Meeting: Team Engineering Meeting
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Author: APD
Date: 12 October 99 – 14 October 99
Those Present:
NRL: Clarence Korendyke, Charlie Brown, Bob Moye, Steven Meyers.
BU: Saad Mahmoud.
RAL: Jim Lang.
MSSL: Len Culhane, Alec McCalden, Chris McFee, Alan Smith, Wilf Oliver, Peter Coker, Rob Gowen, Tony Dibbens.

**Day 1**

**Introduction**

Len Culhane extended a welcome to everyone and best wishes were expressed for Matt. Everyone wished him a full and speedy recovery.
The possibility of Norway joining the team for software development was mentioned.

**MSSL Status**

The situation for the electronic design was presented by AJM in the form of an electrical block diagram dated 11 October 99. Approximately 70% of the spacecraft system is understood.
The ICU will adopt the Temic TSC 21020 DSP (an Analogue Devices chip made under license). This chip is made by an inherently rad-hard process and will be used with the Virtuoso real time operating system.

**BU Status**

There has been interaction with NRL on the design of the structure. The math structural model was sent to Japan in mid-August 99. The first pass of the Thermal model has been sent to Japan (1 week ago) and an updated model (50 Node) has had 1 test to date.
An autoclave has been ordered – expected delivery is mid-January 00.
A Clamshell PDF file has been received recently from CB.

**NRL**

A Requirements Review has been held with NASA (copies were made available today). In process of completing Phase A studies, Phase B is due to start in November 99 and there could be a 2 month extension to this phase.
The NASA PDR may now occur in May as opposed to March.
Conceptual designs of the mechanisms have been prepared and details of the shutter mechanism have been designed.
A full size print of the instrument drawing was tabled. This was an extremely useful reminder of what we were really there for!
There is a need to order optics now. A start has been made on looking at optical tests for EIS validation.

**Technical Status**

**Mass**

A version of the mass budget dated 5 August 99 was tabled. The Clamshell may be light on mass.
There was some discussion about what the actual mass budget actually was and who owns the margin.
**A 166** APD Confirm mass budgets and who owns the margin.

**Power**

Information from HH dated September 99 showed Solar B 10% over spacecraft budget. Pressure may be applied in the future on the power budget. A revised power budget has been prepared.

Currently it is believed that the power budget is 39W + 10W for operational heater + 10W for survival heater.
**A 167** AJM Clarify power budget.
The solar panels have been selected.

**Telemetry**
No particular problems. We understand the limitations of the telemetry and of the on-board data store. The average rate to ground for EIS is 8k bit/sec if we just have Kagoshima as the ground station.
**A 168** APD Chase TW/HH for translation of telemetry/Command Design Standards doc.

**Mechanical/Thermal Model – Interfaces**
SM presented a FE analysis of the proposed structure (2500 elements/nodes). The first resonance mode is at 49.26Hz, the second at 68.42Hz (both cantilever); third is at 86.13Hz and fourth at 105.49Hz (these 2 are skin deformation). This analysis is based on a rigidly mounted EIS. The lowest frequencies can be increased by the judicious application of mass in the form of stiffening ribs. An EM should be built and this can be vibrated with dummy masses. Interfaces still need to be defined before structure build can start. Also there is need for a lot of information/discussion on requirements and test levels. It was considered essential to know who the Japanese mechanical system engineer is and to be able to talk to him. There is also a need for a test philosophy and a scheme for understanding levels for qualification and acceptance testing.
The model philosophy needs to be made clear. Also the acoustic levels may be so high as to necessitate an acoustic test.
**A 169** CK Identify Japanese contacts from other US instrument teams.
**A 170** JLC Raise the issue of talking to mechanical system engineer with TK.
**A 171** APD Prepare a Proposed agenda for the December meeting.
Basic information has been supplied for the spacecraft vibration and its effect on the instruments at certain positions and centres of gravity.

