THEMIS PROGRESS REPORT FOR
July 2004

UC BERKELEY CONTRACT NAS5-02099
SWALES AEROSPACE P.O. 1-0000754359
For the Period 7/1/04 through 7/31/04

Title: THEMIS Bridge Phase
UCB Technical Monitors: Peter Harvey and Dr. Vassilis Angelopoulos
Swales Manager: Mike Cully

This report summarizes major activities from July 1 through July 31 30, 2004. Swales provides status on Monday (general) and Friday (schedule) each week via scheduled conference calls to UCB management.

I. SUMMARY OF WORK PERFORMED

1.0 WBS 2.2.1.1 PROJECT MANAGEMENT

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- Thermal Design tiger team was formed to address CDR actions. Delta CDR planned for early August.
- Held Transponder status review at L3-Com on July 12
- Held Solar Array CDR at COI July 13th
- Held RCS CDR closeout meeting at Aerojet July 14th
    - A number of issues still remain open pending Thermal Subsystem rebaseline
- Further developed schedules for
    - EGSE
    - Harness
- Began Thermal Flight Cable Hardware Procurements
- Began Probe 1 Structure Manufacturing
    - Completed composite Skins for Probe 1
    - Completed a number of inserts
    - Completed consolidation of Solar Array blank panels
- Began manufacturing of BAU EDU
    - Processor Board
    - Communication Module
- Held Technical Interface Meeting with NMSU-Physical Science Lab on Sband Antenna
- Swales provided an updated Subcontract pricing status to UCB

2.0 WBS 2.2.1.2 SYSTEMS ENGINEERING

- Supported Solar Array CDR at COI
    - Reviewed Top, Side, and Bottom panel designs
    - Reviewed solar cell design (presented by Spectrolab)
    - Held reviews of Solar Array Spec and Solar Array Magnetics Test Plan

- Supported ongoing subsystem activities
  - ACS
    - IRU assembly and mounting design
    - Thruster safing design meeting
    - ACS Algorithm Description document review
    - Reviewed IRU Assembly Test Plan
    - Reviewed new rev. of Sun Sensor Spec
  - Comm
    - Reviewed antenna thermal environment and provided input and comments on ongoing thermal cycling and defined operational limit
    - Reviewed transponder EMI specification, and requested modification to match latest revision of Env. Design Spec.
    - Visited L3-Com on June 12 and extracted further mass reductions
    - Comm subsystem meetings
  - C&DH
    - Held Probe bus closeout design meeting (with Contamination, Mechanical, and Thermal)
    - Incorporated further BAU wall thickness reductions based on GSFC Radiation analysis
    - Revisited BAU temperature limits
  - FSW
    - Reviewed LM functionality
  - Harness
    - Harness subsystem meetings
    - Worked wiring requirements
  - I&T
    - Reviewed I&T Plan
    - Worked Verification plans
  - Mech
    - Top deck local temperature exceedences
    - Coupon failure evaluation
    - Shunt location
    - Set target spin rate to 16+/-2rpm
  - Power
    - Solar Array top/side/bottom power analysis, inc. shadows.
    - Power subsystem vendor telecons
    - Working panel magnetic calculations with COI/UCB/UCLA
    - Power Management Tool development
    - Wrote S/A Magnetics Test Plan and Procedure
  - RCS
    - RCS Safety impacts
    - Investigating splitting RCS secondary heater circuit for 3rd year operations.
    - RCS line heater wrapping issue resolution
    - Reviewed Propellant Off-Load Plan
  - Thermal
    - Weekly thermal analysis reviews in preparation for Thermal delta-CDR

        - Investigated alternate thermal control devices (louvers, thermal switches)
        - Investigated expanded temperature ranges for BAU and Transponder
        - Top deck hot spot resolution
        - Updated slew-burn-slew time and power profile
        - Finalize Operational and Test Limits
        - Assisted in Thermal-Probe ICD
    - Safety
        - Got agreement from UCB to reduce repressurant system pressure to guarantee a Class B system.
        - Completed EWR tailoring of Chapters 1 and 6
        - Worked System safety, focusing on causes, inhibits, and controls
        - Worked Safety Deliverable Documents Schedule
        - Worked Hazard reports
        - Continued Range Safety Requirements Tailoring Effort

- Tracked and closed Bus PDR and Mission PDR RFA's
- Tracked, wrote, and/or closed Peer CDR Review RFAs
- Tracked, wrote, and/or closed CDR RFAs
- Supported Leads in generating responses for Peer Review RFAs
- Created inputs to ODA Rev A, in CM for release
- Reviewed Preliminary Magnetics Test Plan for Solar Arrays (to be used as baseline for S/C and other subsystem Mag. Testing)
- Worked harness bakeout decision
- Worked solar array magnetics analysis
- Supported Probe closeout design meeting
- Determined worst-case sun angles for probes following deployment from the PC
- Updating THEMIS Verification Plan & Environmental Test Spec

3.0 WBS 2.2.1.3 LAUNCH VEHICLE INTERFACE

- Supported biweekly telecons with KSC mission manager
- ELV separation status
- Investigated PC mounted cameras to record separation.
- Worked fairing door definition.
- Supporting GSFC TLX contract definition with Boeing and KSC
- Worked second revision to Interface Requirement Document (Payload Questionnaire)
- Provided agenda information for items / issues to be discussed for trip to Astrotech / Pad.
- Worked LV Ground Operations Plan

4.0 WBS 2.2.1.4 LOGISTICS AND PLANNING

- Completed subsystem schedule reviews and continue update to integrated schedules
- Incorporated Harness Schedule
- Re-baselined the BAU schedule with subsystem Lead

5.0 WBS 2.2.1.5 DESIGN REVIEW

- Independent Swales Reviewers supporting Thermal delt CDR

6.0 WBS 2.2.1.6 QUALITY ASSURANCE

- Supported Reviews at Aerojet & COI
- Further developed THEMIS WOA data base and performed internal training
- Supported Processor Board EDU testing.
- Continue supporting electrical lead in selection of EEE parts

7.0 WBS 2.2.2.1 GN&C SYSTEMS

Attitude Control Subsystem

- Derived generalized equations for out-of-plane boom oscillation modes
- Designed IRU rate filter for nutation detection
- Wrote MSPSP ACS subsection
- Created spreadsheet of ACS fault identification and response
- Wrote Thruster Safing Plan
- Wrote IRU Assembly Test Plan
- Computed PCA mass properties for the LV spacecraft questionnaire
- Computed LV + PCA nutation time constants for the LV spacecraft questionnaire
- Wrote draft Rate Sensor Processing & Sun Sensor Processing Algorithm Descriptions
- Refine separation analysis parameters

