RECOMMENDATIONS OF OSTA FLIGHT TECHNOLOGY IMPROVEMENT WORKSHOP - POWER SUBSYSTEMS PANEL

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(Figure 1-9)

This presentation discusses the recommendations of the Power Subsystems Panel of the Office of Space and Terrestrial Application Workshop, which was held in July and August 1979. The primary thrust of the workshop was directed at radiometric problems which have been showing up. But, in the process, several panels were developed to contribute to this workshop.

(Figure 1-10)

The Radiometric Instruments and Calibrations Panel, as I said, was the primary one. There was also concern for electromechanical subsystems, attitude control and determination, and power systems in that each of these subsystems affects what happens with the experiments and instruments on board a spacecraft. If these systems are not working properly, the experiments and instruments are not working right.

(Figure 1-11)

This report is essentially the report from the power panel, which, as you can see, consisted of a large variety of power systems people from the various users, both government and industry.

(Figure 1-12)

The objective of the workshop was to identify the technology needs that become apparent through previous problems. I might say that throughout the workshop, there was a lot of difficulty with how to talk about problems versus failures versus anomalies, and so forth, because of sensitivities of people there. It was related to past and ongoing missions. In other words, problems that have not been completely solved in the past, new problems that we are facing right now, and near-future potentials; not problems that are going to come up because we are going to have space platforms or highly advanced technology requirements coming up in the more distant future.

In the process, though, we could not ignore the direction that things are going. Since we were looking at past problems and the direction they are leading, obviously the future could not be totally excluded.

We did consider both the spacecraft power subsystem and power supplies for the experiments and instruments. The real bottom-line objective was to come up with recommendations for technology development, essentially define areas that needed development. We did not come up with a specific program. I should emphasize that these conclusions and recommendations come from the power panel, not from NASA, not from Goddard, not from me, but from the panel as a group working together.

(Figure 1-13)

The approach used was to identify technology problems. Just about everyone on the panel made a presentation based on problems that had been seen at his agency or with regard to particular spacecraft that he has worked on, or was associated with.

We also looked at papers from the other panels to see where there were relationships between power system problems and other panel problems. Initially, we categorized them by areas.

(Figure 1-14)

Essentially, the basic areas are the power subsystem, the system, the array, the batteries, and so forth. Then, these problems were translated into technology development requirements.

(Figure 1-15)

We classified the requirements into a second group of work categories, and then we did some prioritizing.

(Figure 1-16)

This is the set of work categories, listed in priority order, indicating the areas that are problem areas. The ones noted with an asterisk are those which relate, in one way or another, to batteries themselves.

(Figure 1-17)

We did note particularly two other problem areas. In the one area, the lightweight structures of the arrays cause problems with spacecraft orientation and control systems. In the other area, thermal control can be very serious as far as battery performance is concerned. It is a very important area, but it is not something that battery people can do much about. It is up to thermal control systems to give us good thermal control.

(Figure 1-18)

Now, we get into the specific categories in a little more detail. Although it is currently primarily a problem with solar arrays, there are requirements for analytical modeling in batteries. It is not only a matter of the DC modeling, but we are getting into the area where AC problems require solution. We need to know the AC analytical model for batteries.

There is very little data that exists, and it is a very difficult field to work in right now. The payoff on work in this area is that we safeguard against bus instability. We have run into that in flight spacecraft and can avoid harmful interactions between the array and filter components. By defining the source impedance at the load bus, we could model the spacecraft power system better. We really need this model because the whole systems are getting so large that all-up system tests cannot be performed anymore.

(Figure 1-19)

A second area is the state of health monitoring. The conclusions of the power panel indicate the need for a better state of health monitoring, more detailed monitoring of what is happening in the power system in flight.

