CHAPTER I

EXECUTIVE SUMMARY AND WORKSHOP PROCEDURES

INTRODUCTION

The success of the experimental flights of the Space Shuttle Columbia have led the way to a new era in space. The Shuttle success brings a new capability for placing large payloads into orbit, and for retrieving those payloads for analysis and reflight. This offers scientific investigators and users an exciting opportunity for much more complex instruments and comprehensive investigations than have been feasible heretofore. With this excitement comes the potential of re-igniting the interest of the American people in the nation's space program.

From the inception of the Shuttle program, NASA was concerned about the Shuttle environment. Much work was done by NASA scientists and engineers to create a payload bay environment that would be compatible with virtually any payload NASA could launch. NASA has succeeded in conducting measurements of the environment and in ensuring a relatively clean payload during the pre-launch, flight and post-launch phases.

One of the main experimental monitors used by NASA to determine the environment in the payload bay was the Induced Environment Contamination Monitor. This package of instruments has made environmental measurements during STS flights with a high degree of success. This has shown that the Shuttle environment is relatively free of contaminants, except for special instances of increased abundance of methane, water vapor and particulates. Results of these measurements are rapidly becoming more available.

In establishing the Shuttle Environment Workshop, NASA shared the findings with scientific experimenters, users and other individuals who need to know what the Shuttle is like and what future experimenters may expect in the payload bay. The Workshop was centered around results obtained from the environmental measurements made on the Shuttle.

The Program Agenda for the Workshop is given in Table 1. Figure 1 indicates the procedures and flow of communications for the Workshop. The first two days of the meeting were devoted to the Environmental Measurements session in which speakers made presentations to all Workshop attendees. Question-and-answer sessions followed the presentations, clarifying points and, in some cases, bringing out new details. Chapter II of the Proceedings contains the presentation summaries. All attendees were urged to submit written questions for consideration by Panels (lower right). Following the presentations of results, the three Panels addressed specific issues of concern to Panel participants, and considered the questions that were submitted.

TABLE 1

SHUTTLE ENVIRONMENT WORKSHOP PROGRAM

TUESDAY, OCTOBER 5th

7:30 **Registration**

8:30 **Welcome** — B. Edelson, Associate Administrator for Space Science and Applications, NASA HQ.

8:40 Introductory Remarks — M. Sander, Director, Spacelab Flight Division, NASA HQ.

8:50 Workshop Plans and Panel Structure — T. Wilkerson, University of Maryland

PLENARY SESSION
ENVIRONMENTAL MEASUREMENTS

9:00 Introduction by Chairmen — L. Leger, JSC; E. Miller, MSFC

9:10 Summary of EMI/EMC and Vibroacoustics — R. Colonna, JSC

9:50 Summary of Thermal Measurements — R. Brown, JSC

10:20 **QUESTIONS AND ANSWERS**

10:30 **BREAK**

10:40 KSC Shuttle Ground Turnaround Evaluation — J. Ragusa, KSC

11:20 Ground Environment Evaluation — G. Borson, Aerospace Corp.

11:50 **QUESTIONS AND ANSWERS**

12:00 **LUNCH**

1:30 Low Earth Orbital Environment Interaction with Vehicle Surfaces
- Material Effects — L. Leger, JSC
- Vehicle Glow — P. Banks, Stanford University
- Glow Spectral Measurements — S. Mende, Lockheed

2:15 **QUESTIONS AND ANSWERS**

2:30 Induced Environment Contamination Monitor
- Ascent/Reentry — E. Miller, MSFC
- Optical Measurements — E. Miller, MSFC

3:30 **QUESTIONS AND ANSWERS**

3:45 **BREAK**

TUESDAY, OCTOBER 5th (Cont.)

4:00 Induced Environment Contamination Monitor (Cont.)
- Deposition — E. Miller, MSFC
- Mass Spectrometer — G. Carignan, University of Michigan

5:00 **QUESTIONS AND ANSWERS**

5:30 **ADJOURN**

6:30 **COCKTAIL PARTY - Cash Bar**

WEDNESDAY, OCTOBER 6th

8:00 Opening Remarks — T. Wilkerson, University of Maryland

8:10 Modeling Correlation with Flight Data — H. Ehlers, JSC

8:30 OSTA-1 — A. Potter, JSC

8:50 OSS-1 Measurements
- Contamination Monitor and Surface Effects — R. Kruger, GSFC

9:20 Test for Contamination of Magnesium Flouride(MgF_2) Coated Mirrors — A. Bunner, Perkin-Elmer

9:30 **BREAK**

9:45 OSS-1 Measurements (Cont.)
- Vehicle Charging and Potential — R. Williamson, Stanford University

10:15 Plasma Diagnostics — S. Shawhan, University of Iowa

10:45 EMI/EMC — S. Shawhan, University of Iowa

11:15 **QUESTIONS AND ANSWERS**

11:30 **LUNCH**

1:00 OSS-1 Measurements (Cont.)
- Induced Atmosphere — J. Weinberg, University of Florida

1:30 Solar U.V. Spectral Irradiance — M. VanHoosier, Naval Research Laboratory

1:45 Solar Flare X-Ray Polarimeter — G. Chanan, Columbia University

2:00 Thermal Environment — S. Ollendorf, GSFC

WEDNESDAY, OCTOBER 6th (Cont.)