REACTION CONTROL SUBSYSTEM

- Held CDR Closeout meeting at Aerojet
- SAI-TM-2602 Issued to address Safety Review RFA-006, Classification of RCS pyro-valve actuation as Category B, and reduced helium charge.
- Enhancement of RCS Performance RCS System Specification SAI-SPEC-1088 Revised to include re-press feature.
- Aerojet Status
    - Procurement on baseline program continues on schedule
    - Conducted CDR closeout meeting. A number of outstanding issues remain open particularly in Thermal and component Random Vibration loads.
    - Supported Magnetic Testing of components at UCLA
    - Held review at Check Valve vendor with Swales and GSFC support
- ARDE Status Summary
    - ARDE is Maintaining Schedule, No Issues
    - Completed all the major steps in manufacturing of the Qualification tank through final heat treat.
    - Complete the Qualification tank test procedure and sent Swales for Review.
    - Started fabrication of Qualification Tank

8.0 WBS 2.2.2.2 S/C ELECTRICAL AND AVIONICS SYSTEMS

- Bus Avionics Unit development (GDDS)
  - Processor board EDU #1 delivered to flight software
  - Processor Board EDU#2 manufactured and awaiting Test Fixture validation
    - Swales has requested that GDDS send the second test fixture to Swale so that we can move forward with the Communication Interface Module (CIM) and DPM integration
  - CIM EDU #1 completed and will ship to Swales first week of August
  - CIM EDU #2 in manufacturing
  - Completed the first IDPU/DPM interface test
  - BAU Module Level
    - Created BAU interconnect
    - Moved signals from interboard connector to backplane to reduce required PB area in power modules
    - Performed flex circuit layout
    - Working with plating suppliers to meet UCLA magnetic requirements.
  - Power Modules (PCM, ACM, PRM)
    - EEE parts review completed, Material Quotes in process
    - PCM-Schematics & Net List complete, delivered to Swales for review
    - ACM- Schematics & Net List 95% complete, ECD 8/10/04
    - PRM
      - Schematic & Net List 90% complete, ECD 8/13/04
      - Modified connector placement complete, sent to SAI 7/24/04
      - Parts placement complete and in Swales review
      - PWB Area concern considering separate DC/DC Converter PWB

- Power subsystem
  - Battery Spec Revision completed
  - Performed updated Power Analysis and presented at Thermal Review
  - Lab Battery shipped to Swales
  - Reviewed CDR/MRR materials from AEA Technology
  - Solar Arrays
    - Held CDR/MRR at COI on July 13
      - Currently working off RFAs
    - Revised magnetics analysis and working with Bob Snare of UCLA to further refine
    - DVT Cell production has started
    - Swales shipped DVTs substrates to COI

- Communications Subsystem
  - Transponder Specification Rev B in sign-off
  - Released Transponder ICD Rev 5
  - Started kitting of transponder parts
  - Successfully completed thermal cycling test of stacked patch antenna.
  - Completed first stacked patch antenna with grounding pin

9.0 WBS 2.2.2.2.3 FLIGHT SOFTWARE

- Boot Software (Pre RFA11) loaded and executing on Processor EDU
- Modified Boot Software to include test capabilities not delivered with EDU
- Supported IDPU test with UCB/Swales
- Participated in IV&V telcons, and responses to IV&V issues
- Flight Software Build 1 Commands and Telemetry are received/generated between commercial CF board (Build 1) and ITOS via Ethernet.
- Began ITOS-based Build 1 FSW testing.
- Configured and ran PC-Lint tool against Flight Software (ongoing)
- Continued population of Caliber-RM database
- Participated in various Technical Interchange Meetings
- Continued development of FSW Requirements Testing Matrix
- Supported Bi-weekly Mission Ops telcons
- Incorporation of GSFC code 582 delivered tools and source debugger
- Supported ACS Algorithm Definitions Document Review
- Attended FLATSAT Phase 1 Design Review

10.0 WBS 2.2.2.3 MECHANICAL SYSTEMS (PROBE)

Systems Support

- Submitted proposed EWR-127 Chap 6 tailoring inputs to safety
- Submitted response to CDR RFA #2

Sub-System Support

- Supported design effort for side, bottom and top solar arrays
- Supported thermal design trades
- Performed evaluation of the impact of extremely hot and cold temperature limits of probe structure
    - Qual limits of solar panels are approx. –120 to 100 C
    - For bottom, qual limits are approx. –60 to 70 C
    - Qual limits of top panel are approx. –96 to 115 C
    - Wider limits are a development program
        - Potting temperature range
        - CTE effects
        - Tg of adhesives
        - Cure temperature
    - High conductivity fiber (K13D2U) doublers likely unfeasible
        - High modulus and low compressive strength will probably cause failure
    - Feasibility of thick VDG unknown
    - Suggested thermal mitigation to reduce peak temperatures to 100 C.
- Sent fill drain bracket to Aerojet for approval
- Created and circulated preliminary shunt layout
    - Added co-cured inserts to bottom panel design
- Produced and delivered EO to ARDE propulsion tank ICD
- Reviewed I&T plan and provided mechanical comments
- Released side, top and bottom solar substrate ICDs

Structure Design and Analysis

- Released all remaining insert drawing
- Released RCS fill/drain bracket drawing
- Released corner panel stiffener and clip drawings
- Released side solar substrate assembly drawing
- Submitted Top and Bottom solar array substrates for release
- Submitted draft of Bottom Deck Assembly to checking

Structure manufacturing / I&T support

- Manufactured flight solar array substrate facesheets
- Consolidated solar array substrate blank
- Manufactured flight bottom panel facesheets
- Thermal cycled first batch of structural coupons
    - Experienced failure of CTE lap joint specimen
        - Facesheet compressive failure
        - ·The edge distance of coupon was insufficient and there were high stresses at the free edge.
        - Approach for insert CTE stress analysis assumed that room temperature was the zero stress state of the insert potting (Lord 4688). Revised approach is to use glass transition temperature of the material (65° C) as the zero stress state.
        - Based on results and investigation made decision to change in insert material to Titanium
- Changed affected drawings to titanium and released
- Placed re-designed titanium inserts into Swales machine shop for fabrication
- Thermal cycled and inspected box simulator CTE mismatch coupons
    - No indication of structural degradation
    - Approximately 30% loss of fastener preload
    - Evaluation ongoing to determine whether caused by cycling or Ultem creep
- Performed pull and shear out tests of co-cured insert samples
    - Measured values exceed allowables used in analysis – no further action needed
- Shipped DVT #2 panel to COI.
- Produced preliminary layout for bottom panel assembly tool
- Initiated activity with Swales material engineering to characterize potting material for panel construction.
- Updated development test plan to include additional top deck insert coupons.

