Meeting: EIS Engineering Meeting
Author: APD
Date: 20 - 22 June 2000
Location: ISAS Japan
Those present were representatives from:
NRL, BU, MSSL, ISAS, NAOJ and MELCO

Tuesday 20 June

An introduction was given by T Watanabe and T Kosugi in which they welcomed everyone to Japan, but identified that EIS was behind schedule, particularly with respect to the structure and thermal issues. They requested urgent catch up action.
L Culhane then gave a summary of the project status followed by G Doschek who gave a brief summary of the NASA PDR.

Mechanical Session
Aluminium Structure (A Smith)
An action was taken by MSSL from the NASA PDR to look again at the possibility of using aluminium for the structure. The analysis was not complete, but a presentation of the work performed to date was given.
The base plate would be 15mm honeycomb. There would be an I beam along its length and a reference bulkhead near the P1 and P2 positions from which metering rods would be referenced. All the optical elements would have to be blade mounted. The Clamshell would have to be mounted further forward towards the entrance of the instrument. Access to the internal components would be via access covers, which would be removed one at a time to retain stiffness.
Aluminium honeycomb would be used throughout, giving the same outgassing situation as the composite design. Side and top panels would be 10mm thick, the base 15mm. Bulkheads would have to be moved.
Stiffness does not seem to be a problem, the lowest Eigen frequency being >70Hz from our modelling.
Thermal deformation calculations have been conducted and –56um and +65um in Z were worst. The optics would be metered in Z and therefore would not be affected. In Y there is a long slit to accommodate changes. Variations in the X direction would change the pointing and this could be compensated for by using the mirror adjustment.
There would be a mass penalty for aluminium over composite of approximately 20kg.

C Castelli then gave a summary of the current composite situation.
Great concern was shown at the NASA PDR. Birmingham has been working on resolving these issues and all the recommendations made at that PDR have been adopted.
A Taylor has been taken on as a design consultant. He has a vast experience in using composites in space.
A design review was held on 1 June at Birmingham with MSSL, A Taylor and McLaren Composites in attendance. Various aspects of the design relating to the single piece base plate, inserts and other issues were resolved. McLaren went away to prepare a quotation for manufacturing the composite material and this has now been received. McLaren will make all the composite material and fit all the inserts. Birmingham will assemble and test.
A Presentation of the TAG McLaren Group was then given. There are separate companies for Formula 1, Cars and Composites.
McLaren Composites works in the automotive, defence and space industries. They perform product/process development, research and consultancy. Their key activities in manufacturing

are high performance pre-pregs, resin infusion, resin transfer moulding, assembly and integration.
Their facilities comprise: Cleanroom for lay up (temperature and humidity controlled), 13,000 square feet.
Material preparation and assembly area
Autoclave, 16 feet long by 11 feet diameter
Oven facility
Their space experience is: Beagle 2 – Mars Lander structure (design, development and manufacture); also the entry, descent and landing structure.
Antennae – Research, development and manufacture.
Staff – Extensive space experience, mostly with Matra Marconi.

Composite Structure Design.
Aluminium honeycomb will be used. The base plate will be one piece, 20mm thick. Continuous side panels have also been incorporated. McLaren have a process for eliminating micro-cracking during the resin cure cycle. Carbon fibre block inserts will be used at the 3 attachment points for the instrument (this is a space qualified design). Sub-system attachment will use Shurlock post-potted inserts; these are also space proven. Panels will be joined using titanium inserts, drilled and tapped. L shaped cleats will be used for all the joined panels.
A test plan is in course of preparation. There will be an initial verification programme using sub-element pieces for the evaluation of inserts and test panels. The tests will include basic mechanical tests, fibre volume and void content and CTE.
A sketch of a typical test structure was shown containing 2 pieces edge butted together.
The resin system will be RS3 from YLA in the USA. McLaren have experience of this material and it has a lot of space heritage. A data table for this resin system was shown.
The current EIS design has used conservative figures for the design, because of the variation given by the manufacturer's processes (note: the actual figures achieved will be shown by the proposed test programme).
In conclusion, the programmatic risks have been minimised, a viable programme for the structure is being presented and delivery of the MTM/TTM to Japan is still proposed for 1 May 2001.
A schedule for these activities was shown with contingency built into it.
S Mahmoud presented the detailed design, highlighting the changes. The revised design features a 1 piece base plate of 20mm (18mm honeycomb with 1mm skins), a single 1 piece side and a 2 piece lid. The sides and top are 12mm (10mm honeycomb with 1mm skins). M55J carbon fibre will be used. Bulkheads will use the 20mm material. A detailed design for the 3 main attachment points was shown, using a carbon block insert with small titanium inserts for the screw connections.
The interface connections have been designed using Melco supplied information. A new drawing for the Interface Plate has been placed on the Birmingham FTP site for everyone to look at and comment on.
A discussion took place on the fitting of bulkheads using metal inserts and right angle pieces of composite. The technique proposed by Birmingham is a proven design used by McLaren. Shurlock inserts will be used for attaching internal assemblies (optics and electronic assemblies).
The finite model has been prepared and this shows the first Eigen mode is at 75Hz with the second at 88Hz. With the launch lock fitted, the first Eigen mode is at 95Hz in the area of the radiator, with the second mode at 110Hz.
A discussion took place on whether to have a launch lock or not. It was agreed that Melco would provide a facility for a launch lock, but that the baseline at present is NOT to have one.
A proposal to use strain gauge displacement sensors fitted along the structure to measure the distortion of the structure with temperature was presented. This would be in place of a