**Thermal**
WTO explained the modeling work performed by Daniel Tye.
Predicted CCD temperatures for nominal radiator conditions were:

-18 degrees C to -42 degrees C for the Winter Solstice
-58 degrees C to -67 degrees C for the Summer Solstice

We need to specify what we need for defining the thermal environment.
**A 172** WTO Request better thermal information from Japan.
Information from CJM showed that the preferable operating temperature is <-50 degrees C, but the performance looks OK (signal to noise) at <-30 degrees C. Most other projects operate their CCDs at –60 to –70 degrees C.

**Mechanical Interfaces**
SM presented a general description of the mechanical design. It was proposed that the front door is redundant and its function is performed by the front door of the Clamshell.

Should the Clamshell doors be one shot or commandable? It was agreed that we would baseline one shot Clamshell doors.
**A 173** JLC Approach XRT on issues of front door or not.
It was suggested that the Clamshell be moved further inboard and fixed to the Strong Box. The inner door would then open into the strong box area. This design change would be subject to satisfactory thermal considerations.
It was confirmed that the support legs for the instrument are fixed as is also the position of the back wall of the Strong Box.
MSSL to provide a proposed layout for the MHC Box to SM. This needs to be integrated into the structure.
**A 174** AJM Provide layout of MHC Box to SM.
The interface of the radiator was confirmed as being at its end. A discussion was held about moving the ROE Box nearer to the rear wall of the Strong Box. This would shorten the cold finger. (If it were possible to move the rear wall of the Strong Box forward, this would also help).
**A 175** CB Investigate the optical implications of moving the ROE.
**A 176** CJM Check on CTI problem on ASCA

**Purging, Venting & Contamination**
A total accumulation of molecular contamination of 100Å or 250Å, depending on the wavelength, leads to a 10% drop in response. The TRACE requirement was 500Å . The main problem with molecular contamination is that if it becomes polymerized on the optical surfaces (by UV radiation), then it will not outgas.
Vent ports must be large enough to allow adequate venting speed to remove water vapour and other gases and consideration must be given to conductance paths towards these vent ports during the course of the design process. Vent ports must be designed to minimize back streaming/contamination during ground testing and in space.
Vacuum testing will require re-pressurisation of chamber by inlet of purge gas through the instrument in order to maintain cleanliness.
A lifetime contamination budget must be prepared and applied. Care must be taken to keep PCBs and cables away from the optics and all materials must be screened and certified. All sub assemblies must be conditioned (baked out at 100°C to $10^{-6}$ bar for as long as it takes) before integration. Conditions inside the instrument shall be monitored by the QCMs throughout the integration and test periods. Two QCMs have been budgeted for by RAL. W could put one near the Clamshell and the other near the Camera. It may be possible to use a cold finger to trap contaminants during testing.
**A 177** JL/CB Prepare a test/contamination presentation for December meeting in Japan.
The thin film filters for the Clamshell are made by bonding the thin film onto a supporting mesh with UV curing epoxy adhesive.
Drilling the carbon composite requires extreme care over stress relieving. There will be a need to seal edges. The structure will require regular bonding to ensure electrical continuity.
Bray 601 was the only lubricant allowed on FUSE.
Consideration should be given to the use of red-tagged evacuation ports for extra fast purge during testing.
Expect 60g of water from the structure during purge.

Some other points to consider:
What is pressure in shroud on take off?
**A 178** APD Ask HH what is pressure in shroud on take off.
Should pop off valves be used for over pressurisation?
What are light levels (detector is sensitive to visible light)
Witness optics – 2 in at least 2 positions in the instrument. One to be checked every so often and the other to remain for total dose assessment. NRL have a portable monitor for these witness plates.
The QCMs can measure temperature.