MGSE

- Created preliminary design for Probe assembly fixture

11.0 WBS 2.2.2.4 THERMAL

- Thermal Design
    - Assessed feasibility of achieving high performance MLI e-star of 0.01
    - Verified BAU and Xpdr minimum operating temperatures.
    - Verified ULTEM 1000 and 2200 isolator conductivity

- Modified RCS thermal design.

- Thermal Model/Analysis
  - Integrated detailed RCS model from Aerojet
  - Created detailed Harness Models and integrated with s/c model
  - Created detailed Bracket Models and integrated with s/c model
  - Updated Internal and External Geometry models.
  - Increased Top Deck model resolution. Included titanium tank inserts.
  - Thermal Analyses performed
    - Flight Cold Cases: 15°SAA, 90°SAA, 170°SAA:
    - Flight Hot Cases: 10°SAA, 30°SAA, 77°SAA, 103°SAA, 135°SAA, 170°SAA
    - Slew-burn-Slew: 90°-10°-90°
    - Launch Cases: Second Stage Aero Heating side to sun, corner to sun, top to sun.
- Perfomed Solar Array shadowing analyses for Power Subsystem.
- Hardware
  - OSRs delivered
  - VDG on M55J UV testing finished.
  - New VDG coupon optical properties measured
- Supported Aerojet RFA closeouts via telecon July 14th.
- Analysis Status/Changes
  - New "smoother" VDG on M55J samples produce a/e optical measurements of 0.22/0.02 = 11. Thermal model has an a/e tolerance of >2 and <6. The higher a/e leads to hotter top deck temperatures. Implementing a low a/e conductive paint on local hot spots will alleviate overheating.
  - ULTEM 1000 vs ULTEM 2200 isolator conductivity
    - ULTEM 1000 has conductivity of 0.22 W/m/C while ULTEM 2200 has conductivity of 0.28 W/m/C. Mechanicals have procured ULTEM 2200 which if used will lead to a 22% increase in conductive heat losses, which in turn leads to higher heater power consumption.
  - Bottom Deck hot spot under shunt.
    - Mechanicals team will test bottom deck to a bulk temperature while testing the hot spot under the shunts locally.
  - Antenna exceeds cold temperatures during 170°SAA and Eclipse
    - New non conductive AXB tube is much colder than previous design which caused antenna to exceed cold temperature limits. Heaters, thermostats and MLI blankets required to keep antenna within limits.
  - High Performance MLI e-star:
    - Because of tight clearances around RCS tanks, an effective emissivity of 0.01 should be a goal instead of a requirement. An e-star of 0.02 is used in the thermal model for conservatism. Actual e-stars will be measured during an independent thermal vacuum test. A sensitivity analysis will be performed to show heater powers for blanket e-stars up to 0.05.
  - RCS thermal design changes
    - Baselined Bolted ULTEM isolators on lines and valves.
    - Baselined Copper tape on fuel lines

- Baselined MLI blankets on lines
- Preliminary sizing on heaters provided to Aerojet
- 10 heater zones
  1. Tank 1
  2. Tank 2
  3. Fuel Line 1
  4. Fuel Line 2
  5. Repressurant zone
  6. Service valve zone
  7. Thruster A1
  8. Thruster T1
  9. Thruster A2
  10. Thruster T2

12.0 WBS 2.2.2.5 PROBE BUS I&T

VSat I/O interface: (Hammers Company)

- Continued Integration of Framework and Analysis Models
- Delivery of command-line interface application for use in EDU testing

ITOS and FSW Development Support (Hammers Company):

- Continued updating Command and Telemetry databases for Build 1 testing
- Continued organizing data for the ITOS command and telemetry database, pages, and procs.
- Continued Began text page displays using UCB standards.
- Continued Graphics Development of various ITOS components
- Began Web-based FSW Status tracking

13.0 WBS 2.2.4 PROBE CARRIER & SEPARATION SYSTEM

Probe Carrier Structure

- Released Probe A adapter and deck drawings
- Released PAF ring drawings
- Release strut and clevis fitting drawing
- Placed order for Probe A adaptor
- Completed preliminary layout of initial 18 in of TLX lines
- Finished evaluation of 3rd stage interface load peaking issue
  - Local high flange stresses and bolt loads
  - Adjusted Swales side to eliminate problem
    - Increased flange thickness
    - Change to EWB bolts
    - No significant change to PCA stack height
  - Preliminary evaluation indicates positive margins in Boeing PAF ring
    - Needs to be confirmed by Boeing

Separation system

- Performed fit check of separation system
  - Identified some needed changes
  - Sent out all affected separation system parts for rework
  - Received updated parts
- Experienced excessive friction on fitcheck
  - Identified concern about excessive friction coefficient of shoe coating
  - Pursuing coating options
- Completed calibration of bolt force sensors
- Prepared drafts of development installation and functional test procedures
- Reviewed proposed Boeing TLX system SOW and provided comments
- Finalized design of Invar base plate simulator
- Completed final detailed analysis of separation system deployment test setup

14.0 WBS 2.2.5 MISSION INTEGRATION & TEST

- Continue to support UCB on I&T Planning
- Nearly complete on I&T plan

II. ANALYSIS OF WORKED PERFORMED

1. WBS 2.2.1.1 PROJECT MANAGEMENT

UCB/Swales Subcontract

- Swales received increase funding this last period through end of September 2004. As stated in the previous monthly report Swales requests that we be provided quarterly funding so that there is no interruption of subcontracts and procurements.
- A number Modifications will need to be added to the contract:
  - Processor Board
  - Re-Pressurization (Submitted but to be revised)
  - Launch Date Change & Additional Test Program
  - Descope of Test Facilities (moved from Swales contract to direct from GSFC Explorers Office)

1.1. SIGNIFICANT PERSONNEL CHANGES

- No significant changes this period
- Swales is currently interviewing candidates for the Electrical Systems I&T Lead position. Additional changes are under consideration to address the schedule challenges being posed by the BAU development.

