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FINAL REPORT

on

TRAFFIC MODEL FOR COMMERCIAL PAYLOADS IN THE MATERIALS EXPERIMENT ASSEMBLY (MEA)

(Report No. BCL-OA-TFR-79-1)

by

F. A. Tietzel

Sponsored by

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
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Approved by:

Jack R. McDowell
J. R. McDowell, Task Leader

A. C. Robinson, Project Manager

BATTELLE
Columbus Laboratories
505 King Avenue
Columbus, Ohio 43201

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PREFACE

The study reported herein was carried out by Battelle's Columbus Laboratories for the NASA Office of Space and Terrestrial Applications, and represents the second portion of a two-part task under Contract No. NASw-2800. The work was done under the general supervision of Dr. A. C. Robinson, Battelle's manager for the contract.

Task 32, involving commercially oriented materials processing in space (MPS), is being conducted in two parts, and two reports are being issued to document the completion of the work. The second of these reports is presented here. The report describes the approach taken and how the 60-day study was accomplished by Battelle's Columbus Laboratories (BCL) to assess the potential use of NASA's Materials Experiment Assembly (MEA) by industry. The report summarizes the results of the study and provides a time-phased projection (traffic model) of commercial MPS usage of the MEA.

Battelle would like to acknowledge the efforts of Richard L. Brown of the Marshall Space Flight Center, who was the technical monitor for this task.

TRAFFIC MODEL FOR COMMERCIAL PAYLOADS IN THE MATERIALS EXPERIMENT ASSEMBLY (MEA)

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INTRODUCTION

The National Aeronautics and Space Administration (NASA) has long had an interest in the technical and economic potentials of materials processing in space (MPS). This interest has included active participation in experimentation on available manned and, more recently, unmanned space flights. MPS experiments have been sponsored and flown on three Apollo missions, the Skylab missions, the Apollo-Soyuz Test Project (ASTP), and several sounding rocket flights conducted under the current Space Processing Application Rocket (SPAR) Project. The SPAR Project is intended to bridge the gap of several years for those flight opportunities providing a sustained microgravity environment which will occur from the last manned flight on ASTP (1975) to the future operational Space Shuttle/Spacelab missions (scheduled for 1981).

In recent months, NASA has determined that there is a need to provide a means of evolving and extending MPS research from the short duration SPAR flights to the significantly longer duration experiments made available by the Space Shuttle. To satisfy this need, NASA has initiated the development of the Materials Experiment Assembly (MEA) to provide a low-cost capability for conducting materials research in space before more ambitious, sophisticated and costly experiments are undertaken aboard the Spacelab. The MEA is being designed as a highly self-contained and automated assembly for frequent flights on Space Shuttle missions. The MEA is also being configured to accommodate designs and hardware previously developed for and available from the SPAR Project. This configuration will allow the MEA to operate independently from the Shuttle orbiter and will permit MPS experiments to be conducted simultaneously in four separate materials process areas.

Although the MEA is being developed primarily for NASA's use, plans are to make it, or its capabilities, available to commercial users. Overall, the availability of the MEA, totally or partially, represents a significant incentive to commercial space research. Use of the MEA will provide an obvious savings in flight hardware investments for commercial organizations if that organization is at a point in their research to effectively take advantage of the opportunity. If NASA flies at least two MEAs per year, partial use of the MEA can represent a frequent and usable service to industry. Therefore, NASA requires some measure of the potential interest in and future utilization that may be made of the MEA during the period FY 1981 through FY 1987 in order to assess the hardware needs over and above NASA requirements.

An initial attempt has been made to provide NASA with a first-cut measure of the potential commercial interest in and use of the MEA by developing two time-phased traffic models for commercial payloads for the MEA. This report presents a High Traffic Model (HTM) and a Low Traffic Model (LTM) for the years of interest. The HTM portrays that level of commercial MEA traffic commensurate with a comprehensive NASA effort to establish a scientific and technological basis for commercial MPS ventures. The more conservative and less optimistic LTM reflects a lower level NASA effort, thereby requiring a longer period of time to establish the scientific and technological base to interest commercial organizations in MPS ventures. The LTM also reflects less promising research results which are noted by the deletion of some commercial follow-on activities carried in the HTM.

This study was not intended, as a primary purpose, to "sell" the MEA concept to potential commercial MPS users, nor was it intended to promote the advantages of going to space for MPS-related commercial activities for which a MEA might be suitable. Instead, the purpose of the study was to obtain a preliminary reading of the interest in and possible eventual use of an evolving MEA flight hardware and service concept for the commercial sector. The straightforward way to measure interest in the MEA would be to survey the management of all commercial organizations actively doing MPS research for a commercial purpose and committed, as an organization, to pursuing the results as a commercial venture. At the present time, there are very few organizations which can be placed in that category. Therefore, the survey that was conducted relied predominantly upon contacting individuals such as principal investigators who have in the past or are now actively participating in MPS-related activities. These individuals were contacted in the belief that they have a special insight into the commercial applications of certain areas of MPS research and could be encouraged to envision how a MEA could be used for commercial purposes. Many of those contacted are members of commercial organizations or work with the commercial sector. It should be noted that the projections obtained in the survey were those of the individual contacted and do not represent an official position or commitment of his organization. It is our belief that making contacts with individuals or organizations not familiar with MPS would have precluded a meaningful response regarding plans for commercial MPS activities and commercial use of the MEA.

The traffic models developed as a result of the survey provide an early indication of interest in MEA commercial use as a next step to current and planned MPS activities. It should be noted that this interest exists based only upon a preliminary functional and policy understanding of how the MEA can be used and with little knowledge of design details, no indication of costs, and favorable assumptions made regarding current and planned MPS research results. While the traffic models can be used for planning purposes, without further development of the concept with potential users, they cannot be used to size the MEA relative to user power needs, thermal control, data retrieval, consumables, etc. It should also be noted that the number of MEA flights projected in the traffic models should not be used, without further detailed discussions with the users, for the procurement of MEA flight hardware exclusively for commercial organizations. In many cases, the individuals contacted were willing to project the possibility of using a MEA but were reluctant to specify flights per year. Therefore, the MEA flights per year are not completely shown. Also, those flights per year which are shown do not precisely show how and to what extent the MEA hardware will be used.

It is believed that the required details regarding user hardware and service needs can be obtained by follow-up meetings with the individuals projecting a commercial use of a MEA. It is also believed that a significant increase in the interest of a MEA for commercial ventures can be stimulated by further development of the MEA commercial use concept, promotion of that concept, and the initiation of active marketing.

STUDY OBJECTIVE

The objective of this study is to develop two separate, time-phased traffic models (a high model and a more conservative low model) of commercial MPS payloads/experiments to be accommodated on the MEA during the FY 1981 through FY 1987 time frame. As a part of the study, a breakout of the commercial traffic is to be provided, as a minimum, in the following process areas:

- Crystal Growth and Solidification
- Containerless Processes
- Fluid and Chemical Processes
- Bioseparation.

STUDY APPROACH

The overall approach taken to achieve the study objective, within the given time constraints, was to conduct a survey of selected individuals and organizations to obtain a basis for the commercial MEA traffic projections. In general, the contacts to be made in the survey were to be with those individuals and organizations known to be active in materials processing in space related tasks such as: principal investigators, consultants, advisors, past and future space researchers, and those supporting any of the preceding. In addition, contacts were to be made with certain Getaway Special (GAS) users who were thought to be planning business related research or educational institution related applications for their payloads. Collectively, all contacts to be made were believed to be individuals/organizations already convinced, to various degrees, of the benefits of space who could reasonably project how their present interest in space could evolve into a future use of the MEA for commercial purposes.

As structured, the survey was intended to make individuals aware of the MEA concept being developed and knowledgeable of how they could use the MEA capabilities/services on a commercial basis. The goal of each contact was to help the individual envision a meaningful scenario of how, when and why he or his organization could potentially use a MEA in the future for a commercial payload. It was hoped that this would result in reasonable projections of payload flights in one or more of the specific material process areas. It should be noted that the survey was not intended as a marketing activity to obtain a firm commitment from a commercial organization but was, instead, intended as a means to introduce credibility into a first-cut model of commercial traffic projections for the MEA. A description of how the survey was actually conducted, the contacts made and the results are included in subsequent sections of this report.

Basic to the survey was the need to provide the individual contacted with a brief, but adequate, description of the MEA configuration and the concept of how commercial organizations can plan to use the MEA capabilities/services when they become available. With regard to the MEA configuration, two documents supplied by NASA/MSFC were referenced to provide the level of detail necessary for Battelle to outline the MEA performance capabilities and physical characteristics to a survey contact. The two documents are:

- Materials Experiment Assembly Design and Performance Specification, MSFC-SPEC-951, March 30, 1978.
- Preliminary Experiment Requirements, (MEA), September 1978, Revision B.

It was also assumed that, in addition to the two general purpose furnaces, the single-axis acoustic levitator and the monodisperse latex reaction chamber presently planned for the four research facility bays on the MEA, other research facilities may be available in the future as they are flown and demonstrated on the SPAR Project (e.g., the electrophoretic separator). Another assumption was that NASA would fly two MEAs per year for their own use.

Although the MEA is being developed for NASA's use, it was assumed that NASA plans to make it, or its services, available to commercial users either as separate, additional units or as part of a NASA mission. The spectrum of ways in which a MEA may be used by a commercial organization would include the following:

- An entire MEA, in any configuration, can be purchased or leased. This would provide a complete, automated flight research facility if needed by the user.
- The complete use or partial use of an experiment facility, e.g., a furnace, can be negotiated.
- A user can arrange to fly his own experiment facility, e.g., a user designed furnace, in one of the MEA bays, thus using a pro rata share of the MEA's power, thermal control, etc.
- NASA will offer to fly a commercial user's experiment sample/specimen for a fixed fee. Perhaps as a routine service, NASA will advertise that they will fly, process, and return a preprepared specimen for a user.