complicated and expensive laser technique. C Brown suggested that a laser interferometer might be used. These are readily available.
A test method for thermal distortion needs to be devised and this needs to be conducted on the MTM prior to its delivery (new action 331).
Melco stated that the thickness of the skins could possible be reduced. They use 0.25/0.28mm and apply doubler plates in areas of high stress.
The envelope of EIS, as presented in the structure drawing, does not include the MLI. It was agreed that the additional 10mm on each dimension was acceptable, as long as it was in the ICD. Birmingham needs to include these dimensions on the structure drawing (new action 332).
Melco will reply to extension questions later in the meeting.
A new Template Drawing was presented. The diameter of the shear pins has been increased to 20mm. There were requests for changes from Melco and these will be detailed tomorrow.
A proposal for a flight shipping container was shown. This is still in its initial stages.
Details of the Clamshell design were presented.

Thermal Session
An introduction was provided by C Castelli. I Butler left Birmingham in April 2000. Two new post graduates are starting in July/August and C Goodall is acting in an advisory capacity. I Butler produced a baseline thermal design model and this has now been transferred to Sinda/Navada and been shown to agree with the earlier version.
C Goodall then described the model. Heat conductivity through CFRP/honeycomb is ~5w/m/K transversely and ~ 8w/m/K in the longitudinal direction. This compares with ~200w/m/K for aluminium. Thus it is a predominately radiative coupled system. The MLI is treated as a variable conductor.
Results from the model (No 4) were shown for hot, cold and survival.
The requirements are for a coarse model for interaction with the spacecraft and a more detailed model internal to EIS. What is available at present is probably OK for the spacecraft needs.
Priority was given at Birmingham to convert the existing model into Sinda and further detailing of the model will follow.
Heat flows associated with the CCD were shown. The temperatures are dominated by input radiation from the earth. If you could increase the conductance of the cold finger you could:

lower the CCD temperature
have smaller round orbit variation
direct more power to the CCD bakeout

Taking into account the lack of modelling of the cold finger, the error budget for the thermal system and the status of the mechanical/electrical design, it is predicted that the CCD temperature could rise to –40C for the hot case.

Thermal issues: modelling the cold finger
survival heater power
only 3 channels for the survival heaters

The interface model was originally modelled on Thermica/Esatan. This has now been transcribed into Thermica/Sinda. The Sinda model for the steady state/hot case has been delivered to ISAS and Melco now need to look at this to confirm that they can read it.
Birmingham will provide the remaining models and any necessary updates. Offline discussions on the need/content of thermal models will be held with Birmingham/Melco tomorrow.

Aluminium / Composite Tradeoff
This was presented by A Smith.

Mass:	CFRP	73.5kg (7kg contingency)
	Aluminium	91.5kg (10.4kg contingency)

Performance: If it is necessary to stay within the mass budget, then there would need to be a 20% area loss and a 10% linear reduction for the aluminium design.

Power: No change.
Optical accuracy: Achievable.
Design: Increased complexity for aluminium – metering rods, changes to optics mounting, Clamshell location, adjustable Slit/Slot? the Camera and MHC boxes would also need to change.
Stiffness: No significant change.
Contamination: Aluminium is intrinsically cleaner, but still uses honeycomb. Cleanliness will have to be verified for the composite.
Manufacture: No serious issues for aluminium. McLaren have demonstrated they can make the composite.
Schedule: Problematic to produce the aluminium MTM/TTM in time. OK for composite.
Technical risk: Low for aluminium, medium for composite (there may be a contamination or distortion problem).
Cost: Yet to be determined for aluminium. A quotation has been received from McLaren for the composite - achievable within the UK budget.