**Day 2**

**CCDs**
The requirements for 2 CCDs were discussed. The driver for this is that there is a need to cover a broad range of frequencies. The size of each CCD is 2k x 512.
CK gave a summary of the history of the mission.
There is no alignment available with the white light telescope, no adjustment in the legs of EIS, so any adjustment must be taken up inside EIS.
E/W misalignment can be accommodated in the coarse adjustment of the mirror, N/S adjustment has to done with length of slit and/or length of detector.
A discussion took place on the use of larger CCDs. Unfortunately EEV's yield goes down dramatically with increase in size and the cost to us rises dramatically.
There are 3 areas that make a major contribution to misalignment.
1. Primary mirror. 1 arc minute (2 arc minutes in error budget). Errors caused by mounting of mirror and any change in structure connecting mirror to grating.
2. Overall alignment of EIS versus alignment of visible telescope. No adjustment in visible telescope. 1 arc minute.
"Walking" of grating during vibration etc. 2 arc minutes.
This gives a total of 5 arc minutes of possible error.
NRL were asked if it would be possible to design the grating to accept a mechanism and only fit it down stream if it were found to be necessary? Costs for the larger CCD also need to be identified
**A 179** CK Look at cost and schedule implications for mechanism on grating together with a strategy for its implementation.
**A 180** SM Examine structural deformation at a range of delta T's.
**A 181** CJM Identify costs for larger CCD and examine possible defect positions and selection process.
A presentation on CCDs was given by CFM. A discussion ensued on pixel size. We need to look at the evaluation of CCDs for the SXI project to identify the best type of CCD construction for this mission. Currently we are working on a 20 ohm cm device with a 3.5um pixel (17um effective size).
Information on shielding was presented and this indicated that 15mm of aluminium would be need to protect the CCDs.

**Clamshell**
From Day 1's discussions, we have a proposal to have one shot Clamshell doors.
A pressure sensor needs to be fitted to the Clamshell and this must have a stable and absolute calibration. This sensor will need to be read with EIS switched off. It therefore needs to be powered by the spacecraft. The way to do this would be via an umbilical.
**A 182** MSSL Define and specify requirements for umbilical connections
**A 183** SM/CB Prepare a plan for managing the Clamshell during TV testing.
**A 184** APD Inform Japan that the Clamshell now has 1 shot doors.
It might be useful to have micro switches to indicate the status of the Clamshell doors, one switch to indicate partially open, the other to indicate fully open.

**Mechanisms/Heater Control Box**
The cable from the ICU could be up to 5m long.
We need to know how many heaters and temperature sensors there will be.
It was suggested that the mechanisms are powered from the 28V but with a power conditioner in the MHC. The development plan is to define the specification for the MHC and then task someone to build it.
The specification s for the mechanisms are fairly well covered in the Requirements Review for NASA.
**A 185** AJM Arrange for discussions on architecture of box to take place at NRL.
A discussion on temperature control came up with a figure of approximately 0.5 degree change over 10 minutes for the structure.
The number of nodes for the heaters was proposed as 16.

**Power Budget**
A chart for the power budget was tabled. There is an inrush specification.
The designs are at very early stages and the numbers were considered to be a very good first pass. Some minor comments were made.
The projected figures were not far from the budget figures originally provided.
A rationale for each of the items would be needed for further presentation of the power budget. There also needs to be some margin identified, as power usage usually goes up with time. Instead of average, use typical. Where we know actual figures, they should be included.
**A186** AJM Prepare a further issue of the power budget.

**Internal Electrical Interfaces.**
This covers ICU to both Camera and MHC. Temperature monitors, survival heaters and sensors and the pressure monitor should all be routed via an umbilical.
**Camera**
Connected to ICU via two IEEE 1355 bi-directional, high speed data links. Both CCDs will be clocked simultaneously and with this in mind, the power consumed by the ADCs may have been set too low.
Latency of the shutter movement with respect to the camera exposure should be considered. Perhaps the shutter should be controlled by the camera card.

**MHC**
Power and serial interface come from the ICU. There should be a monitor to the spacecraft for the launch lock, and the 4 Clamshell limit switches.
An arming panel has been introduced as a safety device for key mechanisms.
There is a possibility of using a spare Spacecraft survival heater (6W) attached to the CCD cold finger to warm it when not used. This will help prevent condensation.
**A 187** AJM Where will the survival heaters be positioned and what is their switch on philosophy?