There are a couple of reasons for this: One is that we are getting away from the point where we are in constant contact with the spacecraft. In order to have the spacecraft power system functioning properly, we need more monitoring of what is going on, and, in fact, onboard processing of what is going on in order to handle the power subsystem when we cannot handle it from the ground. Extensive ground monitoring has been required in the past, and a lot of ground analytical work has been required, to the extent of actually flying the spacecraft by wire, you might say, continually controlling it from the ground in order to keep things working. On some recent spacecraft this has been particularly a result of unanticipated poor performance of the battery compared to the desired performance.

(Figure 1-20)

I will not go into much new component development for high voltage and high-power components. The only thing that does relate to the battery is that the power subsystems on the larger spacecraft are getting up to the point where tremendous currents are required. Unless the bus voltages go up, the currents result in tremendous weight penalties.

With the increasing bus voltages, it means either circuitry to take care of it, boost circuitry, or more cells in series in the battery. That, in turn, says something about reliability; also, in turn, says something about the problem of flying multiple batteries to back each other up.

(Figure 1-21)

The high voltage technology was really a matter of reliable-type technology related to spacecraft experiments.

(Figure 1-22)

Array cell testing is related to the solar array, its cells, and the testing in order to get reliability from the array.

(Figure 1-23)

Nickel-cadmium battery manufacturing and application—the consensus of the power panel was that efforts in understanding completed cell, and so forth, should be somewhat modified into the direction of having more basic studies of what is going on within the cells, actually, the electrochemistry and the electrochemical and physical analysis of just what is happening within the cells, so that we can better understand the cells, better know how to manufacture them, and come out with more consistent cells in the long run. Part of this would lead to less requirements for selection if there is more uniformity in the batteries.

(Figure 1-24)

Substorm plasma effects have to do with the high voltages generated on the spacecraft surface primarily in geosynchronous orbit during the geomagnetic substorm periods.

(Figure 1-25)

The engineering data base is listed as moderate priority. I might say that the way priorities were set, it is very difficult to set anything as a low priority once you have identified problems in space that have occurred. So, when we list high priority, moderate priority, low priority, what we are really talking about is the highest of high priority items and the lowest of high priority items.

This area, which the panel discussion will get into quite a bit further, essentially is becoming a very difficult area, because as new technology comes up, it either is unacceptable for the flight programs because the project managers cannot be convinced that it is ready for flight, or if used on the flight programs, it is used with quite a bit of risk because the new technology item has not been fully characterized and we don't really know how it is going to work.

A case in point might be the nickel-hydrogen batteries. They look good, but we really don't know enough about them to dedicate them as the storage system, the sole storage system for spacecraft. So, development of the data base from the development point of the item over to the flight applications point, what you might call the engineering development, has pretty much been dropped as a research phase or development phase.

The engineering development from the research item to the flight item is kind of missing. When it does come in on a flight project because it is mandatory that we use that new equipment, that new battery, and what have you, the engineering data base is developed for that specific flight project and is not directly applicable to all other flight projects.

(Figure 1-26)

Rotary joint for power transfer—this is transfer from the array to the spacecraft, so you essentially get the power from the solar cells into the main spacecraft itself.

(Figure 1-27)

On array power management was a kind of a blue sky type of thing. There is a need for better management before it gets into the spacecraft, better management of the power in order to keep initial high-power levels down. But, we really, as a panel, could not come up with anything really definitive as to how this would be done effectively. That was the reason it was given a low priority.

(Figure 1-28)

This list of references indicates the breadth of how many papers were presented at the workshop, and these were all done on the first morning or the first day of the workshop. The listing will be in the proceedings in case you want to look at any of them in more detail.

DISCUSSION

FORD: Lou, I believe, correct me if I am wrong, that there will be a publication out very shortly?

SLIFER: The proceedings will be published. The schedule given out at the workshop called for the proceedings to be published in December. It looks like they are running perhaps 2 weeks behind the detailed schedule. So, to me, it still looks like December. But, it looks like a real possibility for even picking up those 2 weeks. It may be late November, even. The entire proceedings of the workshop, the results from all four panels, will be published at that time.

GROSS: I saw very little relationship between the problems that you identified in the research program and Bob Riebling set forth.