1.2. CHANGES OR SCHEDULE / COST IMPACTS

1.2.1. BAU Processor Board (Replaces Customer Furnished Equipment)

GDDS informed Swales in early June of additional cost increases for the Processor Board EDU development and testing program. Swales has not received an official cost update. The total cost increase is $166K (total current estimate is $1,579,096 which is cost to Swales) and is predominately composed of difficulties with the EDU test fixtures and test setup, and additional systems

engineering design and tasks. This was a complete surprise to Swales and we are assessing how we should respond to this. However it is very important that we take receipt of the first EDU delivery and press GDDS to the fullest extent possible on working off all issues associated with EDU. There may be further growth in costs at GDDS if problems arise during the Processor Board EDU testing.

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1.2.2. Re-Pressure System Change ($985K)

Based on presentation on March 3rd and a follow up meeting on March 18th with UCB Swales was directed by UCB to move forward with the inclusion of a Re-Pressure system This change has been documented in System Change Notice (SCN) #8. Swales has received a Engineering Change Proposal from Aerojet and has issued a letter contract (limited funding $50K).

Swales sent a change proposal to UCB that captures this contract modification. One of the open items in this proposal was the down select for the check valve which was not finalized until early May. Aerojet has since updated the costs for this item (Solenoid Check Valve) and has sent Swales an update on pricing. The additional price for all Probes is $58,888 (cost to Swales). This pricing will have to be included when the modification to the contract has been completed.

1.2.3. Reaction Control System Requirements Changes

Aerojet has informed Swales that due to delay in the closure of the RCS ICD and a number of engineering changes in requirements and deliverables they are submitting a cost impact on THEMIS. The breakdown of these costs are provided below. Swales believes that this cost impact is justifiable and has authorize Aerojet to proceed. Further cost growth is anticipated due to further changes to the RCS thermal design.

RCS Changes		
1	Added Scope due to Requirements Changes	$82,869
2	Secondary Thermostat	$7,784
3	Arde Tank Tubes	$891
	Total	$91,544

1.2.4. Separation System Change to all Ordnance System

A discussed last period and following a meeting with UCB Management and Engineering at Swales on April 28th it was decided that the program will pursue a full ordnance system driven by the Launch Vehicle. Swales anticipates at least a $200K impact to the program (includes some sunk cost). This assumes that Boeing will supply the larger bolt cutter and performs all the design and implementation of the TLX ordnance system. The impact to the schedule is not anticipated to affect the critical path on the program since the separation systems are needed late in the I&T flow. The impact to the current separation system test program is significant and is currently being assessed. Swales has informed UCB that the test program will continue as originally planned awaiting the arrival of the

larger bolt cutters. This approach allows for the further reduction of risk on the program. A delta qualification program will be required for the larger bolt cutter system.

1.2.5. Solar Array Contract Scope Changes

Swales has received and Engineering change proposal from COI for the addition of the second DVT. This DVT was introduced to address a backup plan for the potential of thermally isolating the Top & Bottom Solar Array panels in order to save heater power. This isolation will drive the top and Bottom Solar Array panels colder (-160 to -180C) and beyond what has been proposed by COI. This lower temperature has not been demonstrated before for a statically clean array and therefore an additional panel has been procured and will be tested pending final results from the Thermal design. Swales has delivered to COI the second DVT and they will begin to lay down cells in mid August. Since there is a significant amount of testing performed on these panels which represents approximately 50% or the cost Swales will trigger the testing program in late August pending results of the Thermal analysis. Swales has directed COI to complete the second DVT through assembly. The current pricing for this effort is provide below.

Description	Qty	Unit Price
Assembly, Second DVT panel.		
Non-Recurring	n/a	n/a
Recurring Fabrication and Assembly	1	$47,542
Test, Second DVT panel.		
SPL Thermal Cycling and Performance Testing	1	$49,413
Total		**$96,955**

In addition to the second DVT the number of different types of Top & Bottom Solar Array panels has increased from 1 type to 2. This has been a result of the thermal design and packaging constraints on the top and bottom panels.

1.3. Long Lead Procurement

Long Lead procurement planning continues. Attachment 2b provides the latest detail schedule (derived from Open Plan schedule). Long lead procurement at Swales and all our subcontractors has been initiated. Swales continues to experience negative schedule trends in the Probe 1 structure and BAU EDU and flight units. The late delivery of the Probe Base panel and Solar Array substrates has resulted in negative slack on the Probe 1 RCS and Solar Array deliveries. All these items are discussed below.

1.3.1. ARDE Propellant Tanks

Hydrazine Tanks continue to maintain good schedule progress. All long lead materials have been received. The Qualification Tank has completed fabrication and was in final heat treat at the end of July. Testing of the Qualification Tank should be completed by the end of July. The Probe 1 flight tanks have completed

fabrication through final heat treatment. These tanks are schedule to be completed by mid September.

1.3.2. Aerojet Reaction Control Subsystem (RCS)

The RCS contract procurements are moving forward and the fabrication of Thrusters continues and is approximately 90% complete. The Baseline component procurements are approximately 70% complete and the Re-Pressurization component procurements are 50% complete. The longest lead item currently is the Check valve and is scheduled to be received for mid November 2004. The detail design of the plumbing and the verification analysis is proceeding. There has been some issues with the Thermal design (heater sizing and thermostats) and in the finalization of the component vibration levels. Swales and Aerojet are working this diligently. The critical path for this subsystem is the delivery of the Swales Base panel. The current panel delivery for Probe 1 is approximately a month later than the original schedule. Swales is pressing Engineering and Production to expedite the schedule by working extended shifts and working weekends. Aerojet will be implementing subassembly fabrication by the use of a Base panel simulator in attempt to reduce the cycle time once the flight panel arrives. This has been already been accounted for in their schedule. At this time Swales has not been able to identify means of recovering this schedule.