It was stated by ISAS that any increase in mass was considered unacceptable.
Further optimisation of the new composite structure may result in mass reduction. Should this not be possible, then savings would be looked for elsewhere in EIS.
The mass budget was stated by ISAS to be 67.43kg. The contingency would be held by the J-side.
It was stated that the aluminium structure could be made in 2 ways. One could be using metering rods, which give a complex design. The other could be without the metering rods, but with accurate temperature control (this might need a major power input).
ISAS agreed to review the structure situation again before the end of the meeting.

Wednesday 21 June

Mechanical Integration
Melco presented some changes that have been made to the interface leg and to the integration procedure.
A cotter pin has been introduced to the attachment positions to prevent rotation around the shear pins.
A discussion took place about the orientation of the fixing points on the OBU for the attachment point BO. Swales had indicated that the load should be at right angles to these 2 points and the Melco design was 78°. It was not practical for Melco to change this and not thought to be a problem for a composite EIS structure.
AO, BO and CO should be used in future to refer to the attachment points (new action 333).
A description of how the legs would be delivered was given. EIS can ask for holes to be drilled in the base plate to which the legs are attached for delivery. These additional holes would be for the attachment of the base plate to vibration equipment. Birmingham will provide a drawing showing any extra holes required (new action 334). Delivery of the legs will be end of January 2001. The size of the base plate is 1.3m x 0.5m.
The shear pins are to be changed to 20mm for position AO only.
The following modifications are required to the Template:

- A cotter pin to be added for all 3 attachment points.
- A hole is required for a Position Pin
- The dimensions for the 2 bushes' lengths have been changed
- The access hole position has been changed

All 4 changes have been marked up on a Birmingham Template drawing and this was handed over.
It was confirmed that P3 is CO, P2 is AO and P1 is BO on the Template drawing. A request was made for the template corners in the area of AO to be radiused, if possible.
It was also confirmed that the material to be used for the construction of the Template would be T300 (a commercial grade composite).
Delivery of the Template is required at Narita by 7 April 2001.
It was again mentioned that the dimensions for the MLI should be included on the structure drawing. Melco will confirm tomorrow that the envelope size on the current drawing is OK.

The **Thermal Discussion Splinter** then reported back.
The information required by Melco has been identified. Node geometry needs to be supplied and information in the delivered model needs to be reformatted for Melco to read.

ICU
The ICU base plate has been modified to be flat so that there is maximum contact of the base with the spacecraft bus. There was a discussion about the need for additional attachment points. Melco recommended a total of 10 attachment points. MSSL agreed to look at this possibility (new action 335).

Testing Issues
MSSL will make a recommendation for the number of cycles for unit level TV testing. These test are specified in SLB 124.
Environmental tests for the EIS models will be included in the next issue of the ICD together with the test levels (new action 337).
Instrumentation for checking the MTM at ISAS needs to be identified – who is going to provide what? (new action 338).
A discussion was held on vibration test levels.

ICD
Appendices 1 and 2 were missing on the printed copies. These were Birmingham drawings that had been distributed separately.
Melco will provide detailed drawings of the legs, which have been modified with cotter pins (new action 339).
Temperature ranges for each sub assembly will be provided to Melco (new action 340).
The purpose of the operational heaters needs to be identified and it was confirmed that there are just 3 channels of 5w each for the survival heaters. The positions of these also need to be identified.
There is a need for a reference to the space coordinate system on the ICD drawings.
A current limiter is required on the power distribution and also for eth MHC?
Power budget: the change from the March meeting is that the heaters will be switched off when the high power mechanisms are activated. The power budget will be re-formatted to represent the operational modes.
Disturbance and FOV information will be included in the ICD.
Documents are required to accompany the Thermal and Structural math models. These documents should include the rationale for the models and descriptions of the modes to help explain their construction and use (new action 341).
Coils and capacitors will not be used on command, status and mission data interfaces.

Thursday 22 June

MDP-EIS Interface

A presentation was given by / K Matsuzaki on changes to the MDP-EIS interface, proposed by ISAS:

1. Busy signal to be busy when MDP is off. MSSL to check the implications of this (new action 342).
2. A definition of byte order to be included in the interface document.
3. Image header changes
4. Memory dump changes
5. Size of status and image header
6. Modified scheme for serial status

The command list should be included in the ICD. A command list has been e-mailed to ISAS, but status information has not yet been detailed. Further information will be provided by the PDR (new action 343).

