Anlizr, genl, IR specph (5)/100, 250, 4.6</td>
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<tr>
<td>010</td>
<td>Anlizr, genl, IR specph (5)/100, 250, 4.6</td>
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<tr>
<td>011</td>
<td>Anlizr, genl, spectropho (5)/300, 450, 15</td>
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<tr>
<td>012</td>
<td>Anlizr, specif ion (5)/10, 10, .5</td>
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<tr>
<td>012A</td>
<td>Anlizr, conductivity (5)/3, 3, .1</td>
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<tr>
<td>013</td>
<td>Anlizr, urine, auto (5)/20, 50, 1</td>
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<tr>
<td>014</td>
<td>Anesthetx (invert handling) (4)/12, 0, .4</td>
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</tbody>
</table>

**Notes:**

1. Time one or more crewmen are using equip.
2. "On" time is defined as power consuming time except for selected items (e.g., refrigerators) which are considered to be on continuously with appropriate averaging of the power.
3. Ave pwr on a 24 hr day, 7 day per wk base.
4. Average time per crew day

* Experiment or payload/layout specific.
  a. automatic
  b. continuous
  c. as required

ad see addendum
<table>
<thead>
<tr>
<th>REF. NO.</th>
<th>EQUIPMENT ITEM (REF.)/INVENTORY WT., PWR., VOL.</th>
<th>CREW USE</th>
<th>EQUIP &quot;ON&quot;</th>
<th>AVE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>EQRTMT (EU)/INVENTORY WT.</td>
<td>NO.</td>
<td>TIME,</td>
<td>MIN/X</td>
</tr>
<tr>
<td></td>
<td>CREW TIME,</td>
<td>TIME,</td>
<td>PK/W</td>
<td></td>
</tr>
<tr>
<td>014A</td>
<td>Antennas, assorted (2)/*</td>
<td>4</td>
<td>a</td>
<td>*</td>
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<tr>
<td>115A</td>
<td>Electromagnetic assay</td>
<td>4</td>
<td>a</td>
<td></td>
</tr>
<tr>
<td>35</td>
<td>Anthropometric grid (93)/4, 0, 0.1</td>
<td>7pk</td>
<td>a</td>
<td>0</td>
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<tr>
<td>65B</td>
<td>Plant activity - time lapse photography</td>
<td>1</td>
<td>a</td>
<td>0</td>
</tr>
<tr>
<td>622A</td>
<td>Crew body position measurements - cine</td>
<td>1</td>
<td>a</td>
<td>0</td>
</tr>
<tr>
<td>821B</td>
<td>Crew body motion measurements - cine</td>
<td>7pk</td>
<td>a</td>
<td>0</td>
</tr>
<tr>
<td>015A</td>
<td>Atmos sampling - unit sys (5)/*</td>
<td>10</td>
<td>a</td>
<td></td>
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<tr>
<td>50B</td>
<td>Gas sampling - micromanifold sys</td>
<td>10</td>
<td>a</td>
<td></td>
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<tr>
<td>013D</td>
<td>Audio stereo headset (91)/1.5, 0.0, 0.2</td>
<td>1</td>
<td>6/wk</td>
<td>0</td>
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<tr>
<td>71A</td>
<td>Auditory-absolute threshold</td>
<td>1</td>
<td>7/wk</td>
<td>0</td>
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<tr>
<td>71B</td>
<td>Auditory-temporal acuity</td>
<td>1</td>
<td>7/wk</td>
<td>0</td>
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<tr>
<td>71C</td>
<td>Auditory-sound localization</td>
<td>1</td>
<td>7/wk</td>
<td>0</td>
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<tr>
<td>72A</td>
<td>Auditory-detection of motion</td>
<td>1</td>
<td>7/wk</td>
<td>0</td>
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<tr>
<td>016B</td>
<td>Audimeter (5)/10,25,0.15</td>
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<td>6/wk</td>
<td>6/wk</td>
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<tr>
<td>71A</td>
<td>Auditory-absolute threshold</td>
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<td>7/wk</td>
<td>7/wk</td>
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<tr>
<td>71B</td>
<td>Auditory-temporal acuity</td>
<td>1</td>
<td>7/wk</td>
<td>7/wk</td>
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<tr>
<td>71C</td>
<td>Auditory-sound localization</td>
<td>1</td>
<td>7/wk</td>
<td>7/wk</td>
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<tr>
<td>72A</td>
<td>Auditory-detection of motion</td>
<td>1</td>
<td>7/wk</td>
<td>7/wk</td>
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<tr>
<td>015D</td>
<td>Badges-rad, std. film (25)/0.1, 0.001</td>
<td>110</td>
<td>110/wk</td>
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<tr>
<td>63A</td>
<td>Radiation monitoring-film sensors</td>
<td>552</td>
<td>16/dy</td>