1.3.3. Probe Primary Structure

Probe 1 Primary Structure long lead procurements consisting of composite prepreg and core have been all received at Swales. The Primary Structure schedule has been reviewed in detail in the last two months to assess the potential of accelerating the schedule. This schedule is composed of the following primary phases:

1.3.3.1. Detail Design Phase (Post CDR)

A number of items have been worked off this last period that have been delaying the release of the Base panel drawings and tooling. The BAU and IDPU foot prints were resolved in late July and early August. The Reaction Control interfaces that have an affect on the Base Panel are near resolution. The RCS ICD is still in process. Swales and Aerojet have completed all items that have impacted the critical path (base panel). The re-pressurization system definition is near complete barring any change to move up the pressurant tank to provide more clearance between the BAU and pressurant tank.

A number of issues that related to the thermal design that impacted the release of the structural drawings was resolved this last period. The elevated temperature issue discussed last period has been resolved by adding more fidelity to the Thermal model. At of the end of July it was determined that a number of changes being considered such as the addition of a louver and or thermal lenses have been abandoned as result of the Thermal Tiger team effort. The Mechanical team is proceeding with the CDR design and it is expected the Base Panel and Top panel assemblies will be released in August.

During July we experienced a coupon test failure of one of the Base panel test coupons. This coupon represented the large aluminum boom interface ring. Based on a thorough failure investigation (report provided to UCB) it was determined that several changes had to be made to a number of inserts (changed from aluminum to titanium). In addition several other inserts and changes to the final panel preparation had to be made. This required a re-ordering and machining of parts which had an approximately a two week impact to the program. This has been captured in the attached schedules.

1.3.3.2. Procurement & Piece Part Inspection Phase

Other than the new inserts discussed above all the Group 1 and 2 inserts discussed last month have been received and are in stock. The group three inserts are scheduled to be completed in late August and the new group representing the new titanium parts are expected to be received in mid September. All these parts have been expedited by paying the vendors premiums and or machining these parts in-house.

The critical path for the Probe 1 structure has migrated from the inserts to the tooling design and fabrication. The main emphasis is on the Base panel tooling which is the most complex tool and has the longest lead time. Swales has estimated the lead time of 6 weeks (out sourced due to size). We will attempt to expedite this by placing incentives on earlier delivery into the subcontract.

1.3.3.3. Panel Fabrication and Consolidation (8 weeks)

This phase consists of the fabrication of skins, consolidation of panels, coupon testing, and inspections (100%). The Swales manufacturing organization has detailed this phase of the fabrication cycle in great detail based on similar builds (1800 Lines). Typically this production will be performed on a goal driven basis with work shifts typically extended into second shift and into weekends in order to meet the stated schedule. Therefore currently Swales does not believe this schedule can be accelerated however once drawings have been released and production planning is in full swing a re-assessment will be performed.

1.3.3.4. Primary Structure Fabrication (8 weeks)

This phase consists of receiving all of the 14 panels and numerous piece parts (battery shelf, thruster brackets, pressurant tank supports, etc.) and assembling all the parts. This fabrication cycle also includes the addition of the transponder radiator which requires the bonding of Optical Reflectors (OSRs). This process requires room temperature adhesive cure time. This was an oversight in the previous schedule and has lengthen the schedule by 7 days.

Due to the optimization of the Probe structure mass this build up is extremely detailed and requires intensive concentration by the engineers and assembly technicians. There is significant match drilling that goes on in the assembly of the primary structure (Solar Array Substrates to other panels) which must be done cautiously so that a mistake does not occur resulting in a schedule setback to the program. Typically this production will be performed on a goal driven basis with work shifts typically extended into second shift and into weekends in order to meet the stated schedule. The schedule has also been updated to add the Optical Reflectors (OSRs)

Therefore currently Swales does not believe this schedule can be accelerated however once drawings have been released at CDR and production planning is in full swing a re-assessment will be performed.

1.3.3.5. Probe 1 Testing Phase (8 weeks)

This phase includes the installation of mockups, the reassembly of the structure, thermal cycling of the structure, shipment to GSFC, acoustic testing (added to validate component levels) strength testing, ship back to Swales, disassembly of the structure and the removal of the mass mock ups, full inspection of the panels and prep of shipment of panels to the RCS vendors. Again as with the previous phases the schedule will be goal driven with extension of shifts as required (8-12hrs). The exception of this is structure thermal cycling which is typically done around the clock. The current schedule is aggressive and is contingent upon testing facility availability and therefore Swales does not at this time anticipate any reduction in this schedule. In the past month we have re-assessed the thermal cycling test time and have reduced this from two weeks to one week. This change has been masked in the new schedule due to the delay in the panel assembly drawings.

1.3.4 GDDS BAU Status

The current critical path for the BAU has migrated from the Processor Board to the Power Module and Communication module. The first Processor Board EDU has been delivered which is a significant milestone. Testing has been started at Swales and we have scheduled a second interface test with the IDPU EDU in mid september. The Communication Module EDU #1 was received in early August and is in testing.

The Power Module design has been delayed by late System design changes (TLX, additional safety inhibits). Bread board circuits have been built and tested to reduce risk associated with the design. Swales has delivered design packages to GDDS this last period. GDDS has begun translation of these schematics and has completed or near completion on the Controller and Solar Array cards. The regulator card layout study indicates that some circuitry will need to be moved. GDDS and Swales are assessing alternatives and will present this to UCB in mid August. This will place further pressure on the BAU schedule.

1.3.5 Separation System

All of the long lead parts associated with the Separation System ETU baseline design (without TLX) have been received. A fit check has been completed and as a result of this several parts have been modified and received. The TLX change required changes to three parts and all parts have been placed on order. The lead time of the booty cover mentioned last period has been reduce by meeting with the supplier and simplifying the design.

1.3.6 Transponder L3-Com

A status review was held at L3-Com in July. The current critical path item is several PWB heat sinks due to the change in material to save mass (CDR action item). The Diplexer still remains on the watch list. L3-Com will begin assembly in mid July short some of these parts.

1.3.7 Sun Sensor ADCOLE

The Sun Sensor procurement remains on schedule with significant progress this last period. Status is as follows:

- Reticles have been received. Inspection is in process.
- Adcole has reviewed the data supplied by the Solar Cell manufacturer
- All EEE components have been received.
- A purchase order has been placed for the modified Electronics PC Board. The ATC PC Board layout has been approved by Adcole. Projected delivery is early September 2004. Adcole expects to send the PC board coupon to Swales the week of 8/16.
- Solar Cell PC Boards have been received.
- Flex Cable assemblies have been received.
- Housing/Rear cover machining is complete. Inspection/finishing operations are in process.
- Baffles are on order. Expected receipt, August 2004

1.3.8 Battery AEA Technologies

AEA Technology has begun long lead procurements and has completed the Lab battery fabrication. The lab battery will be used to start Flatsat activities. The EM battery will be used to start I&T activities and the Qualification battery will be used for Probe 1 testing including environmental testing. This approach saves some money on the program since the flight battery would have to be delivered earlier requiring separate assembly and testing programs for the flight batteries. A review will be held at AEA Technology in early August where a further assessment can be made of the flight battery schedule.