The ground system interface was stated as having the following parts:

Interface for memory map
Satellite information base
Interface for EGSE
Common Quick Look system

Prototype Model

A test plan was presented by H Hara.
Harnesses and breakout boxes will be provided by Melco.
R Chaudery explained the fidelity of the PM versus the FM for both the hardware and the software.

Heater Splinter Group

The group reported back the following heater information:

Operational heaters	Mirror	2.5
	Grating	2
	Mid-box	1.5
	Total	6.0w
CCD (only used by itself for bake-out)		20w
Survival heaters	Mirror	3
	Grating	2
	ROE	1
	Mid-box	4
	CCD	5
	Total	15w

This fits with the baseline provided by the system-side of 3 channels of 5 watts each.

Schedule/Development Plans

The schedule for the EIS project was described by A Dibbens.
Details of the status of the camera development were presented and R Chaudery gave details of the current situation of the ICU development. It was stated by ISAS that there may be the opportunity at the PM testing to evaluate alternative grounding schemes.
C Brown identified the status of the optical parts:

The grating design is complete and NASA has given the go ahead for its purchase.

The prototype mirror is complete. The flight mirror is on hold pending clarification of the height dimension.

Progress on the Slit/Slot is satisfactory.

A supplier has been chosen for the filters (Luxel) and specifications are in place.
S Myers described the MHC status; the digital and analogue boards have both been designed. The digital board has been completed and the analogue card is being made. These are breadboard PCBs and they will be remade to ship to NRL for the PM. A set of EGSE will also be made for functional testing. Certain software issues will be discussed at a meeting to be held at NRL in mid July with Perdix and MSSL.

Melco will review the comments/interpretation of the Environmental Test Document that were tabled by C Brown/S Mahmoud (new action 344).

Melco confirmed that the request for radiator extensions and the extra space for the MLI were both acceptable.

C Goodall was asked to model the first 150minutes of flight (new action 345).

Review of Old Actions
These were reviewed and an updated list will be published.

Review of Structure Options
Actions from the NASA PDR were reviewed. Action 15 is still ongoing, all the others were considered closed.
T Kosugi stated that if the EIS team have confidence that a composite structure will provide a satisfactory instrument and that it can be done in time, then the System-side will accept this decision.
The EIS team have answered all the technical questions that were raised by the NASA PDR by virtue of adopting McLaren as a working partner.
It was stated by A Smith that he was not confident that an aluminium structure could be delivered in time.
Although contamination is still an issue, it is no different than it was 2 years ago. Comfort is taken from TRACE's experience in managing to keep their composite instrument very clean. In addition we have the benefit of Swales experience and advice.
It was therefore agreed to go forward to the UK PDR with composite as the sole candidate for the structure.

Report from the Electrical Splinter
It was reported that the names used for Ground and Com Return have been transposed in the Melco documentation. Furthermore there is some confusion over the names Chassis and Ground. These issues will be pursued off-line.

Agenda for the UK PDR
A Smith described the format for the PDR. He outlined the objectives and went through the agenda. The review panel was identified.

Date of Next Meeting
TBD, but probably in the UK in November 2000.

New Actions

331	Devise a test method for thermal distortion.	CMC	End Jul 00
332	Include the MLI dimensions on the	CMC	6 Jul 00

	structure drawing		
333	AO, BO and CO should be used in future to refer to the attachment points	CMC	6 Jul 00
334	Provide a drawing showing any extra holes required in the leg base plate	CMC	Mid Nov 00
335	Look at the implications (particularly mass) of using 10 attachment points for the ICU	MSSL	Mid Jul 00
336	Make a recommendation for the number of cycles for unit level TV testing	MSSL	Mid Jul 00
337	Include environmental tests for the EIS models in the next issue of the ICD together with the test levels	MSSL	6 Jul 00
338	Check the instrumentation required for testing the MTM at ISAS	MSSL	Mid Sep 00
339	Melco to provide detailed drawings of the legs, which have been modified with cotter pins	HH	22 Jun 00
340	Provide temperature ranges for each sub assembly to Melco	MSSL	6 Jul 00
341	Provide documents to accompany the Thermal and Structural math models	CMC	6 Jul 00
342	Check the implications of the Busy signal being busy when MDP is off.	MSSL	6 Jul 00
343	Provide further information on command and status lists	MSSL	6 Jul 00
344	Melco to review the comments/interpretation of the Environmental Test Document tabled by C Brown/S Mahmoud	HH	29 Jun 00
345	Thermally model the first 150minutes of flight	CMC	Mid Oct 00