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<tr>
<td>015E</td>
<td>Bags-plastic, permeabl (6)/0.1, 0.001</td>
<td>97A</td>
<td>Experiment waste mgmt.</td>
<td>2000</td>
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<td>2000</td>
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<tr>
<td>016D</td>
<td>Coupler ballistocardiogram (30)/0.2,1, .996</td>
<td>1</td>
<td>40/wk</td>
<td>40/wk</td>
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<tr>
<td>325A</td>
<td>Ballistocardiography - discrete unit</td>
<td>1</td>
<td>40/wk</td>
<td>40/wk</td>
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<tr>
<td>326B</td>
<td>Ballistocardiography-backpack</td>
<td>1</td>
<td>15/dy</td>
<td>0</td>
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<tr>
<td>017</td>
<td>Bench, elct/mech (6)/100, 200, 20</td>
<td>1A</td>
<td>Etoelectric XCR installation - manual callib.</td>
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<tr>
<td>1B</td>
<td>Etoelectric XCR installation - precallib.</td>
<td>1</td>
<td>25/wk</td>
<td>25/wk</td>
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<tr>
<td>156B</td>
<td>Primate cage preparation - in space</td>
<td>1</td>
<td>240/90 dy</td>
<td>240/90 dy</td>
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<tr>
<td></td>
<td></td>
<td>1</td>
<td>17/dy</td>
<td>2</td>
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<tr>
<td>018</td>
<td>Bench, 1.5 m flo (4)/175, 100, 23</td>
<td>1A</td>
<td>Orgnms receiving</td>
<td>1</td>
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<td>2A</td>
<td>Material receiving</td>
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<td>97/90 dy</td>
<td>97/90 dy</td>
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<tr>
<td>6A</td>
<td>Urine mgmt - cage to disposal</td>
<td>1</td>
<td>97/90 dy</td>
<td>97/90 dy</td>
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<tr>
<td>1B</td>
<td>Biosampling</td>
<td>1</td>
<td>(see 8B below)</td>
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<tr>
<td>101C</td>
<td>Sterilms of holding units</td>
<td>1</td>
<td>65/dy</td>
<td>65/dy</td>
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<tr>
<td>125A</td>
<td>Crew/organism isolation</td>
<td>1</td>
<td>65/dy</td>
<td>65/dy</td>
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<tr>
<td>125B</td>
<td>Crew/chemical isolation-LFB</td>
<td>1</td>
<td>56/dy</td>
<td>10/dy</td>
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<tr>
<td>159A</td>
<td>Artificial gravity-manned centfrg.</td>
<td>1</td>
<td>30/dy</td>
<td>10/dy</td>
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<td>159B</td>
<td>Vertebrate cage preparation</td>
<td>1</td>
<td>(see other functions)</td>
<td>(see 1A above)</td>
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<tr>
<td>159C</td>
<td>Plant holding unit preparation</td>
<td>1</td>
<td>(see 1A above)</td>
<td>(see 1A above)</td>
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<td>200A</td>
<td>Invertebrate cage-holding unit setup</td>
<td>1</td>
<td>(see 1A above)</td>
<td>(see 1A above)</td>
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<tr>
<td>2028</td>
<td>Vertebrate experiment initiation</td>
<td>1</td>
<td>300/90 dy</td>
<td>300/90 dy</td>
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<tr>
<td>223B</td>
<td>Plant experiment initiation</td>
<td>1</td>
<td>150/90 dy</td>
<td>150/90 dy</td>
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<tr>
<td>224B</td>
<td>Invertebrate experiment initiation</td>
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<td>150/90 dy</td>
<td>150/90 dy</td>
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<tr>
<td>225B</td>
<td>Cells and tissue experiment setup</td>
<td>1</td>
<td>150/90 dy</td>
<td>150/90 dy</td>
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<tr>
<td>353A</td>
<td>Culture/sensitivity-microorganism growth cap.</td>
<td>1</td>
<td>20/3 wk</td>
<td>20/3 wk</td>
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<tr>
<td>018A</td>
<td>Bench liners, LFB (4)/10, 0, 2</td>
<td>10</td>
<td>50/dy</td>
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<tr>
<td>83C</td>
<td>Workbench sterilization-liners</td>
<td>12</td>
<td>50/dy</td>
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Table III-2. Equipment Operations Analysis, Contd
Maxi Max Payload
### Table III-2. Equipment Operations Analysis, Contd