There are several funding options open to commercial organizations interested in performing MPS experiments on the MEA. All of the options are currently under study by NASA. The options described to contacts in the survey were those defined in the Task Statement of Work and are as follows:

- Joint Endeavors: NASA is interested in joint endeavors with commercial concerns. In a joint endeavor, each of the parties agrees to be responsible for specific portions of the total venture. In essense, industry can make NASA an offer stating what the firm will do and what will be expected of NASA. Joint endeavors can be used for a variety of ventures. For example, a joint endeavor might simply call for cooperation or collaboration between an industrial scientist and one of the principal investigators involved in NASA sponsored research. In such a case, the industrial scientist, who would be termed a "guest investigator", would participate to an extent mutually acceptable to his firm, the principal investigator, and to NASA. However, a joint endeavor could cover a substantial research and development effort involving major flight experiments and commercial demonstrations. In joint endeavors, NASA does not fund any portion of the work to be performed by the firms.

- Industry-Funded Ventures:
  - Using Privately-Owned Flight Hardware: Under this provision, private industry will fund the entire venture, including development of the experiment package; a pro rata share of integration, operation, and flight cost; etc.
  - Leasing Government-Owned Flight Hardware: The commercial firm will lease NASA MPS hardware to minimize its capital investment while retaining proprietary rights (the firm is expected to also pay its pro rata share of integration, operation, and transportation costs).
- Government-Funded Ventures: Periodically, NASA will solicit proposals for commercial MPS experiments and demonstrations through formal competitive announcements. Proposals selected will be funded by NASA, in which case invention rights may be retained by NASA. Selection of proposals in this category will follow procedures and criteria oriented to commercial requirements rather than scientific investigation.

SCOPE OF SURVEY

The survey to assess potential commercial use of the MEA was aimed at covering a broad spectrum of the community interested in, actively participating in, and evaluating space processing. Foreign contacts were not made. Companies and individuals were selected from the following lists plus some additional personnel suggested by those contacted:

- AAS Technical Committee on Materials Space Processing
- Participants in previous Space Processing Symposiums
- Committee on and contributors to the National Research Council's report "Materials Processing in Space"
- List of possible users assembled by Battelle personnel and Stanley Gelles of S. H. Gelles Associates.
- Those signed up as potential "Getaway Special" users.

Some of those selected for the survey have been involved with earlier space processing activities such as the Skylab, the ASTP and the SPAR project. Those active in current programs, such as MEA principal investigators (PIs) and Spacelab investigators, were also contacted to learn the future plans for their activity and determine if they had any suggested contacts. A sizable number of those active in current non-MEA programs know nothing about the MEA.

In total, 100 individuals were contacted by telephone. These individuals represented 73 facilities, which included companies, universities, contract research organizations, and non-NASA government organizations. Most of those contacted were at the project manager or PI level. However, a few represented top or upper level management. A number of personnel selected from the initial lists were found to have moved to other organizations. Three or four companies contacted have decided to drop all activities related to space processing. The Appendix provides seven different listings of data which resulted from the survey. The data include the following:

- A listing of all individuals contacted in the survey, with their organization affiliation noted
- A separate listing (for cross reference) of the organizations contacted
- A listing of those individuals/organizations no longer interested in MPS
- A list of individuals who consider the MEA as too limited
- A list of individuals who have requested additional data on the MEA
- A list of individuals who consider that the MEA could be used as a follow-on facility to preliminary Spacelab activities
- A list of individuals/organizations who can be considered as possible future MEA users.

If the individual contacted was unfamiliar with the MEA concept, then a brief verbal description was given outlining the MEA performance capabilities and physical characteristics. In addition, NASA objectives regarding the MEA's use by the commercial sector and a summary of how the MEA could be used and sponsored by commercial firms were provided.

Each individual was asked if he could foresee a commercial application evolving from the area of research in which he had been, was or planned to be involved in. Additionally, he was asked if the MEA represented a suitable facility or service for commercial purposes and whether a reasonable projection of flight requirements and potential sponsors could be made.

SURVEY RESPONSE

The responses from the contacts were very cordial, and each person tried to be as helpful as possible. Numerous contacts expressed regret that they could not be more definite at this time. This was understandable since their potential long range plan depends upon results from near term tests, such as from an ongoing laboratory program, an upcoming SPAR flight, and/or early STS Spacelab/MEA flights. However, some constructive input was gained from most contacts.

Most of the individuals contacted had some direct or indirect active participation with past and/or present MPS activities. The 100 individuals contacted represent 16 universities/technical institutes, 5 government agencies and 52 industrial facilities*. All the inputs to the traffic model were from those active in present MPS programs and proposing future MPS related programs. These positive contributions to the MEA traffic model were received from 19 individuals identified with

* Industrial facilities include contract R&D organizations and commercially operated captive government facilities, such as EG&G, Santa Barbara Operations.

23 separate MPS related research programs. The following tabulation provides a further breakdown of those 19 individuals with their organizational affiliation categories and the number of related MPS programs they are involved in:

Individuals	Organizations	MPS Related Research Programs
3	3 Universities/Tech. Inst.	4
16	14 Industrial Facilities	19

Some of the survey responses that did not affect the MEA traffic model but provided additional information included in this report were from those who viewed the MEA as too limited. Those contacts are actively participating in present and future activities associated with materials processing in space programs which will be using more sophisticated equipment such as the Spacelab and the materials research facilities being developed for that laboratory.

A response from some contacts was that they were monitoring NASA space processing plans and activities but had no active plans of their own at this time. Some of this lack of an active program was due to the fact that they had lost key innovative employees, who had been involved in early space experiments. These losses were the result of retirement, death, and change of employment.

Other contacts indicated that the experimental equipment technology was not at the level needed to support their materials processing in space goals and that ground-based laboratory work was being conducted to improve the situation.

Finally, there were those responses from individuals who, at this time, simply could not express confidence in the economic benefits of MPS and, therefore, could not foresee a commercial need for the MEA. This response was not a rejection of the MEA commercial use concept but, instead, was a negative view of the commercial prospects for the MPS research.

Two unique responses that provided no input to the MEA traffic model but should be monitored for future materials processing in space activities were from Bethlehem Steel Corporation and Wyeth Laboratories. Bethlehem Steel has recently established a company policy to redirect their research activities more toward basic research, and in doing so has assigned specific individuals to direct a portion of their activities toward materials processing in space interests. It should also be noted that Bethlehem has purchased a GAS flight option. This change in research emphasis is too new to have any meaningful impact at this time. However, if Bethlehem becomes involved in a MPS research activity, or when they select a research purpose for their GAS, then they can evaluate the potential use of a MEA as a commercial research follow-on. Wyeth Laboratories has temporarily curtailed their activity toward materials processing in space since they have reached a peculiar impasse with regard to their future commercial interest in space processing. Wyeth has long been interested in the commercial potential and the progress of NASA sponsored research in electrophoretic separation in the microgravity environment. This interest has been affected by recently publicized negative views (The National Research Council's Committee on Scientific and Technological Aspects of Materials Processing in Space) which stated that, "there is no pressing need for an enlarged trial of electrophoresis in space". Therefore, Wyeth is awaiting NASA's resolution of these views and its future sponsorship of continuing or different research in this process area. Additionally, a member of Wyeth's organization was appointed to one of NASA's peer review committees, which could present a conflict of interest situation. The status of Wyeth's commercial interests should be monitored.

TRAFFIC MODEL DEVELOPMENT

The various contacts that provided useful input toward the generation of a potential commercial MEA traffic model, did so with varying levels of detail and certainty. None should be taken as representing an official, approved position from top management of the organization concerned.

The input data represent the views of the various contacts, relative to their present space related activities, present program schedule, and anticipated funding support.

The resulting MEA traffic models are presented in Tables 1 and 2. Table 1 presents the HTM and Table 2 presents the LTM. The HTM should be considered an upper limit at this point in time. It may never be achieved as it is influenced by two main factors: (1) that NASA will continue to provide reasonable support during the initial phase and (2) that the planned work will proceed on schedule with no major setbacks or failures, and the funding (NASA and other) will be available without delay to move on to the next phase. Yet if early tests are successful and reveal beneficial results, it could encourage considerable traffic growth during the later period (1985-1987), especially since few wish to forecast work in the later period. The LTM assumes a lower level of NASA activity plus some unexpected setbacks, and a reduced level of activity and/or funding support. However, equipment delays and flight schedule delays have not been factored into the LTM.

MEA Traffic Model Tables

Each page of the tables contains a listing of separate line items, each identifying a projected use of the MEA for a commercial purpose. The line item identifies the organization associated with the projected commercial use, the product or experiment involved and the process or facility to be used in space. In most cases, the line item shows current space research involvement as the initial activity and then identifies the near term next phase and long term follow-on phase in which commercial use of the MEA is envisioned. It should be noted that all line item entries represent the use of only part of a MEA. The projected use could be one or more research canisters or only one or more cavities in a furnace or a combination of both. In no case did any individual project the need for an entire, dedicated MEA. However, a few stated that they would not rule this out for the later phases of their activity if initial results were satisfactorily achieved.

In a number of cases, the initial space processing activities shown as a line item in the model interact not only with a NASA sponsored MEA but with earlier SPAR flights or the upcoming Spacelab flights. Therefore, to provide the reader with a better understanding of the overall activity and schedule, these ties with other space facilities are indicated. The traffic shown which is not for a MEA is identified by a bracket, []. The line item, therefore, indicates the evolution of current space involvement to projected commercial flights of the MEA through 1987.

Also, while this model was intended to represent only commercial users, it does include NASA-supported PIs who may gain follow-on support from non-NASA government organizations and/or industrial organizations. The footnotes at the bottom of each table will assist the reader in interpreting the mixture of data.

