Minutes of Review by ISAC, Bangalore

People present:

1. DVA Raghava Murthy (PD – Small Satellite Project)
2. Loganathan
3. Vanitha
4. Muthuvel
5. K. Kalpana
6. Ganesh
7. IITB Student Satellite Team
8. Studsat Satellite Team

Date: 2nd Febrary, 2008
Time: 2pm to 4:30pm
Venue: Conference Room near PD's office, ISAC
The things that were discussed in the meeting are as follows:

MISSION

Orbit: The possible orbits we could choose from are those scheduled to be launched at end of this year or in the next year

1. 12:00 polar sun synchronous orbit. (OCEANSAT Nov-Dec 2008)
2. 9:30 polar sun synchronous orbit. (1st quarter of 2009)
3. 10:30 polar sun synchronous orbit. (3-4th quarter of 2009)
4. 6:00 polar sun synchronous orbit. (RISAT 2010)

Out of these, the IITB team is asked to choose the 9:30 or 10:30 orbit, since the payload does not depend heavily on the orbit. The team has to write a formal proposal through IITB to ISRO.

(Action: Saptarshi)

PAYLOAD

Thermopiles:

1. The first payload discussed was a thermopile array to be used for generating thermal images of earth. There were inherent limitations on the resolution that could be achieved because of a) the response time of the thermopile array and b) the minimum flux required to get a good SNR. But the team was advised to go ahead with the idea.
2. The gross-swath was around 200km. However with the use of deconvolution, a resolution of around 20km could be achieved.
3. Since the thermopiles sensor array would be square-shaped, the satellite would require yaw-stabilisation. However, an alternative of using a circular mask was suggested.
4. Then the team discussed the implications of this payload on other sub-systems of the satellite. The thermopile doesn't require stringent thermal control.
5. The amount of data to be handled and transmitted was not too high. The team was advised to use 16-bit resolution for the data.
6. The team was advised to contact LEOS regarding Filters.

The second payload for the measurement of the total electron count in the ionosphere was also discussed.

(Action: Ashish Goel)

STRUCTURES AND THERMALS

1. Kinds of loading and ranges were discussed. Quasi-static loading ranging from +7g to -2.5g as well as random vibrations and thermal fatigue were noted as being significant.
2. Though a docecahedral structure was optimal for load bearing, for a small satellite a simple shape, cubic or cuboidal, was deemed sufficient.
3. For material, nibbled aluminium sheets with stiffeners or aluminium honeycomb were considered appropriate.
4. Factors of safety were advised as being upto 10% UTS for composite materials and upto 20% YS for metallic materials.
5. We were informed that ranges of temperature variation were between -100*C and +140*C on all exposed areas with thermal stresses varying accordingly.
6. Tether type of gravity gradient boom was to be studied. Mechanism for release advised were spring loaded, tape spring extension. Pyromechanical release devices were discouraged, instead nylon wire melting and shape memory alloy release were suggested.
7. Very accurate machining and low tolerances were not considered necessary and tolerances achieved during milling operations were taken as being sufficient.
8. For damping of vibrations, sound damping tape was considered a viable option.
9. On the issue of handling PCBs, potting was advised for all fragile components, along with conformal coating, to handle damping of vibrations. Support for PCBs were also advised, leaving not more than 2 inches lengthwise unsupported.
10. Slotted racks were a good option for stacking PCBs efficiently with a bolt passing through the interiors of the PCBs holding them in place.
11. For fastening, it was decided to use nuts and bolts with adhesive materials on the tips to hold them in place.
12. It was advised to design the structure having a natural resonance frequency as high as possible to avoid resonance due to launch vehicle vibrations and also to reduce displacements due to the vibrations, as at lower frequencies displacements are higher leading to higher risk of failure.
13. For the thermopile, liquid support was discouraged on account of outgassing. Instead, potting and mounting on copper clad PCB was suggested.

(Action: Haripriya)

COMMUNICATION

1. It was discussed that FSK modulation is better than GMSK because it is much simpler.
2. Patch antenna was deemed better than omni-directional antenna for the satellite. Further analysis was suggested in this regard.
3. The team was suggested to go for programmable tracking instead of auto-tracking.
4. In case the satellite has uplink, the team was suggested that the same antenna could be used for downlink and uplink with the use of hybrid coupler.
5. VHF was deemed suitable as bit rate was low.

(Action: Kartavya Neema)

ON BOARD COMPUTING

1. Since the satellite has excess power, the satellite should have some form of redundancy

for the On-board Computer. Both triple redundancy and cold redundancy were feasible.

2. The team was suggested to use FPGAs wherever calculations were not involved. E.g. The team could use FPGAs for various fixed logical functions. The micro-processor should be used for calculations like control loop calculation etc. Hence this will essentially make the system simple.
3. EDAC must be implemented. The team was advised to look at RS codes and CRC.
4. The team was advised to try for channel coding and compression so that bit rates could be improved.
5. There should be watch-dog circuits to take care of latch-ups.
6. The team was advised to study Communication protocols.
7. The team was advised to look into possible methods of Health Monitoring.

(Action: Omkar Wagh)

<u>POWER</u>

1. Maximum power point tracking can be handled by the on-board-computer.
2. Battery may not need heater coils if the thermal management can ensure that the battery temperature does not exceed the rated limits.
3. The efficiency of the total power management circuit should be around 70-75%.
4. The team was advised to use industrial-grade DC-DC converter with a known radiation tolerance. Then, the radiation tolerance could be improved using tantalum sheets.
5. The solar energy reflected from the Earth is negligible from the point of view of producing power.
6. Stand-by mode could be used to increase the satellite life but may not be necessary considering the excess amount of power available on the solar panels.

(Action: Mehul Tikekar)

<u>CONTROLS</u>

1. Magnetometer and sunsensor are appropriate for our task and should be able to give attitude to the required accuracy.
2. Kalman filter and extended Kalman filters should be used as estimators.
3. Linear controller will suffice as per the design requirements.
4. Th team was advised to implement the linear controller on non linear system dynamics in simulations to verify its working.
5. Dynamic controller should be avoided by the team, because of its complexity and computational requirements. However it can be considered if expertise its available.
6. Detumbling is not required as satellite can be launched in a low spin state i.e. boom can be deployed without detumbling. Injection rates are usually provided by the launch vehicle, they are around 0.5^{o}/sec.
7. Idea for Gravity Gradient Boom was discussed and tether type boom is preferable over truss type boom.
8. Small payload could be used as tip mass for the GG boom
9. Matlab was deemed sufficient for simulation purposes.
10. Out-gassing should be considered while making magnetorquers.
11. There must be coordination between Control and Structures team to arrive at satisfactory values of Moment of Inertia.

(Action: Shashank Tamaskar)

GENERAL

1. In case the students want to avail some of the facilities of ISRO, the Head of Aerospace Department should ask for permission and then the students could come.
2. 4 third year students who have to do a compulsory Practical Training during their summer months of June-July. They will get a certificate that they have worked for ISRO if they satisfy the work and deadlines given to them during this period.
3. The student will be given some documents to read for getting a clear picture of the level of documentation necessary.
4. The satellite will pass through the South Atlantic Anomaly (SAA) in some period of its life.

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