SLIFER: This is really because of the first objective, to look at what has been happening in the past, where are our problems. That is really what we started with. The papers that were presented at the workshop essentially presented the problems that we have been having or that we are having right now.

Bob Riebling's program is directed to the future, 1983, 1985, and as near-term and in the far-term program.

Now, Headquarters has taken a very serious look at these recommendations. I don't know what they are going to decide about them, but I do know that they certainly are not ignoring them. They are looking at them very closely.

RIEBLING: Sid, I have to agree with you, and I think this points out the gap that we see existing between the technologists and the users. One of the first things that we are doing about it is that I asked to have the panel discussion this morning to attempt to bring together technologists and users and to see if we cannot find a way of bringing these people closer together and narrowing this gap. It is something that we recognize as a problem.

VASANTH: You have mentioned that more basic studies related to reactions within the cells including nickel-cadmium batteries are required. Can you throw more light on what specific areas you would recommend research activity? Have you had any problems in those nickel-cadmium batteries?

SLIFER: Well, I would have to pass that on to someone who is more expert in the specifics of what is inside the battery and how these chemical reactions take place. Not only the chemical reactions you intend to take place, but also the ones that result from materials that are in there which you really did not want in there.

I think from the panel discussion it really comes out with the electrodes, the separators, and the electrolyte, and all three need better understanding as to the electrochemical and physical processes.

RIEBLING: I would like to add a bit to what Lou just said. It is my personal opinion that many of the flight problems that were discussed at the referenced workshop, the problems lie not necessarily with technology, but rather with manufacturing. There is a difference between understanding the technology or the science of an electrochemical system and being able to reproducibly produce these in small quantities for a small buyer such as NASA.

So it may not always be technology, but it may be production problems in there, and we need again to bring the technologies of manufacturers and users all closer together.

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OSTA FLIGHT TECHNOLOGY IMPROVEMENT WORKSHOP
POWER SUBSYSTEMS PANEL
JULY 31 & AUG. 1, 2, 1979

PRESENTATION TO:
NASA/GSFC 1979 BATTERY WORKSHOP

L. SLIFER
11/13/79

Figure 1-9

WORKSHOP PANELS

RADIOMETRIC INSTRUMENTS AND CALIBRATION
ELECTROMECHANICAL SUBSYSTEMS
ATTITUDE CONTROL AND DETERMINATION
POWER SUBSYSTEMS

Figure 1-10

POWER PANEL

ORGANIZATION	NAME
NASA-GSFC	L. SLIFER (CHAIRMAN)
NASA-OAST	L. RANDOLPH
NASA-GSFC	F. FORD
NASA-GSFC	J. WESTROM
NASA-MSFC	J. MILLER
NASA-LARC	E. KELSEY
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NRL	J. WINKLER
AEROSPACE CORP.	H. KILLIAN
JPL	M. SWERDLING
COMSAT LABS.	W. BILLERBECK
BOEING AEROSPACE	S. SILVERMAN
FORD AEROSPACE	H. MCKINNEY
GENERAL ELECTRIC	S. PECK
HUGHES AIRCRAFT	J. HAYDEN
MARTIN-MARIETTA	M. IMAMURA
RCA	P. NEKRASOV
TRW	R. SPARKS

Figure 1-11

OBJECTIVES

- o TO IDENTIFY TECHNOLOGY NEEDS THAT HAVE BECOME APPARENT THROUGH A REVIEW OF PROBLEMS THAT OCCURRED ON PAST AND ON-GOING SPACEFLIGHT MISSIONS. (NOT FUTURE POTENTIALS)
- o CONSIDER BOTH SPACECRAFT POWER SUBSYSTEM AND EXPERIMENT/INSTRUMENT POWER SUPPLIES
- o TO RECOMMEND A TECHNOLOGY DEVELOPMENT PROGRAM TO ACCOMMODATE THE IDENTIFIED NEEDS