In cases where the interviewee would not project both a high and a low level of activity, the author estimated the indicated traffic. Author-estimated data are identified by a solid dot above and to the right of the data, ($^{\bullet}$). In cases of high uncertainty when little or no project input could be obtained, TBD has been inserted to indicate, To Be Determined.

There are three other symbols used to identify the credence the reader might reasonably place on the data. A numerical scale of 1, 2 or 3 appears under the heading Confidence Code. This more or less indicates the level of confidence assigned to the data based upon interpretation of the interviewee's remarks. Where those remarks were vague or somewhat indefinite, the author-assigned confidence code will be followed by a dot in the superscript position, such as $2^{\bullet}$. The meanings of the confidence code values are:

Code	Meaning
1	Highest Confidence - almost certain to occur
2	Moderate Confidence - will probably occur
3	Lowest Confidence - might not occur.

Major MEA Use Categories

The traffic model data shown in Tables 1 and 2 are grouped under each of five major MEA use category subheadings. Four of the headings are related to specific materials processing categories, and the fifth heading covers a broader and less specific use of the MEA. The five groups are: (1) Crystal Growth and Solidification; (2) Containerless Processes; (3) Fluid and Chemical Processes; (4) Bioseparation and Biological Processes, and (5) General Research and Development. This last category was added to accommodate use of the MEA envisioned by contract research organizations. A more detailed discussion of the entries in each of the use categories is included in following subsections of this report.

MEA USE CATEGORY RESULTS

Crystal Growth and Solidification

The Crystal Growth and Solidification section of Table 1 (HTM) contains eight entries. Only three of these entries are indicated as being definite uses of the MEA. The others, due to uncertainties, are noted as being possible MEA uses.

The first entry on Sheet 1 of the HTM is the Rensselaer Polytechnic Institute (RPI) crystal growth activity, where the PI has used consultants from IBM and RCA. Either of these companies or both are likely candidates for follow-on activity if the preceding phases are promising. The third entry is the EG&G experiment in Spacelab 3 with mercuric iodide radiation detectors. EG&G's Santa Barbara facility is a Department of Energy (DOE) laboratory and thus would not produce the detector for commercial application. Two industrial firms have shown an interest in follow-on work once the product is developed. One of these firms, Radiation Monitoring Devices (RMD), contacted Battelle with regard to this MEA survey. This entry is shown as Item 4, on Sheet 1 of the HTM. Neither the EG&G or the RMD entries are carried in the LTM because the follow-on phases may require Spacelab facilities and/or the benefits versus cost may not be worth the investment.

The other two entries on Sheet 1 show the follow-on activity without NASA funds being supported by the organizations involved in the initial effort. Both Rockwell International and Bell Laboratories are supporting in-house

TABLE 1. HIGH TRAFFIC MODEL (HTM)

CRYSTAL GROWTH AND SOLIDIFICATION

PROCESS OR FACILITY / PRODUCT OR EXPERIMENT / ORGANIZATION / DIVISION	SPACE CARRIER(S): INITIAL ACTIVITY / NEXT PHASE / FOLLOW-ON PHASE	DURATION h = hours d = days	FUNDING STATUS G/O = Ground Only	SPONSOR(S)	FLIGHTS PER CALENDAR YEAR 80	81	82	83	84	85	86	87	Confidence Code	TOTAL
Crystal Growth - Gradient Furn.	MEA 1	7d	Approved	NASA[a]	1								1	1
Vapor Growth of Alloy-Type Semiconductor Crystals	MEA	7d	??	NASA		2							2	2
Rensselaer Polytechnic Inst.	MEA	7d	--	NASA/IBM and/or RCA[b]			←			TBD		→	2	TBD
Special RI Furnace[c]	SPAR	N/A	Approved	RI/NASA	←								1	
Crystal Growth	Spacelab 3 or 4	7d	Pending	RI/NASA			[1]						1	[1]
Rockwell Inter. Science Ctr.	Possibly MEA[d]	7d	--	RI/?				2	3	3	3	4	2	15
Crystal Growth	Spacelab 3	7d	Approved	NASA/DOE			[1]						1	[1]
Mercuric Iodide Radiation Detectors	Possibly MEA	7d	??	DOE/NASA?				1	←	TBD	→		2	TBD
EG & G, Inc. Santa Barbara	SEE NEXT ENTRY[e]													
Crystal Growth	SEE PRECEDING ENTRY FOR INITIAL ACTIVITY - TRANSITION TIME UNCERTAIN													
Mercuric Iodide Radiation Detectors	Possibly MEA	7d	--	DOE/ ?				1?					2	1?
Radiation Monitoring Devices	Possibly MEA	7d	??	DOE/RMD. Inc.					1	←	TBD	→	3	TBD
TBD[f]	Possibly MEA	--	Ground only	Bell or Bell/NASA[g]		←	TBD	→					2	1 or 2
Crystal Growth and Semiconductor Improvements	Possibly MEA	--	No request	Bell			←		TBD		→		3	TBD
Bell Laboratories	---	--	No request	Bell				←		TBD		→	3	TBD

NOTE: All of the above projections are those of individuals contacted and do not represent an official position of the organization shown.

a. Consultants from IBM and RCA partly supported by NASA and part by their company.
b. Follow-on industrial venture will depend upon preceding results and cost/contracting requirements.
c. Special tubular resistance heated SPAR furnace designed for liquid phase epistaxis. The Rockwell International furnace allows translation of the substrate crystal in and out of the melt.
d. "There is a good chance we would use MEA equipment if we knew more about it."
e. Two industrial firms have shown an interest in follow-on activities.
f. Laboratory work active in two areas. Uncertain which may move into space first, if at all.
g. Ground program totally company funded. Unknown what arrangement might be made for any space activity. Presently no plans for space.

TABLE 1. HIGH TRAFFIC MODEL (HTM)

CRYSTAL GROWTH AND SOLIDIFICATION (Continued)

Sheet 2 of 7

PROCESS OR FACILITY / PRODUCT OR EXPERIMENT / ORGANIZATION / DIVISION	SPACE CARRIER(S): INITIAL ACTIVITY / NEXT PHASE / FOLLOW-ON PHASE	DURATION h = hours d = days	FUNDING STATUS G/O = Ground Only	SPONSOR(S)	FLIGHTS PER CALENDAR YEAR 80	81	82	83	84	85	86	87	Confidence Code	TOTAL
Gradient Furnace + JHU Special Hdw	SPAR 4	--	Approved	NASA	←									--
Foamed Copper	Possibly MEA	8-20 hr	-- ?	NASA		←		TBD[a]		→			2	TBD
Johns Hopkins University	Possibly MEA	8-20 hr	-- ?	NASA/Industry?						←	TBD	→	2	TBD
Isothermal Furnace	MEA	--	GND Only[b]	NASA			1[c]						1	1
Diffusion vs Time Above Solubility Gap in Pb-Zn	MEA	--		NASA				1	1	1			2	3
Johns Hopkins University	MEA (R & D)	--	--	Industry ? [d]							1	1	2	2
Diffusion [e]	GAS [f]	7d	Pending	Army / NASA			1	1					2	2
Graded Index Laser Focusing Mirrors	MEA	7d	--	Army / ?					1	←	TBD	→	3	TBD
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NOTE: All of the above projections are those of individuals contacted and do not represent an official position of the organization shown.

a. Not far enough along to predict space flight needs.
b. Ground-based study shows that the experiment can NOT be satisfactorily done on the ground.
c. Plans to recommend early in 1979 that micro-g work be done.
d. Follow-on phase could be carried by industry if more R & D is needed. Results should directly aid earth based alloy production of Pb-Zn. Beneficial results will stimulate activity of other alloy industries.
e. May require a furnace with levitation device.
f. GAS "Getaway Special" actual program would utilize BCL's "SARP" equipment.

TABLE 1. HIGH TRAFFIC MODEL (HTM)

CONTAINERLESS PROCESSES

Sheet 3 of 7

PROCESS OR FACILITY / PRODUCT OR EXPERIMENT / ORGANIZATION / DIVISION	SPACE CARRIER(S): INITIAL ACTIVITY / NEXT PHASE / FOLLOW-ON PHASE	DURATION h = hours d = days	FUNDING STATUS G/O = Ground Only	SPONSOR(S)	FLIGHTS PER CALENDAR YEAR 80	81	82	83	84	85	86	87	Confidence Code	TOTAL
Acoustic Levitator	SPAR 7, SPAR 8	--	Approved	NASA or RI/NASA ?	←									--
Advanced Optical Glass	MEA 1	--	Approved	NASA or RI/NASA ?	1								1	1
Rockwell Inter. Space Div.	MEA ?	--	?	RI/?		1	1	1	2	2	2	1	2	10
Induction Furnace W. Levitation	SPAR	--	Completed	NASA/KBI ?	←									--
Beryllium Processing	MEA	--	G/O in Process[a]	KBI/NASA ?			1[ab]	←TBD→					2	1+?
Kawecki Berylco Industries	MEA	--	--	KBI					←TBD→				3•	TBD
Levitation	Possibly MEA	--	Proposed Gnd Only	NASA		1	1						2	2
Metallic Fusion Targets	Possibly MEA	--	Unknown	NASA ? / DOE ?				1	1				2	2
Battelle Pacific Northwest	Production Equipment[c]	--	Unknown	Unknown•								c →		
A/L with Heating & Quenching	Possibly MEA	--	GND Only[d]	DOE / NASA				1[e]					2	1
Fusion Target Spheres	Possibly MEA	--	Unknown	DOE / ?					1	2	1	2	3	6
KMS Fusion, Inc.	Possibly MEA	--	Unknown	DOE / ?						2	2	2	3	6

NOTE: All of the above projections are those of individuals contacted and do not represent an official position of the organization shown.

a. Additional ground experiments being conducted in preparation for space work. Results will determine space program. Ground work geared to being ready for space in 1981.

b. G.E. does not expect to have Induction Furnace w. Levitation ready until 1982. Present funding status - Proposed.

c. Production-type equipment would be operating in the 1990-1995 time period.

d. Present 3-year contract does not include space processing.

e. If present work proceeds as planned, KMS would be ready for a space experiment in 1983.