The Battery effort is moving along smoothly with no major hiccups. The DCR was delayed until mid-August due to conflicts in schedules with Swales and AEAT personnel. An updated electrical analysis shows good margin for 3 hour eclipse case with updated load profile (minimum voltage = 26V EOL with conservative battery fade.).

1.3.9 Antenna New Mexico State (Prototype)

At this time a contract has been awarded to produce two Prototype antennas Swales has completed thermal cycling of the stack patch antenna and the test results were positive. The second element (single) was characterized for ESD coatings. Swales has finalized the scope of the Prototype and flight builds. The prototype antennas are expected to be delivered in mid August. Swales has reviewed the NMSU and we have suggested several changes which NMSU is incorporating.

1.3.10 Solar Array

COI has made good progress on the Solar Array design. COI has presented an update schedule which indicates the pacer to the schedule being the delivery of the flight substrates. Swales will be working with COI in the next couple of months to ascertain a reduction in the Solar Array cycle times.

The Solar Array CDR at ATK COI went very well with 9 RFAs generated, many of them for SPL concerning adhesive and test clarification. Panel designs are now frozen with only "small" changes due to magnetic cleanliness requirements. ATK COI generating comprehensive magnetics analysis using Matlab. Model verified with UCLA. Magnetics requirements will be difficult to meet. Second DVT panel quoted for cold testing (-180C) for thermal design risk mitigation.. Slight schedule slip due to coverglass availability (SpectroLab issue).

1.4. INTEGRATED SCHEDULE STATUS

1.4.1. GENERAL SCHEDULE

Swales is meeting each week (Fridays) with UCB and Bob Miller (GSFC) to discuss schedules. The meeting is to focus on Critical Path items. A schedule review will be held on August 19th to discuss all subcontract schedules and critical path items.

1.4.2. MAJOR MILESTONE AND CRITICAL PATH SCHEDULE

Enclosure 2a contains the major milestone schedule. The specific direction from the schedule reviewers at GSFC in March and subsequently included a full up Magnetic testing and EMI/EMC testing on Probe 1. In addition it has been requested to constrain the start of Probes 2-5 instrument integration based on the completion of Probe 1 through environmental testing.

Enclosures 2b and 2c provide the critical path schedules for Probe 1 Mechanical and BAU respectively.

1.5. RISK MANAGEMENT STATUS

Enclosure "0407_Risk_Status.pdf" provides copies of the Top Risks, Stoplight, and Risk Exposure reports for the last period. Closed two risks this period: ID#14 "Antenna Polarization" was closed based on recent TIM with NMSU-PSL, where the presented analysis results and test data showed acceptable performance, for both stacked patch and side-by-side; ID#19 "Late change in RCS System design (SCN008)" has become a problem, and as such is now moved to the weekly schedule meeting action item list. Risk ID#11 was greatly reduced in likelihood based on post-CDR analysis presented on 7/23/04 that shows that all panels will provide adequate margin to cover minimum probe operations (10.5W for BAU/Xponder) plus heater power in all attitudes. The two new risks have actually been in the system for many months, but are now in the top-ten list since there are only ten open risks at this time.

2. WBS 2.2.1.2 SYSTEMS ENGINEERING

2.1. RESOURCE MANAGEMENT

Enclosure "Themis System Resources Jul04.pdf" provides the latest Mass and Power status for the Probe and Probe Carrier systems. Small changes in several areas resulted in a 0.24 kg decrease in the Probe Bus estimate, as noted in the comment column. The mature estimate exceeds the allocation by 3.49kg.

Probe Carrier mass has increased due to several post-CDR design changes, the largest being the PAF interface issue. The remaining increased are documented in the Comment column. The new mature estimate exceeds the allocation by 1.94kg.

The thermal heater budget is in flux at this point, and thus has not been changed since last month.

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2.2. SYSTEM ENGINEERING ISSUES

- The Probe Mass allocation is still below mature estimates. Swales continues to refine the mass estimates as data matures. A new assessment of harness mass will be performed in August focusing on design maturity.
- The Magnetic stability requirement mentioned last period of 0.1nT imposed by UCB remains a challenge to the Probe design. The impact to compliance has not been fully captured and the methodology of verification needs to be worked further by all members of the team. The biweekly meeting on magnetics, led by UCB, continues to address magnetic compliance and design. Issues of vendor testing for Aerojet need to be addressed.
- Magnetic signature of the Solar Panels currently exceeds the requirement and needs to be resolved. This is being worked with COI and UCLA and will be addressed at a meeting at COI in late August.
- Thermal design is extremely challenging. Model correlation will be most difficult to perform in the TV chamber and the required space environment simulation GSE has not yet been located. The Swales Tiger team is currently addressing all issues associated with the Thermal design and this will be addressed at the delta CDR in early August.
- UCB has agreed to implement sun angle restriction of +Z axis ± 10 deg to provide additional trade space for the thermal design. This issue is resolved.
- The repressurization system maximum operating pressure has been reduced to permit a safety classification of grade B at the expense of approximately 1% of dV. This issue is resolved.
- Potential hot top deck is no longer above 115°C, and is resolved.

2.3. INSTRUMENT ICD & INSTRUMENT THERMAL MODELS

- Swales has received Instrument ICDs which have been updated and issued for CDR
- Update Instrument Thermal Models have been received and have been inserted into the Probe models.

3. WBS 2.2.1.3 LAUNCH VEHICLE INTERFACE

- Boeing provided bolt cutters and matching SMDC line including final installation positions this last period. All TLX component required for the ETU program have been placed on order. This issue has been resolved.
- Boeing recently stated that theydesire a separation wire placed within the separation bolt cutter area. Swales has stated that there is no plan to do this (it is not in the

current test program) and further that this has not been done before as far as we know. Swales has requested further information from Boeing and is investigation design implementation. This will have to be discussed further at the upcoming Launch Vehicle meeting.