Figure 1-12

APPROACH

IDENTIFY TECHNOLOGY PROBLEMS

- PRESENTATIONS (SEE REFERENCES)
- PAPERS FROM OTHER PANELS

INITIAL CATEGORIZATION BY AREA

TRANSLATE PROBLEMS INTO TECHNOLOGY DEVELOPMENT REQUIREMENTS

CATEGORIZE REQUIREMENTS

PRIORITIZE REQUIREMENTS

Figure 1-13

TECHNOLOGY PROBLEM AREAS

1. POWER SYSTEM
2. SOLAR ARRAY
3. BATTERY
4. POWER DISTRIBUTION (SWITCHING, FAULT PROTECTION, CABLES, HIGH VOLTAGE)
5. POWER CONDITIONING ELECTRONICS
6. HIGH VOLTAGE POWER SUPPLIES
7. POWER TRANSFER
8. GENERAL PROBLEMS (DATA, QUALIFIED PARTS, ETC.)

Figure 1-14

INTER-PANEL PROBLEMS

SENSORS	- OUTGASSING
	- NOISE
ELECTRO-MECHANICAL	- HIGH VOLTAGE (STAR TRACKER) CORONA DISCHARGE/ARCING
	- SLIP RING - BRUSH TRANSFER
	- DEPLOYMENT AND ORIENTATION
ATTITUDE CONTROL	- POWER SUPPLY OSCILLATION
	- ARRAY DRIVE STEPPING
	- ARRAY BLOCKAGE
	- PARTICLE CONTAMINATION IN TUBES AND INTEGRATED CIRCUITS
	- STABILITY OF POWER TO DEFLECTION COILS OF STAR TRACKER
	- COLLECTOR TO BASE SHORT IN TRANSISTOR
	- FLEXIBLE STRUCTURE DYNAMICS
	- FEASIBILITY ----- PRODUCTIVITY

Figure 1-15

PRIORITY LISTING

HIGH PRIORITY (NEW)

- *ANALYTICAL MODELING
- *STATE OF HEALTH MONITORING
- NEW COMPONENT DEVELOPMENT
- HIGH VOLTAGE TECHNOLOGY

HIGH PRIORITY (INCREASE EMPHASIS)

- ARRAY/CELL TESTING

HIGH PRIORITY (MODIFY)

- *NICD BATTERY MFG. AND APPLICATION

HIGH PRIORITY (CONTINUE)

- SUBSTORM PLASMA EFFECTS

MODERATE PRIORITY

- *ENGINEERING DATA BASE
- ROTARY JOINT FOR PWR TRANSFER

LOW PRIORITY

- ON ARRAY POWER MANAGEMENT

Figure 1-16

INTERDISCIPLINE DEFICIENCIES

LIGHTWEIGHT STRUCTURE (ARRAYS)

THERMAL CONTROL (BATTERIES)

Figure 1-17

•ANALYTICAL MODELING

RECOMMENDATION:

1. DEVELOP AC MODELS FOR POWER SUBSYSTEM COMPONENTS
2. SYNTHESIZE ANALYTICAL MODEL FOR POWER SYSTEM
3. DEFINE NECESSARY PARAMETERS FOR ELECTRONIC SIMULATION OF AC SOLAR ARRAY MODEL

RATIONALE:

VERY LITTLE AC DATA AVAILABLE FOR COMPONENTS AND SYSTEM

EXISTING DATA NEEDS REVIEW, REVISION, REFINEMENT AND UPDATING

GUIDELINES NEEDED FOR ACCURATE ELECTRONIC SIMULATION

ELECTRONIC ARRAY SIMULATION IS NEEDED - ONLY KNOWN WAY TO "INCLUDE" LARGE ARRAYS IN GROUND TESTS

PAYOFF:

SAFEGUARD AGAINST BUS INSTABILITY

AVOID HARMFUL INTERACTION BETWEEN ARRAY AND FILTER COMPONENTS AT OUTPUT

DEFINE SOURCE IMPEDANCE AT LOAD BUS

SUPPLEMENT INADEQUATE DC ARRAY SIMULATORS WITH MORE ACCURATE AND REALISTIC AC SIMULATION

Figure 1-18

•STATE OF HEALTH MONITORING

RECOMMENDATION:

1. DEVELOP IMPROVED TECHNIQUES FOR ON-BOARD MONITORING AND CONTROL OF POWER SYSTEM AND ITS COMPONENTS
   - SOFTWARE/HARDWARE TECHNIQUES TO MINIMIZE
     - IMPACT ON DATA HANDLING AND COMMAND SYSTEM
     - GROUND OPERATIONS
   - IDENTIFY REQUIRED STATE OF HEALTH DIAGNOSTIC MEASUREMENTS
   - DEVELOP SENSING TECHNIQUES AND SENSORS FOR DETECTING
     - PARTIAL FAILURES
     - DEGRADATION
2. DEFINE TECHNIQUES FOR REDUCING COMPLEXITY OF MANAGING DEGRADED SYSTEM/COMPONENTS FROM GROUND

RATIONALE:

EXISTING ON-BOARD SENSORS/MEASUREMENTS INADEQUATE FOR ACCURATE DEFINITION OF STATE OF HEALTH
GROUND MONITORING AND ANALYSIS IS INADEQUATE AND EXPENSIVE
GROUND CONTROL IS COMPLEX AND SLOW TO RESPOND
INADEQUACIES AFFECT MISSION PLANNING AND FLIGHT OPERATIONS
REAL EFFECTS OF ENVIRONMENT ON SYSTEM ARE NOT KNOWN

PAYOFF:

LOWER GROUND SUPPORT COST
IMPROVED RESPONSE IN COMPENSATING FOR PARTIAL FAILURE/DEGRADATION
IMPROVED DESIGN CAPABILITY
IMPROVED MISSION OPERATIONS
LOWER POWER SYSTEM COST AND WEIGHT
SIMPLIFICATION IN C & DH SYSTEM

Figure 1-19

NEW COMPONENT DEVELOPMENT

RECOMMENDATION:

DEVELOP HIGH VOLTAGE - HIGH POWER COMPONENTS

- DEVELOP PARTS
- DETERMINE SCREENING TECHNIQUES
- FLIGHT QUALIFY

RATIONALE:

HIGH POWER LEVELS REQUIRE INCREASED BUS VOLTAGE (150-400V)

NO QUALIFIED HIGH VOLTAGE - HIGH CURRENT PARTS AVAILABLE

PAYOFF:

REDUCED SIZE AND WEIGHT OF POWER SYSTEM

AVOIDS POTENTIAL DESIGN OR RELIABILITY COMPROMISES

SETS GROUNDWORK FOR FUTURE VERY HIGH POWER MISSIONS

Figure 1-20

HIGH VOLTAGE TECHNOLOGY

RECOMMENDATION:

1. DEVELOP A DETAILED HIGH VOLTAGE DESIGN GUIDE HANDBOOK
2. DEVELOP A MODEL DETAILED HIGH VOLTAGE PROCUREMENT SPECIFICATION

RATIONALE:

HIGH VOLTAGE SYSTEMS ARE FAILING

- LACK OF UNDERSTANDING
- LACK OF DATA BASE FOR MATERIALS, ANALYSIS, AND DESIGN/APPLICATION TECHNIQUES

PAYOFF:

INCREASED RELIABILITY AND LIFETIME OF HIGH VOLTAGE CIRCUITRY

- PREVENT FAILURES DUE TO LACK OF KNOWLEDGE
- BASELINE TESTING REFERENCE PROVIDED
- USE OF VERIFIED TECHNICAL GUIDELINES IN PROCUREMENTS
- PROVIDES CRITERIA FOR SELECTION, SCREENING, AND ACCEPTANCE OF COMPONENTS

Figure 1-21

ARRAY/CELL TESTING

RECOMMENDATION:

CONTINUE (WITH HIGH PRIORITY) DEVELOPMENT OF SPECIFIC TECHNIQUES FOR CONTROLLING PROCESSES INVOLVED IN MAKING RELIABLE INTERCONNECTS/INTERCONNECTION, FOR VERIFYING INTERCONNECT INTEGRITY, AND FOR PERFORMING ACCELERATED CORROSION TESTING OF SOLAR CELL CONTACTS

RATIONALE:

CURRENT METHODS ARE LABOR INTENSIVE - TIME CONSUMING AND COSTLY

METHODS OF VERIFYING REQUIRED NEW TECHNOLOGY ARRAYS (WELDING ON FLEXIBLE SUBSTRATES WITH PRINTED CIRCUITS) ARE UNKNOWN

RELIABILITY AS RELATED TO MISSION NEEDS IS UNCERTAIN

PAYOFF:

INCREASED CONFIDENCE IN IMPLEMENTATION OF NEW TECHNOLOGY

REALIZATION OF BENEFITS INHERENT IN NEW TECHNOLOGY

- HIGH EFFICIENCY
- HIGHER RELIABILITY
- LOWER COST

Figure 1-22

*NI CD BATTERY MFG. AND APPLICATION

RECOMMENDATION:

1. CONTINUE (WITH HIGH PRIORITY) TECHNOLOGY DEVELOPMENT FOR RECONDITIONING AND FOR CELL MANUFACTURING PROCESS OPTIMIZATION
2. MODIFY ON-GOING PROCESS SELECTION AND STANDARDIZATION WORK TO EMPHASIZE DEVELOPMENT OF ELECTRO-CHEMICAL AND PHYSICAL ANALYSIS METHODS

RATIONALE:

PERFORMANCE OF NI CD BATTERIES HAS BEEN INCONSISTENT AND IS ONE OF THE MOST COMMON CAUSES OF DEGRADED SPACECRAFT OPERATION

RECONDITIONING HAS BEEN USED TO IMPROVE PERFORMANCE BUT WITH VARIABLE SUCCESS AND IS POORLY UNDERSTOOD

CELL PERFORMANCE OVER LIFE HAS BEEN INCONSISTENT AND BELOW MISSION NEEDS

- PROCESS AND PROCESS CONTROL SUSPECTED
- FUNDAMENTAL UNDERSTANDING INADEQUATE
- IMPROVED UNDERSTANDING WILL IMPROVE BOTH THE MANUFACTURING PROCESS AND THE RECONDITIONING METHODS

PAYOFF:

IMPROVED BATTERY LIFE AND VOLTAGE REGULATION
IMPROVED UTILIZATION - REDUCED WEIGHT
REDUCED GROUND STATION OPERATIONS
INCREASED PAYLOAD OPERATION IN ECLIPSE
REDUCED COSTS - REDUCED MANUFACTURING FAILURES

Figure 1-23

SUBSTORM PLASMA EFFECTS

RECOMMENDATION:

ENHANCE THE SPACECRAFT CHARGING PROGRAM (CURRENTLY PERFORMED AT LERC) BY ADDING DEVELOPMENT OF SPACE PLASMA ENVIRONMENT SIMULATION FOR GROUND TESTING OF POWER SYSTEMS TO INCLUDE ENERGY PROFILES, WHERE IT FLOWS, AND HOW IT IS DISSIPATED

RATIONALE:

FAILURES AND DEGRADATION DUE TO PLASMA EFFECTS HAVE OCCURRED
CURRENT SIMULATIONS ARE INADEQUATE FOR STUDY OR TESTING OF EFFECTS ON POWER SYSTEMS
ACCURATE PREDICTION OF SYSTEM OR COMPONENT PERFORMANCE CANNOT BE MADE
DEFINITION OF SYSTEM AND COMPONENT DESIGN REQUIREMENTS IS NEEDED
REFINEMENT AND UPDATING OF ACTUAL ENVIRONMENT IS ALSO NEEDED

PAYOFF:

ELIMINATE FAILURE MODES OF SPACECRAFT
DESIGN DATA AVAILABLE FOR SURVIVAL IN PLASMA ENVIRONMENT
CHECKOUT OF SPACECRAFT CHARGING PROBLEMS BY ANALYSIS/SIMULATION BECOMES POSSIBLE

Figure 1-24

• ENGINEERING DATA BASE

RECOMMENDATION:

DEVELOP A DOCUMENTED AND BROADLY DISTRIBUTED ENGINEERING DATA BASE ON EMERGING TECHNOLOGIES

RATIONALE:

TIME GAP EXISTS BETWEEN NEW TECHNOLOGY AVAILABILITY AND THE APPLICATION DATA NEEDED TO USE IT ON FLIGHT PROGRAMS

DATA BASE IS NEEDED FOR NEWLY DEVELOPED SOLAR CELLS AND THEIR PERFORMANCE CHARACTERISTICS UNDER MANY DIVERSE EXPECTED OPERATING AND ENVIRONMENTAL CONDITIONS

NICKEL HYDROGEN CELLS MUST SIMILARLY BE CHARACTERIZED

IN ADDITION, RECONDITION METHODOLOGY AND MAINTENANCE DURING DORMANT PERIODS MUST BE ESTABLISHED

APPLICABLE DATA ON SUCH POWER RELATED DEVICES AS POWER MOS TRANSISTORS, MICROPROCESSORS, AND HIGH VOLTAGE COMPONENTS IS REQUIRED IMMEDIATELY TO PROPERLY APPLY THESE COMPONENTS

PAYOFF:

FEWER MISTAKES AND FAILURES IN THE APPLICATION OF NEW TECHNOLOGY AND DEVICES

MORE RAPID TRANSFER OF NEW TECHNOLOGY INTO ONGOING PROGRAMS

INCREASED COST EFFECTIVENESS AND SCHEDULE CONFIDENCE IN THE UTILIZATION OF NEW TECHNOLOGY

Figure 1-25

ROTARY JOINT FOR POWER TRANSFER

RECOMMENDATION:

DEVELOP A COMBINATION ROTARY POWER AND DUPLEX TRANSFORMER CONFIGURED TO PROVIDE FOR HIGH POWER AND HIGH DATA RATES WITH INCREASED RELIABILITY AND REDUCED NOISE

RATIONALE:

MECHANICAL SLIP RINGS CONVENTIONALLY USED

SLIP RING PERFORMANCE WILL NOT INSURE RELIABLE DATA TRANSFER AT HIGH DATA RATES

SLIP RINGS AND NEWLY DEVELOPED ROLL RINGS HAVE CHARACTERISTIC NOISE AND VOLTAGE DROP MODES

ROTARY TRANSFORMERS, WHICH HAVE BEEN PREVIOUSLY USED FOR TRANSFERRING MULTI-CHANNEL DATA ACROSS A ROTARY INTERFACE IN BOTH ANALOG AND DIGITAL FORM WITH A MULTIPLEXER FOR TRANSMISSION AND DEMULTIPLEXER FOR RECEPTION, ARE NOT CURRENTLY CAPABLE OF OPERATING AT FREQUENCIES BEYOND THE 15 KH_Z RATES

PAYOFF:

LONGER LIFE

HIGHER RELIABILITY

IMPROVED DATA RETURN QUALITY

HIGHER DATA RATE

Figure 1-26

ON-ARRAY POWER MANAGEMENT

RECOMMENDATION:

DEVELOP COMPONENTS/DESIGNS TO PROVIDE BASIC POWER MANAGEMENT ON THE SOLAR ARRAY RATHER THAN WITHIN THE SPACECRAFT

RATIONALE:

VARIABILITY OF ARRAY POWER OUTPUT RESULTS IN EXCESSIVE REQUIREMENTS FOR BOTH ELECTRICAL POWER CONTROL AND THERMAL CONTROL SYSTEMS TO ACCOMMODATE

PAYOFF:

SIMPLIFY POWER SYSTEM

REDUCE THERMAL CONTROL REQUIREMENTS

Figure 1-27

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Figure 1-28