TABLE 1. HIGH TRAFFIC MODEL (HTM)

CONTAINERLESS PROCESSES (Continued)

Sheet 4 of 7

PROCESS OR FACILITY / PRODUCT OR EXPERIMENT / ORGANIZATION / DIVISION	SPACE CARRIER(S): INITIAL ACTIVITY / NEXT PHASE / FOLLOW-ON PHASE	DURATION h = hours d = days	FUNDING STATUS G/O = Ground Only	SPONSOR(S)	80	81	82	83	84	85	86	87	Confidence Code	TOTAL
Melting and Cooling in ACPM	STS w. ACPM	--	Approved	NASA				?						--
Fining Glass	Possibly MEA	--	Undetermined	Westinghouse[a] or Joint					←	TBD[b]	→		3	TBD
Westinghouse Research Labs.	Possibly MEA	--	Undetermined	Westinghouse						←	TBD	→	3	TBD
Glass Processing (equip't unknown)	Possibly MEA ?	--	Proposed	NASA		←	TBD[c]	→					2	TBD
Fiber Optics for Medical Use	SL or MEA	--	Preliminary Indus. Discussions	NASA / Industry ? [e]				←	TBD	→			2	TBD
ECP, Inc.	TBD	--	--	Industry [e]						←	TBD	→	3	TBD
A/L w. Heating & Quenching	MEA	--	Approved G/O[d]	NASA					1				2	1
Ultra-Pure Glass Blanks for Fiber Optics	Probably Spacelab	--	Pending	NASA						[1]	[2]		3	[3]
Battelle Columbus Labs.	MEA	--	--	Industry [f]								1	3	1

NOTE: All of the above projections are those of individuals contacted and do not represent an official position of the organization shown.

a. Westinghouse presently on subcontract to Clarkson College of Technology on glass fining.
b. Potential commercial application will depend upon results of preceding experiments.
c. Future MEA use could not be forecast as status of proposed work is unknown and details of MEA's capability are not known.
d. Program calls for 1 year basic research, followed by laboratory experimentation. NASA has talked about flying sometime in 1984.
e. Preliminary industrial discussions indicate high interest and support.
f. Industry is expected to pick up additional R & D effort if preceding results are promising.

TABLE 1. HIGH TRAFFIC MODEL (HTM)

FLUID AND CHEMICAL PROCESSES

Sheet 5 of 7

PROCESS OR FACILITY / PRODUCT OR EXPERIMENT / ORGANIZATION / DIVISION	SPACE CARRIER(S): INITIAL ACTIVITY / NEXT PHASE / FOLLOW-ON PHASE	DURATION h = hours d = days	FUNDING STATUS G/O = Ground Only	SPONSOR(S)	FLIGHTS PER CALENDAR YEAR 80	81	82	83	84	85	86	87	Confidence Code	TOTAL
MLR (Mono Latex Reactor)[a]	MEA 1	7d	Approved	NASA	1[a]								1	1
Latex Spheres	MEA	7d	Partial Approval[b]	NASA		2							1	2
Lehigh University	Spacelab 3 [c]	7d	SL-3 Approved	NASA / Industry ?			[1]						1	[1]
MLR (follow-on R&D/Production)	SEE PRECEDING ENTRY FOR INITIAL ACTIVITY													
Latex Spheres	MEA	7d	Accupart/NASA?	Accupart/NASA?			2						1	2
Accupart Laboratories	MEA or Spacelab		Accupart Labs.	Accupart Labs.				2	2	2	2	2	2	10
Battelle Cols. Lab. Hardware	GAS[d]	1d	Preproposal	BCL/Non-NASA		[1]	[1]						1	[2]
Collagen Processing	Possibly MEA	1d	--	Non-NASA			1	1	1	←TBD	→		2	TBD
Battelle Columbus Labs.														
Battelle Cols. Lab. Hardware	GAS	--	Preproposal work	BCL / NASA/Non-NASA				[1]					2	[1]
Biological Crystals or Macro Molecules	SL or MEA[e]	--	--	BCL / NASA					[1][f]				3	[1][f]
Battelle Columbus Labs.	Possibly MEA	--	--	BCL/Non-NASA						←TBD	→		3	TBD

NOTE: All of the above projections are those of individuals contacted and do not represent an official position of the organization shown.

a. New equipment test and initial experiment will be accomplished on same flight. Equipment tests monitored by GE-SD.
b. One MEA flight in 81 approved prior to SL-3 mission. Other MEA flights needed before follow-on flights.
c. SL-3 will be carrying production-type equipment.
d. GAS "Getaway Special" actual program would utilize BCL's "SARP" equipment.
e. Space Carrier undetermined.
f. Space Carrier undetermined. [] deleted if MEA is used.

TABLE 1. HIGH TRAFFIC MODEL (HTM)

BIOSEPARATION AND BIOLOGICAL PROCESSES

Sheet 6 of 7

PROCESS OR FACILITY / PRODUCT OR EXPERIMENT / ORGANIZATION / DIVISION	SPACE CARRIER(S): INITIAL ACTIVITY / NEXT PHASE / FOLLOW-ON PHASE	DURATION h = hours d = days	FUNDING STATUS G/O = Ground Only	SPONSOR(S)	FLIGHTS PER CALENDAR YEAR 80	81	82	83	84	85	86	87	Confidence Code	TOTAL
BCL Hardware Cell Culture Equipment	MEA	--	Preproposal	BCL / NASA				1					2	1
Bone Cell Functions	MEA	--	--	BCL/Non-NASA					1	← TBD →			2	TBD
Battelle Columbus Labs.														

NOTE: All of the above projections are those of individuals contacted and do not represent an official position of the organization shown.

TABLE 1. HIGH TRAFFIC MODEL (HTM)

GENERAL RESEARCH & DEVELOPMENT

PROCESS OR FACILITY / PRODUCT OR EXPERIMENT / ORGANIZATION / DIVISION	SPACE CARRIER(S): INITIAL ACTIVITY / NEXT PHASE / FOLLOW-ON PHASE	DURATION h = hours d = days	FUNDING STATUS G/D = Ground Only	SPONSOR(S)	FLIGHTS PER CALENDAR YEAR 80	81	82	83	84	85	86	87	Confidence Code	TOTAL
Research Dependent Variable	GAS = BCL "SARP"[a]	--	Contract R & D & in-house	NASA/Joint & Non-NASA		[1]	[1]						1	[2]
Research Dependent Variable	MEA	--	Contract R & D & in-house	Non-NASA				1	1	1			2	3[b]
Battelle Columbus Labs.	MEA or Free Flyers	--	Contract R & D ?	Non-NASA						←TBD→			2	TBD
Research Dependent Variable	GAS or MEA	7d	Contract R & D ?	Industry or Joint		[2]	[3]	[3] 1	[3]				1	[11] 1
Crystal Growth, Solidification and Containerless	MEA	7d	Contract R & D ?	Non-NASA				1	2	2			2	5
International Technical Assoc.	MEA	7d	Contract R & D ?	Non-NASA							4	4	2	8
Solidification & Levitation	Getaway Special[c]	--	Contract R & D ?	Non-NASA ?		[1]							1	[1]
Varies with market	MEA	--	Contract R & D ?	Industry			3	3					2	6
Southern Res. Institute	MEA	--	Contract R & D ?	Industry				←TBD→					3	TBD

NOTE: All of the above projections are those of individuals contacted and do not represent an official position of the organization shown.

a. BCL is marketing Getaway Special (GAS) work under Project "SARP".

b. Additional BCL programs appear on sheets 4, 5 and 6.

c. GAS PL#5, Southern Research is integrating the loading for Alabama Space and Rocket Center, Huntsville, AL.

TABLE 2. LOW TRAFFIC MODEL (LTM)

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CRYSTAL GROWTH AND SOLIDIFICATION

Sheet 1 of 4

PROCESS OR FACILITY / PRODUCT OR EXPERIMENT / ORGANIZATION / DIVISION	SPACE CARRIER(S): INITIAL ACTIVITY / NEXT PHASE / FOLLOW-ON PHASE	DURATION h = hours d = days	FUNDING STATUS G/O = Ground Only	SPONSOR(S)	FLIGHTS PER CALENDAR YEAR 80	81	82	83	84	85	86	87	Confidence Code	TOTAL
Crystal Growth - Gradient Furn.	MEA 1	7d	Approved	NASA[a]	1								1	1
Vapor Growth of Alloy-Type Semi Conductor Crystals	MEA	7d	??	NASA			1						2	1
Rensselaer Polytechnic Inst.	Possibly MEA	7d	??	NASA/Industry					← TBD			→	3	TBD
Special RI Furnace [b]	SPAR	N/A	Approved	RI / NASA	←								1	
Crystal Growth	Spacelab 3 or 4	7d	Pending	RI / NASA			[1]						1	[1]
Rockwell Inter. Science Ctr.	Possibly MEA[c]	7d	--	RI / ?				1	1	2	2	2	2	8
Gradient Furnace + JHU Special Hdw	SPAR 4	--	Approved	NASA	←									--
Foamed Copper	Possibly MEA	8-20 hr.	-- ?	NASA		←		TBD[d]		→			2	TBD
Johns Hopkins University	Possibly MEA	8-20 hr.	-- ?	NASA/Industry							← TBD	→	3	TBD
Isothermal Furnace	MEA	--	Gnd Only[e]	NASA			1						2	1
Diffusion vs Time Above Solubility Gap in Pb-Zn	MEA			NASA					1	1			3	2
Johns Hopkins University	MEA (R & D)			NASA/Industry								1	3	1

NOTE: All of the above projections are those of individuals contacted and do not represent an official position of the organization shown.

a. Consultants from IBM and RCA partly supported by NASA and part by their company.
b. Special tubular resistance heated SPAR furnace designed for liquid phase epistaxis. The Rockwell International furnace allows translation of the substrate crystal in and out of the melt.
c. "There is a good chance we would use MEA equipment if we knew more about it."
d. Not far enough along to predict space flight needs.
e. Ground-based study shows that the experiment can NOT be satisfactorily done on the ground.