- Two Doors is the baseline. Decide on location of doors either to be centered on the connectors for easy electrical access or sacrifice some access to the connectors to provide access to Probes B and E fill / drain valves.

4. WBS 2.2.1.4 LOGISTICS AND PLANNING

- Conversions from Open Plan to Microsoft Project continue to be an issue

5. WBS 2.2.1.5 DESIGN REVIEW

- No issues at this time

6. WBS 2.2.1.6 QUALITY ASSURANCE

- No issues at this time

7. WBS 2.2.2.1 GN&C SYSTEMS

- RCS ICD has been delayed due to Base panel not being finalized and thermal design issues. It is expected that we will complete closure of all action items by the end of August.

8. WBS 2.2.2.2 S/C ELECTRICAL AND AVIONICS SYSTEMS

- Bus Avionics Unit development schedule is the highest risk schedule item and is discussed above, in the management section.
  - There continues to be significant delays in completing the schematics translations. Swales is turning around redlines as quickly as possible.
  - The module test fixture design and fabrication has gone poorly at GDDS. We are pressing GDDS to complete the validation testing of fixture #2. A third fixture will be placed on order so that we can test two EDUs in parallel.
  - Regulator card layout issues are being worked by GDDS and Swales. A number options are being considered such as adding a slice and or moving battery relays out of the BAU. A decision will be made in mid August after completion of a new packaging study performed by GDDS.

9. WBS 2.2.2.2.3 FLIGHT SOFTWARE

- FPGA problems found in Processor Board EDU:
  - External clock not connected to UART. This means that UART Port 2 cannot be operated at the required rate of 38.4K baud.
  - Processor EDU requires numerous resets and restarts after being powered-off for an extended time period.

- DMA bugs found in Coldfire Processor, requiring FSW workaround
    - Yet another increase in the amount of interrupts to be handled by FSW

- Impact of providing only one complete BAU EDU will be a severe impact to FSW testing and delivery.

- Under present design assumption, Flight Software will need to handle more than 200 interrupts per second to meet downlink and other requirements. This may exceed 75%, CPU utilization, and have other adverse effects on operation.
    - Strongly suggest that 2, 4, or more Transfer Frames output to downlink per interrupt. This will reduce interrupt overhead.
    - Strongly suggest revisiting CPU clock speed.

- RAM sizing estimate is 82%, EEPROM is 75%, PROM is 80%. CPU Utilization is 75%

- Schedule required for Boot Software testing prior to delivery to GDDS

10. WBS 2.2.2.3 MECHANICAL SYSTEMS (PROBE)

- Key issues
    - Resolution of systems, electrical and interface issues that affect the Probe mechanical design and schedule
        - Thermal ICD updates
            - Bottom deck local hot spot under shunt?
        - RCS / repress system accommodation (Aerojet thermal/structural analysis finalization)
        - Location of propulsion line standoffs.
        - Demonstration of insert grounding approach
            - Thermal cycling of coupons
    - Effect of using higher Glass Transition Temperature in analysis
        - Currently showing negative margins in small inserts
        - Evaluating additional sample coupons to prove design to provide a sufficient statistical basis.
    - Possible negative margin on propulsion lines with updated loads
        - Not yet assessed by Aerojet
    - Detailed implementation of thermal design

11. WBS 2.2.2.4 THERMAL

- RCS model integration and Harness model were integrated into the detail Probe thermal model. Results will be presented at the delta CDR.
- Top deck local maximum temperature exceedances were resolved this past period.
- A Slew-burn-slew to minimum of 30 deg has opened the trade space and has been incorporated into the thermal design.

12. WBS 2.2.2.5 PROBE BUS I&T

- The detail I&T schedule developed by Marc Kaylor does not align with the UCB top level I&T schedule. Some of the test flows are assumed to be in parallel (i.e. Mass Properties Probe 2&3, 4&5) in the UCB schedule however this can not be achieved. Swales will provide an updated I&T schedule to UCB and GSFC on August 19th that addresses a number of these issues.

13. WBS 2.2.4 PROBE CARRIER

- Key issues
  - Harness routing approach and its impact on mechanical design and mass.
  - Potential impacts from packaging of additional electrical hardware (camera) on PC
  - Potential impacts from packaging of ordnance panel and TLX lines on PC
  - Effect of undefined components on spin balance and spin balance mass allocation
  - Pyro actuation uncertainty:
    - Size and mass of identified ordnance actuated bolt cutter
    - Increased pyro size plus rigid SMDC line will project more than 3 in further into envelope for Probe Deployment - Reduction in deployment clearance which was presented at the Mission CDR
  - Delivery of ordnance parts and debris booty
    - Debris booty was pulled back for bolt cutter dimension change based on final info from Boeing.
    - Awaiting final delivery schedule from vendor
  - Separation system shoe plating issue
    - Incorrect plating has much too high friction
    - Pursuing plating options

14. WBS 2.2.5 MISSION INTEGRATION & TEST

- Staffing and training of test conductors will be the major focus in the upcoming weeks.

III. PLANNED WORK

1.0 WBS 2.2.1.1 PROJECT MANAGEMENT

- Assign Thermal Design tiger team to address CDR actions and reduce heater power loads.
- Hold FSW Status review at Swales on August 19th
- Hold Schedule review at Swales on August 19th
- Hold Battery CDR/MRR at AEA Technology on August 9th
- Re-assess staffing needs for THEMIS Electrical organization and develop action plan.
  - Bring on STI to perform Power Module Analysis
- Complete contract negotiations with NMSU/PSL on flight SBand antennas
- Further develop schedules for
  - SBand Antenna

2.0 WBS 2.2.1.2 SYSTEMS ENGINEERING

- Continue supporting ongoing trade studies
- Make revision on THEMIS Verification Plan and Environmental Test Spec based on CDR Presentation Review, updated mechanical loads, and Post Thermal CDR Review (to be held 8/13/04).
- Continue system design documentation for fault management
- Further define system states for thermal / power and propulsion design, to remove unnecessary conservatism
- Document the Separation Subsystem Safety inhibit design
- Release Magnetics Test Plan
- Begin Development of Safety Compliance Checklist
- Resolve UCB support for SAI and our vendors for magnetics testing including Aerojet and L3
- Work on Magnetics allocation and test data reduction
- Complete RFA's from Systems Peer CDR Review
- Manage and status CDR RFAs
- Support Leads in generating responses to CDR RFAs
- Begin CPT System Level Plan
- Create implementation systems needs list
- Work on Battery Management Planning with Power and I&T
- Work thermal heater and thermostat location and wiring
- Work operation planning with UCB
- Work harness interface and wiring details
- Safety
  - Continuing support of each groups and meetings as needed.
  - Prepare Weekly Briefing for UCB
  - Write MSPSP Overview Sections based on CSR.