**Maxi Max Payload**

<table>
<thead>
<tr>
<th>REF.</th>
<th>EQUIPMENT ITEM (EQUI)</th>
<th>INVENTORY WT., PWR., VOL.</th>
<th>CREW USE</th>
<th>CREW EQP</th>
<th>CREW AVE</th>
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<td>NO.</td>
<td>TIME, MIN</td>
<td>TIME, MIN</td>
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<td>018B</td>
<td>Bench Insert LFB, radioc (4)/50, 0, 2</td>
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<td>2</td>
<td>15/2 wk</td>
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<td>018C</td>
<td>Ceramic X-cr X-cr installation - precal</td>
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<td>2</td>
<td>1/2 dy</td>
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<td>018D</td>
<td>Custom bite boards (12)/0.5, 0, 0.001</td>
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<td>3</td>
<td>15/0 wk</td>
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<tr>
<td>018E</td>
<td>Spatial localization</td>
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<td>3</td>
<td>2/0 wk</td>
<td>0</td>
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<td>018F</td>
<td>Ocular counter-rolling</td>
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<td>3</td>
<td>150/0 wk</td>
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<td>018G</td>
<td>Angular acceleration threshold</td>
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<td>12</td>
<td>73/0 dy</td>
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<td>018H</td>
<td>Bench. genl exper (5)/100, 50, 9</td>
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<td>1</td>
<td>10/0 dy</td>
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<tr>
<td>018I</td>
<td>Bioelectric X-cr installation - emi cal</td>
<td></td>
<td>1</td>
<td>6/0 wk</td>
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<tr>
<td>018J</td>
<td>Bioelectric X-cr installation - precal</td>
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<td>30/0 dy</td>
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<tr>
<td>018K</td>
<td>Invertebrate counting and sorting (insects)</td>
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<td>018L</td>
<td>Work bench cleanup</td>
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<td>320/2 wk</td>
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<td>018M</td>
<td>Plant radiochemistry</td>
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<td>Ocular counter-rolling</td>
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<td>018O</td>
<td>Angular acceleration threshold</td>
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<td>018P</td>
<td>Helmet, micro (42)/0.1, 0, .05</td>
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<td>018Q</td>
<td>Monitor ECG - 50m or 60m</td>
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<td>16</td>
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<td>018R</td>
<td>Monitor ECG - recver at CM</td>
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<td>16</td>
<td>20/0 wk</td>
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<td>018S</td>
<td>Body mass measurement (12)/25, 2, 26</td>
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<td>018T</td>
<td>Body mass measurement for man</td>
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<td>32</td>
<td>40/0 dy</td>
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<td>Burner, catalytic (3)/*</td>
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<td>a</td>
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<td>018V</td>
<td>Sterilization of air gases</td>
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<td>10</td>
<td>5/0 dy</td>
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<td>018W</td>
<td>Botl C/T cult opt flts (61)/0.3, 0.02</td>
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<td>17</td>
<td>20/0 dy</td>
<td>0</td>
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<tr>
<td>018X</td>
<td>Water analysis - total solids content</td>
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<td>5</td>
<td>15/0 dy</td>
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<td>018Y</td>
<td>Water analysis - bacteriological assay</td>
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<td>2</td>
<td>1/2 c</td>
<td>25</td>
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<td>018Z</td>
<td>Liquid transfer - collapsible bladder</td>
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<td>8</td>
<td>a</td>
<td>40</td>
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<td>019A</td>
<td>Cage, colony, rat (40)/4, 20, 2.2</td>
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<td>8</td>
<td>10/0 wk</td>
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<tr>
<td>019B</td>
<td>Organum holding unit cleanup-at washer</td>
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<td>8</td>
<td>2/0 dy</td>
<td>0</td>
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**III-26**
### Table III-2. Equipment Operations Analysis, Contd