TABLE 2. LOW TRAFFIC MODEL (LTM)

CONTAINERLESS

Sheet 2 of 4

PROCESS OR FACILITY / PRODUCT OR EXPERIMENT / ORGANIZATION / DIVISION	SPACE CARRIER(S): INITIAL ACTIVITY / NEXT PHASE / FOLLOW-ON PHASE	DURATION h = hours d = days	FUNDING STATUS G/O = Ground Only	SPONSOR(S)	FLIGHTS PER CALENDAR YEAR 80	81	82	83	84	85	86	87	Confidence Code	TOTAL
Acoustic Levitator	SPAR 7, SPAR 8	--	Approved	NASA or RI / NASA ?	←									
Advanced Optical Glass	MEA 1	--	Approved	NASA or RI / NASA ?	1								1	1
Rockwell Inter. Space Division	MEA ?	--	?	RI / ?		1	1	1					2	3
Induction Furnace w. Levitation	SPAR	--	Completed	NASA / KBI ?	←									--
Beryllium Processing	MEA	--	G/O in process[a]	KBI / NASA ?			1[ab]	1 •					3 •	2
Kawecki Berylco Industries	MEA	--	--	KBI										
Levitation	Possibly MEA	--	Proposed Gnd only	NASA			1						2 •	1
Metallic Fusion Targets	Possibly MEA	--	Unknown	NASA ? / DOE ?					1				3 •	1
Battelle Pacific Northwest														
A/L w. Heating & Quenching	Possibly MEA	--	Gnd only[c]	DOE / NASA					1				3 •	1
Fusing Target Spheres	Possibly MEA	--	Unknown	DOE / ?						1			3 •	1
KMS Fusion Inc.														
Melting and Cooling in ACPM	STS w. ACPM	--	Approved	NASA				?						
Fining Glass	Possibly MEA	--	Undetermined	Westinghouse[d] or Joint					←	TBD[e]		→	3 •	TBD
Westinghouse Research Labs.														

NOTE: All of the above projections are those of individuals contacted and do not represent an official position of the organization shown.

a. Additional ground experiments being conducted in preparation for space work. Results will determine space program. Ground work geared to being ready for space in 1981.
b. G.E. does not expect to have Induction Furnace w. Levitation ready until 1982. Present funding status - Proposed.
c. Present 3-year contract does not include space processing.
d. Westinghouse presently on subcontract to Clarkson of Technology on glass fining.
e. Potential commercial application will depend upon results of preceding experiments.

TABLE 2. LOW TRAFFIC MODEL (LTM)

Sheet 3 of 4

CONTAINERLESS PROCESSES

PROCESS OR FACILITY / PRODUCT OR EXPERIMENT / ORGANIZATION / DIVISION	SPACE CARRIER(S): INITIAL ACTIVITY / NEXT PHASE / FOLLOW-ON PHASE	DURATION (h = hours, d = days)	FUNDING STATUS (G/O = Ground Only)	SPONSOR(S)	80	81	82	83	84	85	86	87	Confidence Code	TOTAL
A/L w. Heating & Quenching	MEA	--	Approved G/O[a]	NASA					1				[illegible]•	1
Ultra Pure Glass Blanks for Fiber Optics	Probably Spacelab	--	Pending	NASA						[1?]			2•	[1?]
Battelle Columbus Labs	Possibly MEA	--	--	NASA/BCL & Industry								1	3•	1

FLUID AND CHEMICAL PROCESSES

PROCESS OR FACILITY / PRODUCT OR EXPERIMENT / ORGANIZATION / DIVISION	SPACE CARRIER(S): INITIAL ACTIVITY / NEXT PHASE / FOLLOW-ON PHASE	DURATION (h = hours, d = days)	FUNDING STATUS (G/O = Ground Only)	SPONSOR(S)	80	81	82	83	84	85	86	87	Confidence Code	TOTAL
MLR (Mono Latex Reactor)[b]	MEA 1	7d	Approved	NASA	1[a]								1	1
Latex Spheres	MEA	7d	Partial Approval[c]	NASA		1							1	1
Lehigh University	Spacelab 3[c]	7d	SL-3 Approved	NASA / Industry ?		[1]							1	[1]
MLR (Follow-on R & D Production)	SEE PRECEDING ENTRY FOR INITIAL ACTIVITY													
Latex Spheres	MEA	7d	Accupart/NASA?	Accupart/NASA?			2						1	2
Accupart Laboratories	MEA or Spacelab	7d	Accupart Labs.	Accupart Labs.					1•		1•		2•	2
Battelle Cols. Lab. Hardware	GAS	--	Preproposal work	BCL/Non-NASA					1				2	1
Collagen Processing	SL or MEA[d]			BCL/Non-NASA						[1][f]			2	[1][e]
Battelle Columbus Labs.	Possibly MEA			BCL/Non-NASA							←TBD→		2	TBD

NOTE: All of the above projections are those of individuals contacted and do not represent an official position of the organization shown.

a. Program calls for 1 year basic research, followed by laboratory experimentation. NASA has talked about flying sometime in 1984.

b. New equipment test and initial experiment will be accomplished on same flight.

c. One MEA flight in 81 approved prior to SL-3 mission. Other MEA flights needed before follow-on flights.

d. Space Carrier undetermined.

e. Space Carrier undetermined. [] deleted if MEA is used.

TABLE 2. LOW TRAFFIC MODEL (LTM)

BIOSEPARATION AND BIOLOGICAL PROCESSES

Sheet 4 of 4

PROCESS OR FACILITY / PRODUCT OR EXPERIMENT / ORGANIZATION / DIVISION	SPACE CARRIER(S): INITIAL ACTIVITY / NEXT PHASE / FOLLOW-ON PHASE	DURATION (h = hours, d = days)	FUNDING STATUS (G/O = Ground Only)	SPONSOR(S)	FLIGHTS PER CALENDAR YEAR 80	81	82	83	84	85	86	87	Confidence Code	TOTAL
BCL Hardware Cell Culture Eq't.	MEA	--	Proproposal	BCL/NASA					1				2	1
Bone Cell Functions	MEA	--	--	BCL/Non-NASA							←TBD	→	2	TBD
Battelle Columbus Labs.														
GENERAL RESEARCH AND DEVELOPMENT														
Research Dependent Variable	GAS = BCL "SARP"[a]	--	Contract R&D & In-House	NASA/Joint & Non-NASA		[1]	[1]						1	[2]
Research Dependent Variable	MEA	--	Contract R&D & In-House	Non-NASA					1	1			2	2[b]
Battelle Columbus Labs.	MEA or Free Flyers	--	Contract R&D?	Non-NASA						←—	TBD	—→	2	TBD
Research Dependent Variable	GAS or MEA	7d	Contract R&D?	Industry or Joint		[2]	[3]	[3] 1	[3]				1	[1] 1
Crystal Growth, Solidification and Containerless	MEA	7d	Contract R&D?	Non-NASA					1	1			3•	2
International Technical Assoc.	MEA	7d	Contract R&D?	Non-NASA							2	2	3•	4
Solidification & Levitation	Getaway Special[c]	--	Contract R&D?	Non-NASA ?		[1]							1	[1]
Varies With Market	MEA	--	Contract R&D?	Industry			1	1					3•	2
Southern Res. Institute	MEA	--	Contract R&D?	Industry				←—	—	TBD	—	—→	3•	TBD

NOTE: All of the above projections are those of individuals contacted and do not represent an official position of the organization shown.

a. BCL is marketing Getaway Special work under Project "SARP".
b. Additional BCL programs appear on sheets 3 and 4.
c. GAS PL#5, Southern Research is integrating the loading for Alabama Space and Rocket Center, Huntsville, AL.

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laboratory work in the area of crystal growth, which is aimed toward future microgravity experiments in this area. Bell is concurrently working on semiconductor improvement activities which may or may not be ready to go into space before the crystal growth activity. Rockwell's plans are for a joint endeavor aboard Spacelab 3 or 4 followed by possible MEA flights involving no NASA funds. Bell's plans are indefinite at this time; however, it is believed that they could potentially use MEA for both the initial work and the follow-on activities. Most or all of Bell's work is expected to be supported by in-house funds. The Bell activity is not shown in the LTM.

The two Johns Hopkins University (JHU) experiments in the area of solidification shown on Sheet 2 of the HTM have high potential industrial involvement in the later phase. The first one, processing foamed copper, could in the final stages involve other metals for industrial applications. Since the initial activity is on SPAR with special JHU hardware, the possibility of continuing on MEA is very high. The second experiment involving Pb-Zn alloy has moved along far enough in the laboratory to definitely direct further activities toward working in the microgravity environment, as the process cannot be done satisfactorily on the ground. This work with a Pb-Zn alloy is of considerable interest to industry for corrosion protection material processing. Results should be directly applicable to Earth-based alloy process techniques. Success with this one alloy will stimulate further space activities with other alloys to aid the alloy industry in general.

The third entry on Sheet 2 is a controlled diffusion process in microgravity proposed by Battelle's Columbus Laboratories (BCL) to improve the performance of laser focusing mirrors for the U.S. Army. This one will initially use a BCL GAS operated under Project SARP and then proceed to MEA. Army or Army plus industry will be supporting the initial MEA activity. Program follow-on has not been fully investigated as it could take place later than 1987. The LTM reflects an assumption that the initial research will not justify a follow-on phase using a MEA.

Containerless Processes

The Containerless Processes section of Table 1 (HTM) contains seven entries. Only three inputs are indicated as being definite uses of the MEA. The others, due to uncertainties, are noted as being possible MEA uses. The Containerless Processes category involves both glass and metal processing.