2:30 The Microabrasion Foil Experiment (MFE) — J.A.M. McDonnell, W. C. Carey, Kent University

2:45 **QUESTIONS AND ANSWERS**

3:00 **BREAK**

3:15 Other Measurements
- The Particulate Environment of STS-3 as Observed by the Cargo Bay Television System — C. Maag, JPL

3:30 Radar Detection of Particles Near Orbiting Manned Spacecraft — A. Potter, JSC

4:00 Other Papers and Speakers to be Selected

4:15 **QUESTIONS AND ANSWERS**

5:00 **Summary and Panel Session Plans** — T. Wilkerson, University of Maryland

PANEL SESSIONS
PLASMA, INFRARED AND ULTRAVIOLET

7:00 **Panel Sessions**

Plasma Panel, New York Room — R. Williamson, Chairman, Stanford University
- Introduction and Objectives
- Organization of Submitted Questions
- Discussion of Questions
- Recommendations from Panel

Infrared Panel, North Carolina Room — W. Hovis, Chairman, NOAA
- Introduction and Objectives
- Organization of Submitted Questions
- Discussion of Questions
- Recommendations from Panel

Ultraviolet Panel, Pennsylvania Room — T.Gull, Chairman, NASA/GSFC
- Introduction and Objectives
- Organization of Submitted Questions
- Discussion of Questions
- Recommendations from Panel

9:00 **ADJOURN**

THURSDAY, OCTOBER 7th

PANEL SESSIONS (Cont.)
PLASMA, INFRARED AND ULTRAVIOLET

8:30 **Panel Sessions**

Plasma Panel, New York Room — R. Williamson, Chairman, Stanford University
- Discussion of Questions
- Recommendations from Panel

Infrared Panel, North Carolina Room — W. Hovis, Chairman, NOAA
- Discussion of Questions
- Recommendations from Panel

Ultraviolet Panel, Pennsylvania Room — T. Gull, Chairman, NASA/GSFC
- Discussion of Questions
- Recommendations from Panel

11:00 **BREAK**

11:15 Moderator's Work Session

12:00 **LUNCH**

WORKSHOP DISCUSSION AND RECOMMENDATIONS

1:00 **Panel Reports to Workshop** — T. Wilkerson, Chairman, University of Maryland
- Plasma Panel Report — R. Williamson, Stanford University
- Infrared Panel Report — W. Hovis, NOAA
- Ultraviolet Panel Report — T. Gull, NASA/GSFC

2:30 **BREAK**

2:45 **Discussion of the Compatibility of Shuttle Environment and Experiments** — J. Lehmann, Moderator, NASA HQ.

Participants: T. Wilkerson, University of Maryland
L. Leger, JSC
E. Miller, MSFC
R. Williamson, Stanford University
W. Hovis, NOAA
T. Gull, NASA/GSFC