**Spacecraft Interface.**
A summary of the Space craft interface was presented.
There is a need to request adequate shielding on the ICU to Camera flight cable, as this is being provided by Japan.
**A 188** AJM Obtain clarification about this cable build.
**A 189** AJM Clarification also needed on connecting to the 28V regulated bus.
**A 190** APD What is the purity of hydrazine used on the mission?

**Day 3**

**Preparation for Meeting With Melco**
Prior to the meeting an e-mail was sent to TW asking for a structure for the December meeting and a reply has been received. In the reply there is mention of first round thermal results being ready by the end of November with second round results being available by PDR. No mention is made of the structural model.
**A 191** APD Is further information or help required with the structural model.
In December there needs to be a complete definition of the way forward with this modeling.
Also in December there needs to be confirmation of hard wired items and signal timings etc.
**A 192** APD Prepare list of items for inclusion in the December agenda.
For PM testing, the aim is to be able to demonstrate the electronics and basic software operation. Simulators would be used to represent the mechanisms. It would be nice to be able to demonstrate a camera and shutter and the high speed serial link.
**A 193** APD Prepare a plan and schedule for targets for the PM.
There is a need to discuss umbilical requirements with Melco.
There is a need to supply a replica of our box to test the mechanical interface.
Plans need to be discussed for integration onto the spacecraft and any special MGSE required for this.
Confirmation/clarification of ICU to STR cable is needed and a replica will be required for EMC testing.
An Experiment Interface Control Agreement document is needed. (see also A 169 and A 170).

There was some concern expressed over how long documents take to be translated. Specifically Telemetry/Command Design Standards (not yet seen) and Electrical Design Standards (Revision not yet seen).
Suggest how we might move forward more profitably by regular communication.
Suggest that HH brings along a Melco representative to the next meeting in November.
Suggest an engineering meeting every three months with the Japanese team being a combination of ISAS and Melco. Supplement these meetings with teleconference calls.
**A 194** APD Prepare a summary of these 3 days including an item list for inclusion in December's agenda.
**A 195** JLC Encourage Lockheed and SAO to attend the November meeting

**EIS Components**
The EIS components development plan was presented by SM. This included a program overview, major milestones, near term objectives, project data deliverables and various areas of concern.
These were identified as Resolution of the NASA funding, EIS contamination control in Japan, instrument co-alignment on the spacecraft and other open technical issues. Phase B will almost certainly be extended by 2 months.
SM also spoke about the interaction with NRL and the fitting of the optical elements into the structure.

**EIS Structure and Clamshell**
The baseline concept for the structure has been established. Earlier in the meeting it has been agreed that there will be no front door and that the Clamshell doors will be one shot. There is also the possibility of moving the Clamshell to the Strong Box, thermal conditions permitting.
An autoclave is on order and delivery is due in mid-January.
**A 196** SM Give material details to CK to confirm the same as FUSE.
**A 197** APD/AS Go to BU to discuss model philosophy and resources.
**A 198** APD Add clarification of STM testing to December list.

**ICU Development**
Rahil Chaudery will be employed for logic and control circuitry design and Robert Card will design the power regulation and monitoring.
The aim is to prepare a prototype model for early 2001 with basic functionality.
Long lead time components will be reviewed early next year.
A commitment has been made to the Temic 21020 DSP and the Virtuoso RTOS. The data memory size has yet to be identified and the IEEE 1355 buffer needs to be finalised.
The mechanical foot print for the ICU is not yet agreed. There will probably be 4 or 5 PCBs.

**Camera Development**
The near term plan was presented by CJM. The first part is radiation testing and this should be completed by end of Jan 00. Tests should be completed by end Feb 00.

A list of proposed features has been identified.
The CCD procurement is almost ready to start. We need to confirm chip size and agree and specify whether MPP or non-MPP. Anti-blooming probably not required.
A photo of a proposed layout of CCD with flexible leads was shown.
Two or three CCDs will need to be evaluated at Brookhaven for QE.
**A 199** CFM Prepare a list of the CCD options together with the implications of the choices.