The first and second entries show the expected evolution from SPAR to MEA, with the follow-on activity also satisfied by MEA. Rockwell International's investigation into advanced optical glass processing is intended to significantly improve the quality by processing in a microgravity environment. The numerous subsequent flights are needed to better understand how the microgravity environmental effects may vary with different formulations of glass. The second entry is another projection from SPAR to a MEA follow-on. Kawecki Berylco Industries (KBI) needs an induction furnace with levitation. KBI indicated they would be ready for their first MEA experiment in 1981; however, General Electric's Space Division is planning on 1982 for the initial flight of the proposed MEA induction furnace with levitation. As a result, the KBI first MEA flight is shown as 1982 instead of 1981.

The third and fourth entries are aimed at the same final product--fusion target spheres. The Battelle Pacific Northwest Laboratories' work is investigating metallic spheres while the KMS Fusion activity involves using glass spheres. Both of these experiments are expected to have increasing DOE support once the initial activities are completed.

The continuing sheet on Containerless Processes presents three glass processing activities. The first, on Sheet 4 of the model, shows a possible industrial follow-on activity by Westinghouse. Actually, as noted by footnote "a" on that sheet, Westinghouse is on a subcontract to Clarkson College of Technology. The initial activity will use the ACPM (Acoustic Positioning Module), a 3-axis levitation device designed by Taylor Wang of JPL. This pallet-mounted piece of equipment is more versatile than the MEA equipment. However, Westinghouse would prefer to use the lower cost MEA equipment if it will perform satisfactorily for the next and follow-on phases. At this time, there is insufficient data to determine minimum equipment needs.

The next two entries are concerned with producing improved and/or special purpose fiber optics. The first of these has been or is about to be proposed to NASA. This proposed effort from Engineered Ceramics Processes (ECP), Inc., is for processing fiber optics for medical use. The commercial application of this proposed product has already been discussed with a company that plans to support the necessary follow-on activities. The follow-on, however, assumes that the initial activities produce results that demonstrate that the needed product performance is achievable. The LTM makes an assumption that this effort will not occur. The other process, projected for BCL, is already under contract for the ground phase. This effort is aimed toward an initial flight with MEA in 1984. The next phase will probably use Spacelab, and present thinking is that industry can use MEA for any needed follow-on R&D effort.

Fluid and Chemical Processes

The Fluid and Chemical Processes section of Table 1 (HTM) has four entries. The first entry shown, Lehigh University's latex sphere activity, does not itself identify a commercial use of the MEA. The research work by Lehigh is funded by NASA and will use NASA MEA missions to accomplish the initial and planned next-step research in this process area. The follow-on phase will probably be accomplished on the Spacelab. The Lehigh University entry is listed so as to show the transition of that specific area of research to a commercial follow-on, including the use of a MEA, with a new industrial organization, Accupart Laboratories of Huntsville, Alabama. Accupart Laboratories has been established to commercialize, as one objective, the results of the NASA/Lehigh University research on latex spheres. Accupart, in this endeavor, and as shown in the second entry on Sheet 5, will depend upon a commercial use of the monodisperse latex reactor (MLR) and the MEA flight capabilities, and can project routine commercial flights (two per year) starting in 1983. These projections and schedule are dependent upon the success and scheduling of the NASA sponsored research with Lehigh University.

The other entries on Sheet 5 are programs initiated by BCL. These two entries are not with the general purpose research entries listed on Sheet 7 for BCL, since these specifically fit this process category. The initial activity on both of the BCL programs will start with a GAS and then progress into something more sophisticated. Here again, "Possibly MEA" is indicated for the later phase. Both of these entries have moved far enough along to have identified the source of non-NASA funds for at least the last phase of work. The collagen processing will probably not involve any NASA funding. The biological crystals entry is dependent upon favorable results from the collagen processing research and will not be initiated in the LTM.

Bioseparation and Biological Processes

The Bioseparation and Biological Processes section of Table 1 (HTM) contains only one input. Generally, experimenters involved in this area indicated that the MEA equipment would not be adequate for their needs. Human interaction with the process is needed during the microgravity environment. The Battelle Columbus Laboratory entry represents a proposed joint BCL/NASA research program as a first step to be followed by a non-NASA sponsored use of the MEA. BCL proposes to develop a specially designed space research facility to potentially fly in one of the MEA research bays.

General Research and Development

The General Research and Development section of Table 1 (HTM) presents three organizations: Battelle's Columbus Laboratories, International Technical Associates (INTA), and Southern Research Institute (SORI), who are all engaged in marketing contract R&D work to a wide range of companies and government agencies.

BCL has the broadest scope of planned sponsored space research interests and thus is not identified with any particular materials processes or hardware. It will be dictated by the sponsored research achieved. INTA and SORI are initially concentrating their marketing effort in two select process/product areas: the semiconductor industry and the metal processing industry, respectively. Thus, INTA and SORI are identified with specific MEA processes and hardware. All three organizations have made initial contacts with prospective industrial sponsors. Also, BCL and INTA have purchased GAS flight options from NASA and plan to conduct research in conjunction with their business objectives. SORI is also involved in developing a research package for a GAS. These organizations consider the GAS as the first step toward broader, more sophisticated research which will evolve into routine commercial use of a MEA.

CONCLUSIONS

This investigation to determine potential commercial MEA use during the period 1981 through 1987 revealed a definite interest and projected use for this type of MPS flight facility and service throughout the entire period. The traffic load represented by the HTM may appear lower than anticipated. However, when considering that the survey was conducted very early in the MEA concept development, with minimal prior marketing and/or publicity, the results can be viewed as better than should have been anticipated.

The traffic models developed are believed to be meaningful and credible, but do represent a limited projected commercial use of the MEA. This should not, however, be construed as a rejection of the MEA commercial use concept but should, instead, be viewed as a reflection of the present situation regarding the lack of interest, confidence, participation and commitment in MPS programs on the part of many individuals and industry. It should be noted that the ability to envision the use of a MEA for commercial purposes comes, primarily, from those who do appear to have an interest and confidence in the future of MPS and, in most cases, are currently involved in a space research project or planning. Predominantly, the projections have come from PIs on NASA-funded projects who can foresee commercial applications and can visualize the commercial benefits of a MEA.

It should also be noted that some GAS users can reasonably project a transition to a MEA. Those users who plan to use the GAS concept for business related purposes can recognize the limitations of the GAS and the future need for a more extensive, sophisticated, but low cost, space facility.

It should be accepted that the MEA capabilities will always be too limited for a certain group of commercial space users. At the present time, as an example, commercially oriented research in the bioseparation process area cannot be extensively envisioned because of control and life support limitations. Overall, it is also seen that the MEA may have limited applicability when routine, production operations are required.

In general, the MEA is viewed as a stepping stone concept to be used effectively in an organization's plans to pursue space research toward commercialization of the results. If properly evaluated, the MEA, with its definable assets and limitations, can minimize flight hardware investments, especially in the early stages of commercial MPS ventures. It is concluded that a significant increase in the interest of a MEA for commercial use can be stimulated by developing the MEA concept with commercial users' needs in mind and the initiation of active marketing of the concept. The marketing strategy to be used should recognize that, in many cases, the marketing effort must stimulate interest and achieve confidence in the benefits of MPS as a step prior to achieving interest in the MEA.

RECOMMENDATIONS

The survey which was conducted and the resultant time-phased traffic models developed demonstrate the ability to make a reasonable projection of the commercial traffic for the MEA. The indicated traffic, however, must be considered as a preliminary, first-cut projection which can be expanded in conjunction with a further development of the commercial use concept and active marketing. The following recommendations are made:

- Further develop the MEA commercial use concept in areas of policy, technical capabilities, and service features.
- Prepare documentation, such as a handbook, describing the MEA commercial use concept in terms of its technical and service capabilities, how it can be used by industry, terms and conditions of use, its planned availability, and costs. Production of a combined MPS and commercial MEA film is recommended.
- Promote the MEA commercial use through briefings, seminars and publications.
- Follow up on requests for more MEA details by individuals listed in the Appendix of this report.
- Develop marketing strategy and initiate active marketing of the commercial MEA concept.
- Periodically issue a revised commercial MEA traffic model.

APPENDIX

SURVEY DATA LISTINGS

APPENDIX

SURVEY DATA LISTINGS

Contents

LIST A

INDIVIDUALS CONTACTED
(Alphabetized Listing)

ALI, M.A.	E.C.P., Inc. (213) 322-9302
ALVARADO, U.R.	General Electric Space Division (215) 962-3297
ANDERSON, Wendell	RCA Government Services Division (609) 338-5835
AUBIN, William L.	Grumman Aerospace Corp. (516) 575-2233
BARLOW, Grant	University of Rochester (716) 275-3761
BIER, Milar	Veterans Administration Hospital (602) 792-1450
BLICKWEDE, Donald J.	Bethlehem Steel Corp. (215) 694-6416
BOONE, Charles	National Cancer Institute (301) 496-5141
BOWMAN, Robert L.	National Heart, Lung, & Blood Institute (301) 496-2557
BUNING, Harm	University of Michigan (313) 764-4310 or 3310
BURG, Alan	A. D. Little (617) 864-5770
CARBONARA, Robert S.	Battelle Columbus Laboratories (614) 424-5440
CHAPMAN, Philip K.	A. D. Little (617) 864-5770 x-3303
CLARK, John	RCA Laboratories (609) 452-2700
CUOMO, J. J.	IBM Corporation (914) 945-1357
DEEG, E. W.	Anchor-Hocking (614) 687-2111
DIMMICK, Robert L.	Naval Biosciences Laboratory (415) 832-5217
DOTY, J. P.	Eagle-Pitcher Industries, Inc. (918) 542-1801
DRIGGERS, Gerald W.	Southern Research Institute (205) 323-6592
EASTMAN, Dean	IBM Corporation (914) 945-1012