5:30 **ADJOURN**

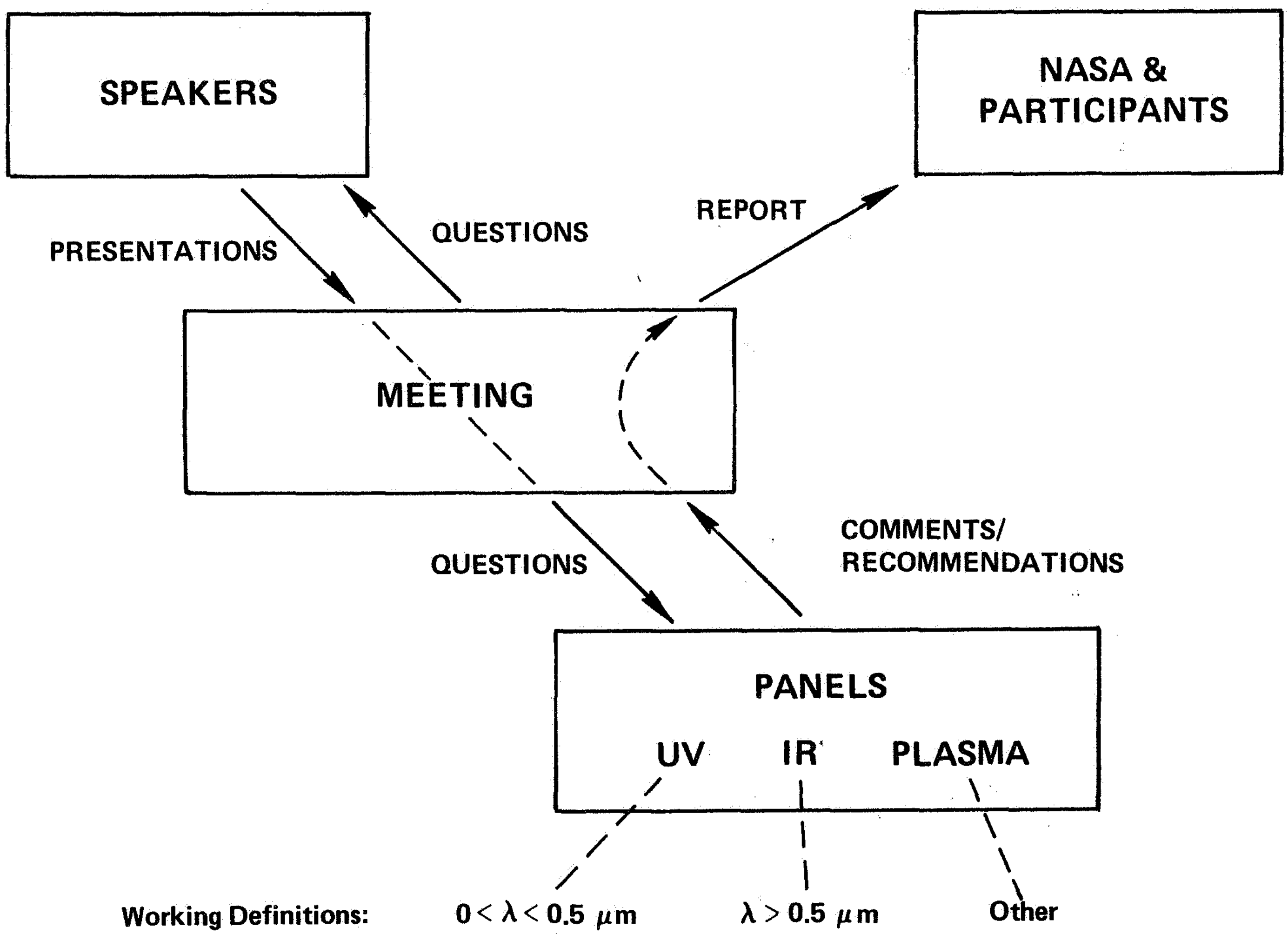

Figure 1. SHUTTLE ENVIRONMENT WORKSHOP PROCEDURES

TABLE 2

AREAS OF CONCERN FROM THE SHUTTLE ENVIRONMENT WORKSHOP AND RECOMMENDED ACTIONS

	Area of Concern	Recommended Actions
1.	Vehicle Glow: Optical contamination	Study glow and coordinate with other agencies
2.	Particulates: Optical contamination, damage to surfaces	Eliminate source or minimize effect, and clean up ground environment
3.	Operational Vehicle Data: Vehicle influence on observations	Redesign information system to make data available more easily
4.	Users/Operators Interface: Mismatch of environment and experiment requirements	Management to re-examine and improve the user-operator interfaces
5.	Environmental Qualifications: Feedback from measurements to future operations	Review, modify procedures based on measurements
6.	Erosion of Materials: Degradation of essential components	Avoid use of affected materials; use substitutes
7.	Gas Environment: Role of vehicle payload, thrusters, atmosphere	Establish more measurements to determine parameters under varying conditions
8.	Operational Monitoring: Flight intercomparisons needed for planning	Develop standardized monitoring module with other users
9.	Induced Electric Fields: Uncertain vehicle effects, and microwave transmission	Review EMI test plan and include all frequencies and environmental conditions
10.	Temperature: Damage to instruments, compromise data	More extensive temperature measurements, and provide protection options

The Panels represented three major classes of instruments/measurements on future Shuttle missions. Their purpose was to reflect on the material presented in the meeting, on the basis of their experience with operations in space, and make recommendations to NASA accordingly. The Panels met in an evening and a morning session and reported back to the Workshop as a whole. A group of "areas of concern" was developed in these Panels for general consideration, and detailed recommendations were made to the Workshop at large. These recommendations appear in Chapter III of the Proceedings, which is the "report" called out in the figure (upper right). Summary comments and the outlook for the future made by several of the principals of the Workshop were presented in the final session. These comments are included in the Proceedings in Chapter IV.