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### Table III-2. Equipment Operations Analysis, Contd

**Maxi Max Payload**

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**Chemical storage cabinet (7)/50,0,6**

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**Clean, instrmt/appar (6)/150,500,11.5**

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III-29
### Table III-2. Equipment Operations Analysis, Contd

Maxi Max Payload

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053-059F to be revised

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|          | 13B Monitor EOG - hardware multiplex data to IM | 32 9/wk 0 32 |
|          | 13F Monitor EOG - electrophysiology blk-man | 3 90/wk 90/wk |
|          | 32 17/dy 32            |                          |          |            |           |

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Table III-2. Equipment Operations Analysis, Contd
Maxi Max Payload

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III-32
### Table III-2. Equipment Operations Analysis, Contd

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<td>Holding - C &amp; T</td>
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<td>Water analysis, bacteriological assay</td>
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<td>Culture/sensitivity, microorganism growth exp.</td>
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<td>Viral culturing</td>
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<td>Holding, rabbits, cats, marmots, etc.</td>
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<td>137A</td>
<td>Holding, colony, mice, hamsters, etc.</td>
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<td>Holding, colony, marmots, rabbits</td>
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<td>772A</td>
<td>Gross psychomotor nents, gross body equilbim</td>
</tr>
<tr>
<td>758A</td>
<td>Gross psychomotor nents, spd of limb movement</td>
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<td>Sleep behavior nents, response to emergency</td>
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Table III-2. Equipment Operations Analysis, Contd

Maxi Max Payload

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III-34
### Table III-2. Equipment Operations Analysis, Contd

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**III-35**
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III-36
### Table III-2. Equipment Operations Analysis, Contd

Maxi Max Payload

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III-40
### Table III-2. Equipment Operations Analysis, Contd

Maxi Max Payload

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<td>701A Visual, acuity, dynamic</td>
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<td>703A Visual, stereopsis, dynamic</td>
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<td>709A Visual, glare recovery</td>
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<td>714A Visual, accommodation range</td>
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<td>306A Vomitus collection</td>
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<td>187</td>
<td>Waste mngmt sys (3)/*</td>
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<td>82A Workbench cleanup</td>
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<td>94A Organism subculturing, c and T</td>
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<td>96A Radiochem waste mngmt</td>
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**Table III-2. Equipment Operations Analysis, Contd**

Maxi Max Payload
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Table III-2. Equipment Operations Analysis, Contd
(Addendum A)

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III-45
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Table III-2. Equipment Operations Analysis  
(Addendum B)

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<td>60/wk</td>
<td>0</td>
</tr>
<tr>
<td>186A</td>
<td>Trace gas concentrator (5)/10, 0, 0.25</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>059A Atmospheric ethylene monitoring</td>
<td></td>
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</tr>
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</table>

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