FLEARY, Paul A.	Bell Laboratories (201) 582-2276
FOWLE, Arthur	A. D. Little (617) 864-5770 x-3079
FRANCO, N. B.	Bethlehem Steel Corp. (215) 694 3019
GATOS, Harry	MIT (617) 253-5301
GELLES, Stan	S. H. Gelles, Assoc. (614) 276-2957
GILVEY, John	IBM Corporation (914) 945-1382
GLEN, Jerry	Owens-Illinois, Inc. (419) 247-8853
GLICKSMAN, M. E.	Rensselaer Polytechnic Institute (518) 270-6372
GOULD, C. L.	Rockwell International Space Div. (Seal Beach) (213) 594-3560
GREGORY, Daniel L.	Boeing (206) 773-2016
GRODZKA, Philomena G.	LMSC Huntsville (205) 837-1800
HAMMEL, R. L.	TRW - Defense & Space Systems Group (213) 535-3807
HAPPE, Ralph	Rockwell International Space Div. (Seal Beach) (213) 594-3615
HENDRIKS, Ferdinand	IBM Corporation (914) 945-3000
HELFAND, Eugene	Bell Laboratories (201) 582-3409
HORNYAK, Emery	Owens-Illinois (419) 247-8910
HUGHES, Kenneth	Battelle Columbus Laboratories (614) 424-7627
JACKSON, Kenneth	Bell Laboratories (215) 582-4188
JACOBUS, David P.	(Retired from Merck & Co.) (609) 921-6421
JELINEK, Frank	Battelle Columbus Labs (Material Applications) (614) 424-7472
JONES, Morton E.	Texas Instruments (214) 238-2468
KAUFMAN, Larry	Manlabs, Inc. (617) 491-2900
KAYE, Sam	General Dynamics Convair Division (714) 277-8900 x-1302
KOTTCAMP, E. H.	Bethlehem Steel Corp. (215) 694-6611
LARSEN, L. D.	IIT Research Institute (312) 567-4437
LEE, William	A. D. Little (617) 864-5770 x-2901
LEIDHEISER, Henry	Lehigh University (215) 691-7000 x-2292

LEMKEY, Frank D.	United Technologies Research Center (203) 727-7318
LEOPOLD, Martin	Jet Propulsion Laboratory (213) 354-3931
LIND, M. D.	R. I. Science Center (805) 498-4545 x-190
LIONETTI, Sabian	Center for Blood Research, Boston (617) 731-6470
LOVOI, Paul	International Technical Assoc. (INTA) (415) 854-3741
MANNING, John	National Bureau of Standards (301) 921-3354
MAZELSKY, (Dr.)	Westinghouse Research Laboratory (412) 256-7683
MLAVSKY, A.	Mobil -Tyco (617) 890-0909 x-207
MOORE, Gilbert	Thiokol Astro Met Plant (801) 399-1193
MONTGOMERY, Brian	Accupart Laboratories (205) 881-9617
NOLEN, Robert	KMS Fusion, Inc. (313) 769-8500
O'BRIEN, James	Pharmaceuticals Manufacturers Assoc. (PMA) (202) 296-2440
OSTRACH, Simmon	Case Western Reserve University (216) 368-2940
PATTEN, James W.	Battelle Pacific Northwest Laboratories (509) 946-2603
PINTO, Norman	Kawecki Berylco Industries, Inc. (215) 921-5285
POND, Robert	Johns Hopkins University - Dept. of Mechanics (301) 338-7125
PRENENGER, Tom	Sandia Laboratories - Albuquerque (505) 264-1016
REMBAUM, Alan	Jet Propulsion Laboratory (213) 354-3189
REUSSER, Raymond E.	Western Electric - Allentown Works (215) 439-6348
RINDONE, Guy	Pennsylvania State University (814) 865-0497
RINGER, Ira	Abbott Laboratories (312) 688-5010

ROSE, James T.	McDonnell Douglas Astronautics Co. (314) 232-5485
RUBIN, B. A.	Wyeth Laboratories (215) 688-4400
SAMAROO, Winston R.	Western Electric Engineering Research Center (609) 639-2292
SAVILLE, Dudley	Princeton University (609) 452-4585
SCHMIDT, Rick	Iowa State University (515) 294-5236
SCHNEPPLE, Wayne F.	E.G. & G., Inc., SBO (805) 962-0456
SEAMEN, G.V.F.	University of Oregon (503) 225-7711
SEKERKA, Robert F.	Carnegie-Mellon University Department of Metallurgical and Material Science (412) 578-2700
SERREZE, Harvey	Radiation Monitoring Devices (617) 962-1167
SHLICHTA, Paul	Jet Propulsion Laboratory (213) 354-3339
SHURMAN, Bennett	Servo Corp. of America (516) 938-9700 x-315
SMITH, Gale P.	Corning Glass Works (607) 974-9000
SNYDER, Richard	Western Electric Co. (212) 571-6508
STINE, G. Harry	Consultant (602) 997-1696
SUBRAMANIAN, R. S.	Clarkson College of Technology (315) 268-6648 or 6650
UHLMANN, Donald	MIT (617) 253-6895
VANDERHOFF, John W.	Lehigh University (215) 691-7000 x-292
VAN OSS, Carel	State University of New York (716) 831-2900
VERHOEVEN, John	Iowa State University (515) 294-5900
WACHTMAN, John B.	National Bureau of Standards (301) 921-2891
WAGNER, J. Bruce	Arizona State University (602) 965-6959
WANG, C. C.	RCA Laboratories (609) 452-2700
WANG, Taylor	Jet Propulsion Laboratory (213) 354-6331

Individuals Contacted, Continued

WALSH, John W.	Beckman Instruments, Inc. (714) 871-4848
WEINBURG, Michael C.	Jet Propulsion Laboratory (213) 354-2869
WIEDEMEIER, H.	Rensselaer Polytechnic Institute (Dept. of Chemistry) (518) 270-6456
WILCOX, W. R.	Clarkson College of Technology Dept. of Chemical Engineering (315) 268-6650
WITT, August	MIT, Dept. of Metallurgy (617) 253-5303
WOODCOCK, (Dr.)	American Optical (617) 765-9711
WYMARK, Roy	Intersonics, Inc. (312) 272-1772
YARKIN, Sam	Rockwell International Space Div. (213) 922-5273
YEAEND, James	Intersonics, Inc. (312) 272-1772

LIST B

ORGANIZATIONS CONTACTED
(Alphabetized Listing)

FACILITIES	INDIVIDUALS
Abbott Laboratories North Chicago, Illinois 60064	Ira Ringler (312) 688-5010
Accupart Laboratories Huntsville, Alabama	Brian Montgomery (205) 881-9617
American Optical Co. Southbridge, Massachusetts 01550	Dr. Woodcock (617) 765-9711
Anchor Hocking Lancaster, Ohio 43130	Dr. E. W. Deeg (614) 687-2111
Arizona State University Tempe, Arizona 85281	Dr. J. Bruce Wagner (602) 965-6959
Battelle Columbus Laboratories Columbus, Ohio 43201	Dr. R. S. Carbonara (614) 424-5440 Kenneth Hughes (614) 424-7627 Frank Jelinek (614) 424-7472
Battelle-Pacific Northwest Laboratories Richland, Washington 99352	Dr. James W. Patton (509) 942-2603
Beckman Instruments, Inc. Anaheim, California 92806	John W. Walsh (714) 871-4848 X298
Bell Laboratories Murray Hill, New Jersey 07974	Kenneth Jackson (201) 582-4188 Paul A. Fleary (201) 582-2276 Eugene Helfand (201) 582-3409
Bethlehem Steel Corp.	Dr. Don J. Blickwede (215) 694-6416 Dr. E. H. Kottcamp (215) 694-6011 Dr. N. B. Frankco (215) 694-3019
Boeing, Co. Seattle, Washington	Daniel Gregory (206) 773-2016
Case Western Reserve University Cleveland, Ohio	Prof. Simmon Ostrach (216) 368-2940
Carnegie-Mellon University Pittsburgh, Pennsylvania 15213	Dr. Robert F. Sokerka (412) 578-2700

Organizations Contacted, Continued

FACILITIES	INDIVIDUALS
Center for Blood Research Boston, Massachusetts 02115	Dr. Sabian Lionetti (617) 731-6470
Clarkson College of Technology Potsdam, New York 13676	R.S. Subramanian (315) 268-6648 W.R. Wilcox (315) 268-6650
Corning Glass Corning, New York, 14830	Dr. Gale Smith (607) 974-9000
Engineered Ceramic Processes (ECP), Inc. El Segundo, California 90245	Dr. M. A. Ali (213) 322-9302
E. G. & G., Inc. (Santa Barbara Operations) Goleta, California	Wayne F. Schnepple (805) 967-0456
Eagle-Pitcher Industries, Inc. Miami, Oklahoma 74354	Dr. J. P. Doty (918) 542-1801
S. H. Gelles, Assoc. Columbus, Ohio 43204	Dr. Stanley H. Gelles (614) 276-2957
General Dynamics - Convair Div. San Diego, California 92138	Sam Kaye (714) 277-8900 X 1302
General Electric - Space Div. Philadelphia, Pennsylvania 19101	U. R. Alvarado (215) 962-3297
Grumman Aerospace Corp. Bethpage, New York 11714	William M. Aubin (516) 575-2233
IBM Corporation Yorktown Heights, New York 10598	Ferdinand Hendriks John Gilvey (914) 945-1382 Dean Eastman (914) 945-1012 J. J. Cuomo (914)945-1357
IIT Research Institute Illinois Institute of Technology Chicago, Illinois 60616	D. C. Larsen (312) 567-4437
International Technical Assoc. (INTA) Menlo Park, California	Paul Lovoi (415) 854-3741
Intersonics, Inc. Northbrook, Illinois 60062	James Yeaend (312) 272-1772 Roy R. Whymark
Iowa State University Ames, Iowa 50010	Dr. John Verhoeven (515) 294-5900 Rick Schmidt (515) 294-5236