SUMMARY OF PANEL FINDINGS

This summary highlights the areas of concern from the Infrared, Ultraviolet, and Space Plasma Panels of the Shuttle Environment Workshop. These areas and the recommended actions from the Workshop deliberations are itemized in Table 2. The Panels expressed concerns falling into the following areas:

- Vehicle Glow
- Particulates
- Operational Vehicle Data
- User/Operator Interface
- Environmental Qualifications
- Erosion of Materials
- Gas Environment
- Operational Monitoring
- Induced Electric Fields
- Temperature

Summaries of each topic are given in the following paragraphs.

1. Vehicle Glow

The properties of this glow need to be determined. Information is needed on the following:

- spectrum and intensity
- vehicle surfaces involved
- geometry of glow layer around vehicle (thickness and extent)
- dependence on altitude and surface materials
- day/night effects
- ways to minimize glow contamination of optical measurements
- relationship (if any) of glow to surface deterioration

Although the origin of the glow is important from a scientific standpoint, the above practical questions need to be answered first for maximum benefits to early Shuttle flights. NASA, DoD, and other organizations are all concerned.

2. Particulates

The data on particulates are confusing at present, even though some sensational imagery has been recorded with cameras in the payload bay of the Shuttle. Several sources of particles are known to exist: debris released during initial payload bay door opening, (2) ice particles which are known to form, with the dumping of waste water, (3) water released from thermal protection system (developmental problem), (4) particles released from aft end of vehicle (also probably associated with developmental problem). However, IECM data indicates that the particle environment is within specifications for a significant portion of each mission after the first 24 hours of the mission. These possible particles source correlations need to continue to better define the particle environment. Apparently, the ground environment of the Shuttle needs to be made cleaner with regard to the accumulation of dust on surfaces.

3. Operational (Vehicle) Data

The need has been expressed for additional (and more timely) operational data to compare with events detected by experimenters. Part of this problem appears to be the long lead time needed for the vehicle people to reply to a specific request by experimenters. Another part is the great volume of operational data that might conceivably be wanted by experimenters. The continuing impasse on this issue, attested to by several scientists and engineers, may be a management/communications problem that needs to be addressed by NASA.

4. Management System for Shuttle Environment and Communications between Experimenters and Vehicle Engineers

There is a recurring dialogue in which experimenters are characterized as not knowing how to specify their Shuttle environment needs, and engineers are described as reluctant to say what the environment will be like unless expensive procedures are instituted. Given that both groups are clearly striving for the best possible results (and have achieved many of their goals), work is needed at the management level to resolve this situation. A sound "conflict management" process could help identify the sources of the problem and point to a solution.

5. Definition of Environmental Specifications for Operations on the Ground and In Orbit

The process whereby these specifications are set up, and how they may be modified by experience and measurements, needs to be reviewed and elucidated for the users - and perhaps modified. Not many of those present at the meeting seemed to know how the clean room specifications at KSC were set up, how to have it adjudicated whether a given improvement can be made without undue costs, etc. NASA needs to face this issue squarely or there will be a continuing potential for unfair criticism of the Shuttle project and environment.

6. **Loss of Material**

The attrition of selected surfaces in the Shuttle environment needs to be documented more completely, and the consequences assessed for:

- thermal control of vehicle and payload
- contributions to gaseous species
- sources for particulates observed
- effects on exposed optical reflectors and coatings
- possible substitution of other materials at key points on the vehicle and in payload.

7. **Gas Environment**

The gaseous environment around the Orbiter needs better definition. Sources discussed so far include:

- thruster firings
- vehicle outgassing/venting
- payload outgassing/venting
- "ram" from the atmosphere
- leak of cabin pressure
- chemical interactions of the above

8. **Routine Payload/Vehicle Monitoring**

In addition to the extensive monitoring systems already in use, it has been proposed that standardized monitoring modules be flown on every operational Shuttle flight. Costs and benefits of this proposal need to be considered. The principle seems sound - while it is not clear that such a monitor will be representative of the environment on any given flight, or typical of a set of flights, in view of changes from payload to payload. However, standard items such as upper stages may need additional measurements.

9. **Induced Electric Fields**

While some of the data show that the Shuttle affords a fairly benign electromagnetic environment (DC to high frequency), there seem to be gaps in: (1) the understanding of the relationship of the field to vehicle operations; and (2) the certainty that the payload bay is safe from EMI problems for all possible microwave operations (e.g., Ku band). The test plan for EMI checkout may need to be reviewed to satisfy all the users.

10. **Temperature**

While measured temperatures have agreed well with modeled data, one anomalous temperature measurement of 260^{o} needs to be documented more fully.