**MHC Development**
Discussions need to be finalised on interfacing with NRL's mechanisms.
The MHC needs to fit into the Strong Box on the spectrometer. It will probably consist of 4 PCBs which will be built at MSSL, but which will require major design input from NRL. It is not as crucial as the ICU to be ready for the PM, but it would be good if it were available.
In designing the box it was thought expedient to plan for a cooler.
**A 200** WTO Approach Dynatherm and Swales to see if there is a suitable heat pipe for cooling.

**AIV**
End to end tests and calibration will be done at RAL.
NRL will start testing on an optical test bench at NRL, but it is hoped that testing at RAL will take place as early as possible.

**Schedule**
It was stated that there was as mismatch between the Japanese master schedule and those of the contributing organizations. Many reasons had contributed to a 6 month delay in the start of the programme in the West.

**Review of Actions from Last Meeting**
Actions arising

| | |
|---|---|
| A-125 BU consider view of SOT MLI in thermal model | CLOSED |
| A-126 NRL elaborate/justify component temperature ranges | OPEN |
| A-127 NRL elaborate component disturbance torques | OPEN |
| A-128 BU state number and position of required survival heaters | OPEN |
| A-129 HH Request information about the MTQ flux reaching ICU | OPEN |
| A-130 CMB send Saad example filter drawing. | CLOSED |
| A-131 CMB/MWT clarify debris issue. | CLOSED |
| A-132 NRL Mechanism ICD | CLOSED |
| A-133 MSSL show wiring harness concept on structure drawing | OPEN |
| A-134 NRL show access requirements on structure drawing | OPEN |
| A-135 RAL show purge harness concept on structure drawing | OPEN |
| A-136 HH to find out what freedom existed in the leg position. | OPEN |
| A-137 HH system side to comment on purity of thruster gas | OPEN |
| A-138 HH system side confirm thruster usage frequency | OPEN |
| A-139 BU Develop thermal model of instrument | OPEN |

A-140 CK trace information from the FUSE carbon composite experience. CLOSED
A-141 MWT/CMB calculate (roughly), carbon load for 90 % efficiency. Density = 1 g/cc may be assumed complete CLOSED
A-142 CK forward EUVE instrument contamination control plan to EIS technical teams via MWT. EUVE spacecraft contamination control plan to Solar-B side via HH. OPEN
A-143 HH to report on observed levels of (e.g. particulate) contamination in the ISAS clean rooms. OPEN
A-144 MSSL Measure resistivity of BU's Cycom plate sample OPEN
A-145 BU Review grounding practice in carbon structures CLOSED
A-146 Repeat of 144
A-147 Repeat of A 145
A-148 MSSL Continue radiator study CLOSED
A-149 MSSL Determine tolerable temperature from dark current OPEN
A-150 MSSL Incorporate shielding in camera concept CLOSED
A-151 MSSL propose MHC accommodation OPEN
A-152 System side comment on Purge and Vacuum harness discussion OPEN
A-153 HH clarify instrument emergency power-off sequence CLOSED
A-154 HH/system impedance of twisted pair cable in "hardware command interface" OPEN
A-155 HH/system is HKU used for other than temperatures? complete CLOSED
A-156 HH/system How often is EIS status line requested by PIM? OPEN
A-157 HH/system any pin allocations on the interfaces? OPEN
A-158 ECG Data rate performance of "Hcompress" OPEN
A-159 ECG Data length (bits) of hcompress OPEN
A-160 MSSL Does EIS use bi-level hardware status monitor, number of channels? CLOSED
A-161 AJM/DGS Estimate Occurrence rate of SEU in ICU OPEN
A-162 DGS Concept diagram of ICU, showing switching etc… power converters OPEN
A-163 MSSL UK proposal (science part) to NRL CLOSED
A-164 MWT to prepare a complete table of instrument specifications for consumption by EIS scientists 1 Sept CLOSED
A-165 LH/MWT Plan of action for compression group OPEN

New Actions:

**A 166** APD Confirm mass budgets and who owns the margin.
**A 167** AJM Clarify power budget.
**A 168** APD Chase TW/HH for translation of telemetry/Command Design Standards doc.
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**A 170** JLC Raise the issue of talking to mechanical system engineer with TK.
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