Organizations Contacted, Continued

FACILITIES	INDIVIDUALS
Merck & Co., Inc. Rahway, New Jersey	Dr. David P. Jacobus (Retired) Princeton, New Jersey 08540 (Home) (609) 921-6421
Jet Propulsion Laboratories Pasadena, California 91103	Dr. M. C. Weinburg (213) 354-2869 Dr. Martin Leopold (213) 354-3931 Dr. Alan Rembaum (213) 354-3189 Dr. Paul Shlichta (213) 354-3339 Dr. Taylor Wang (213) 354-6331
Johns Hopkins University Baltimore, Maryland 21218	Robert Pond (301) 338-7125
KMS Fusion, Inc. Ann Arbor, Michigan	Robert Nolen (313) 769-8500
Kawecki Berylco Industries, Inc. Reading, Pennsylvania 19603	Norman Pinto (215) 921-5285
Lehigh University Bethlehem, Pennsylvania	Dr. John W. Vanderhoff (215) 691-7000, X 292 Prof. H. Leidheiser x 2292
A. D. Little Cambridge, Massachusetts 02139	Dr. Philip K. Chapman (617) 864-5770 X 3303 Arthur Fowle X 3079 Dr. Alan Burg William Lee X 2901
Lockheed Missile & Space Co. Huntsville, Alabama 35807	Dr. Philomena G. Grodzka (205) 837-1800
Manlabs, Inc. Cambridge, Massachusetts 02139	Larry Kaufman (617) 491-2900
Massachusetts Institute of Technology Cambridge, Massachusetts 02139	Prof. Harry Gates (617) 253-5301 Prof. August Witt (617) 253-5303 Prof. Donald Uhlmann (617) 253-6895
McDonnell Douglas Astronautics Co. St. Louis, Missouri 63116	James T. Rose (314) 232-5485
Mobil-Tyco Waltham, Massachusetts	Dr. A. Mlavsky (617) 890-0909 X 207
National Bureau of Standards Gaithersburg, Maryland	John B. Wachtman (301) 921-2891 John Manning (301) 921-3354

Organizations Contacted, Continued

FACILITIES	INDIVIDUALS
National Cancer Institute Bethesda, Maryland 20014	Dr. Charles Boone (301) 496-5141
National Heart, Lung & Blood Institute Bethesda, Maryland 20014	Dr. Robert L. Bowman (301) 496-2557
Naval Biosciences Laboratory Oakland, California	Dr. Robert L. Dimmick (415) 832-5217
Owens-Illinois, Inc. Toledo, Ohio	Dr. Jerry Glen (419) 247-8853 Dr. Emery Hornyak (419) 247-8910
Pennsylvania State University University Park, Pennsylvania	Dr. Guy Rindone (814) 865-6932
Pharmaceuticals Manufacturers Assoc. Washington, D.C.	James O'Brien, D. R. Beekley (202) 296-2440
Princeton University Princeton, New Jersey	Dudley Saville (609) 452-4585
RCA Laboratories Princeton, New Jersey 08540	Dr. John F. Clark, C. C. Wang (609) 452-2700
RCA Government Services Division Cherry Hill, New Jersey 08034	Wendell Anderson (609) 338-5835
Radiation Monitoring Devices, Inc. Watertown, Massachusetts 02172	Dr. Harvey Serreze (617) 926-1167
Rensselaer Polytechnic Institute Troy, New York 12181	Prof. H. Wiedemier (518) 270-6456 Prof. M. E. Glicksman (518) 270-6372
Rockwell International Science Center Thousand Oaks, California 91360	M.D. Lind (805) 498-4545 X 190
Rockwell International - Space Div. Division Downey, California 90241	Sam Yarkin (213) 922-5273
Rockwell International Seal Beach, California	Ralph Happe (213) 594-3615 C. L. Gould (213) 594-3560
Sandia Laboratories Albuquerque, New Mexico	Thomas Prenenger (505) 264-1016

Organizations Contacted, Continued

FACILITIES	INDIVIDUALS
Servo Corp. of America Hicksville, New York 11802	Bennett Shurman (516) 938-9700 X 315
Southern Research Institute Birmingham, Alabama 35205	Gerald W. Driggers (205) 323-6592
State University of New York School of Medicine Buffalo, New York 14214	Dr. Carel Van Oss (716) 831-2900
G. Harry Stine (Consultant) Phoenix, Arizona 85021 (602) 997-1696	
TRW - Defense and Space Systems Group Redondo Beach, California 90278	R. L. Hammel (213) 536-3807
Texas Instruments, Inc. Dallas, Texas 75231	Dr. Morton E. Jones (214) 238-2468
Thiokol Corp. Ogden, Utah	Dr. Gilbert Moore (801) 399-1193
United Technologies Research Center East Hartford, Connecticut 06108	Frank D. Lemkey (203) 727-7318
University of Michigan Ann Arbor, Michigan	Prof. Harm Buning (313) 764-4310
University of Oregon Portland, Oregon	Dr. Geoffrey V. F. Seamen (503) 225-7711
University of Rochester Rochester, New York	Dr. Grant Barlow (716) 275-3761
Veterans Administration Hospital Tucson, Arizona 85723	Dr. Milan Bier (602) 792-1450
Western Electric Co. New York, New York 10007	Richard Snyder (212) 571-6508
Western Electric Co. Princeton, New Jersey 08540	Dr. Winston R. Samaroo (609) 639-2292

Organizations Contacted, Continued

FACILITIES	INDIVIDUALS
Western Electric Co. Allentown, Pennsylvania	Raymond E. Reusser (215) 439-6348
Westinghouse Research Laboratory Pittsburgh, Pennsylvania	Dr. R. Mazelsky (412) 256-7683
Wyeth Laboratories Radnor, Pennsylvania 19087	Dr. B. A. Rubin (215) 688-4400

LIST C

DELETION LIST

Contacts that are no longer associated with space processing activities. Where the company is underlined, it indicates the organization is no longer supporting an active interest in this field.

CHAPMAN, P. K. Avco Everret Research Labs (Dr. Chapman is now at A.D. Little, working on the Solar Power Satellite.)

DEEG, E. W. <u>American Optical Co.</u> (Dr. Deeg is now at Anchor Hocking in Lancaster, Ohio.)

FULMER, LES (Deceased) Rockwell International - Science Center

MLAVSKY, A. <u>Tyco Laboratories, Inc.</u> (Dr. Mlavsky is now at Mobil-Tyco in Waltham, Massachusetts.)

PRENENGER, TOM <u>Sandia Laboratories</u>, Albuqurque, New Mexico.

STEURER, W. H. (Retired) <u>General Dynamics - Convair Division</u>
(Per S. Kaye) General Dynamics Convair Division has decided not to become active in space processing.

SMITH, GALE <u>Corning Glass Works</u>

LIST D

MEA TOO LIMITED

Contacts that indicated MEA was too limited for their initial project needs and thus could not forecast future use of MEA.

AUBIN, William L.	Grumman Aerospace Corp.
BIER, Milan	Veterans Administration Hospital
BURG, Alan	A. D. Little
FOWLE, Arthur	A. D. Little
GATOS, Harry	MIT
HAMMEL, R. L.	TRW
HORNYAKE, Emery	Owen Illinois, Toledo, Ohio
MANNING, John	National Bureau of Standards
OSTRACH, Simmon	Case Western Reserve University
REMBAUM, Alan	Jet Propulsion Laboratories
ROSE, James T.	McDonnell Douglas
SAVILLE, Dudley	Princeton University
SCHMIDT, Rick	Iowa State University
SEAMAN, G.V.F.	University of Oregon
SUBRAMANIAN, R. S.	Clarkson College of Technology
VERHOEVEN, John	Iowa State University
WEINBURG, M. C.	Jet Propulsion Laboratories

LIST E

REQUESTS FOR MEA DATA

Contacts that had too limited or no knowledge of MEA and thus were reluctant to forecast future use for the equipment. These contacts all want more data on MEA for reference and/or planning purposes.

ALI, M. A.	E.C.P., Inc.
BIER, Milan	Veterans Administration Hospital

Requests for MEA Data, Continued

DOTY, J. P.	Eagle-Pitcher Industries, Inc.
FOWLE, Arthur	A. D. Little
GLICKSMAN, M. E.	Rensselaer Polytechnic Institute
GATOS, Harry	MIT
GRODZKA, Philomena G.	LMSC, Huntsville, Alabama
HUGHES, Kenneth	Battelle Columbus Laboratories
JACOBUS, O. P.	Consultant (retired from Merck & Co., Inc.)
LIND, M. D.	Rockwell International Science Center
MOORE, Gilbert	Thiokol, Ogden, Utah
SCHNEPPLE, Wayne C.	E.G. & G., Inc., Santa Barbara, Calif.
SERREZE, Harvey	Radiation Monitoring Devices
REMBAUM, Alan	JPL
RINGER, Ira	Abbott Laboratories

LIST F

MEA AS A FOLLOW-ON FACILITY

Contacts that think MEA may be useful to them after some initial Spacelab experiments using real time human interaction/observation.

HUGHES, Kenneth	Battelle Columbus Laboratories
MONTGOMERY, Brian	Accupart Laboratories
SCHNEPPLE, Wayne C.	E.G. & G., Inc.
SERREZE, Harvey	Radiation Monitoring Devices

LIST G

POSSIBLE FUTURE MEA USERS

Contacts that stated that it is probable they would have use for MEA in the future. However, they were uncertain due to program status and/or their knowledge of MEA's capabilities and limitations.

HUGHES, K.	Battelle Columbus Laboratories (Joint with NASA and Sponsor)
LIND, M. D.	Rockwell International Science Center (Non-NASA funds)
WEINBURG, M. C.	Jet Propulsion Laboratories