3.0 WBS 2.2.1.3 LAUNCH VEHICLE INTERFACE

- Continue Monthly Dialogs with KSC Mission Integration Manager
- Develop Launch Vehicle Meeting Schedule and Documentation Flow
- Continue work on Launch Site Ground Operations Document
  - Launch Site Operations Flow has been reviewed internally
- Work the details of TLX separation system with Boeing and KSC
- Get our hands on the Boeing provided bolt cutters and matching SMDC ordnance lines.
- Work Astrotech interface and plan for a facility tour
- Release 2nd revision of Payload Questionnaire
- Establish EGSE needs

4.0 WBS 2.2.1.4 LOGISTICS AND PLANNING

- Continue updating and refining schedules

5.0 WBS 2.2.1.5 DESIGN REVIEW

- Support Probe and Probe Carrier Peer Reviews action item closure

6.0 WBS 2.2.1.6 QUALITY ASSURANCE

- Support battery and solar array procurements
- Continue to work EEE parts selection with engineers
- Support PWB coupon testing at GSFC for Transponder & Sun Sensor

7.0 WBS 2.2.2.1 GN&C SYSTEMS

ATTITUDE CONTROL SUBSYSTEM

- Release purchase order for IRU
- Finish writing and release ACS software Algorithm Description Document (ADD)
- Write and release Thruster Plume Counter-Torque Analysis
- Close ACS CDR actions
- Perform stability analyses with updated mass properties
- Write and release Nutation Time Constant Analysis
- Revise and Separation Analysis Plan

REACTION CONTROL SUBSYSTEM

- MSPSP Submittal for RCS, including compliance matrix.
- Support Propellant Tank Qualification at UCLA & ARDE

8.0 WBS 2.2.2.2 S/C ELECTRICAL AND AVIONICS SYSTEMS

- Bus Avionics Unit development
  - Perform Processor EDU #2 testing
    - Implement changes to FPGA implementation to meet spec
    - Update EDU test software
    - Update Test Fixture design
  - Complete Comm board EDU #1 fabrication
    - Complete FPGA design
    - Complete test fixture
    - Perform design verification testing
  - Complete Power module design
    - Release schematics
    - Layout and fabricate EDU boards
    - Complete Power module FPGA requirements document
    - Develop test plan
    - Design and build test fixture
  - Finalize module interconnect scheme
    - Begin flex circuit layout
- Power subsystem
  - Power tool development
  - SAS design
  - Battery management rack design
  - S/A magnetic cleanliness effort

- Battery DCR
- Lab battery delivery
- Power analysis in support of thermal design

- Release Flight Harness design information, parts lists
  - Initiate procurement of flight connectors

9.0 WBS 2.2.2.2.3 FLIGHT SOFTWARE

- Complete Build 1 Testing with ITOS

- Continue Build 0 RFA 11 incorporation (CF5208) into EDU
  - RIO CIM Module emulation

- Continue Build 1 Phase B (CF5208) and BSP for installation into EDU

- Continue collecting updates for next release of FSW SRS

- Continue integration of VirtualSat Framework and Models

- Continue development of graphics components for ITOS

- Resolve Peer CDR RFA 6

10.0 WBS 2.2.2.3 MECHANICAL SYSTEMS (PROBE)

- Design Priority Schedule
  1: Detail Deck assembly drawings for manufacturing
  2: Release Solar Array ICDs
  3: Release IRU drawings
  4: Complete RCS ICD
  5: Detail Pressurant System Brackets
  6: Finalize thermal spacer drawings for Transponder, BAU, & separation ring

11.0 WBS 2.2.2.4 THERMAL

- Present Thermal Design at Delta CDR Peer Review
- Support Battery Meeting at AEAT
- Finalize RCS thermal design.
- Start Thermal Balance/Vacuum thermal models
- RFA's
- Generate Test Plans for
  - High Performance MLI e-star measurements
  - Interface conductance tests.
  - VDG on M55J humidity testing.
- Hardware Procurement
  - Thermostats

- Heaters
- PRTs
- MLI blankets
- Thermal Gaskets

12.0 WBS 2.2.2.5 PROBE BUS I&T

EGSE & ITOS

- Continue support of BAU testing
- Begin fabrication of EGSE harnesses as required
- Hold ITOS training session for Engineering team

13.0 WBS 2.2.4 PROBE CARRIER

- Define harness / electronics accommodation
- Continue work on packaging ordnance system
- Continue testing / evaluation of ETU separation system
- Continue detailed PC design and analysis

14.0 WBS 2.2.5 MISSION INTEGRATION & TEST

- Issue I&T plan
- Further develop resource planning documentation
- Further develop detail I&T work flows with UCB
- Support meetings at Solar Array and RCS vendor

Enclosure 1 Current Mass and Power Allocations (July 30, 2004)
(Enc 1 Themis System Resources Jul04.pdf)

Enclosure 2a Integrated Probe and Probe Carrier Schedule (August 11, 2004)
(Enc2a Integrated Probe & Probe Carrier 8-11-04.pdf)

Enclosure 2b Critical Path Probe 1 Mechanical (August 11, 2004)
(Enc2b CP1MechanicalRCS 8-11-04.pdf)

Enclosure 2c Critical Path Probe 1 BAU (August 11, 2004)
(Enc 2c CP2 BAU.pdf)

Enclosure 3 Risk Management CDR Presentation (July 30, 2004)
(Enc3 0407_Risk_Status.pdf)

Enclosure 4a Instrument ICD/Thermal Model/System Document Status (August 23, 2004)
(Enc_4_UCB_ICD_status_July 04.pdf)

Enclosure 5 THEMIS Document List (August 24, 2004)
(Enc 5 2004-08-24 Document List Status.pdf)

Note 533Ms supplied under separate cover

cc:
T. Ajluni with Enclosures 1-4
C. Lashley “
M. Cully “
R. Kraueter “
M. McCullough “
R. Zara “
R. Leboeuf “
M. Kaylor
JM. Haas “
S. Hammers “