FINAL REPORT OF THE ALMA MANAGEMENT ADVISORY COMMITTEE (AMAC)

Meeting of October 13/14th at ASTRON, Dwingeloo, The Netherlands

1. AMAC Members

Arnold van Ardenne, Robert Aymar, Sergio Bertini, Gordon Chin, John Credland (chair), Janet Fender, Gary Sanders, Herwig Schopper, Domenick Tenerelli and apologies for absence from Robert Wilson.

2. Introduction

The AMAC met at ASTRON, Dwingeloo, The Netherlands on 13/14th October 2003 to review the status of the ALMA project in accordance with a written charge from the ALMA Board. The charge together with the agenda adopted for the meeting is attached to this report.

The ALMA Director, Massimo Tarenghi, was welcomed in his new capacity by the AMAC and he was ably supported by staff from the JAO and the IPT Leaders. Representatives from both the North American and European Executives were also in attendance.

This report concentrates on aspects of the project which the AMAC felt needed attention in order to ensure the smooth transition of the project from design through construction and testing to scientific operations. The AMAC does, however, wish to congratulate the project on the progress made to date and in particular the way in which the IPT's have managed to co-ordinate the best of both the North American and European experience and cultures to the benefit of the ALMA project.

The AMAC wishes to thank ASTRON, in particular Arnold van Ardenne and Truus van den Brink for organising the meeting and for their generous hospitality.

3. Overall Status of the ALMA project.

The overall status of the project was presented by the ALMA Director, Massimo Tarenghi, and the current acting JAO Project Controller, Richard Simon. The technical work of the key integrated project teams (IPT's) is advancing well and notable achievements are evident. However, from these presentations and a subsequent series of one-on-one meetings between the AMAC and the ALMA Director and the Regional Project Managers, a sense of the overall project status emerged that causes the AMAC significant concern:

• The consolidation of the top project management has stalled and is,

indeed, facing significant internal obstacles that must be promptly and vigorously overcome. Unless this can be rapidly accomplished, ALMA faces increased risk, schedule overrun and cost growth and true project performance will not be visible to the ALMA Director and the Board.

Below follows specific observations which have given rise to these major concerns:

- The ALMA Director's responsibilities and authorities as defined in the Bilateral Agreement have not been implemented. The appointment of the ALMA Director which the AMAC commented upon so favourably in our previous report continues to garner our Committee's enthusiastic endorsement. Massimo Tareghi is a fortunate choice for this role, indeed his expertise and energy are apparent in every aspect of ALMA that he has touched. It is imperative that he receives the full support of both Executives in fulfilling his functions.
- The responsibilities and authorities of the ALMA Director as carefully • conceived by the ALMA Board in the Project Plan and reviewed and endorsed by the AMAC, have not been put into place in a manner that will lead to a successful ALMA construction project. The AMAC learned at this meeting that crucial visibility into cost performance in the Executives has been withheld. Apparently requests by the ALMA Director are frequently refused, routed circuitously up through the Executives' management or responded to in a tardy manner. This approach seriously detracts from efficient, agile project management. It was clear to the AMAC that the skeletal framework for management defined in the Bilateral Agreement and the Project Plan is not being followed in spirit. The spirit of the management plan was optimistic, hopeful and mindful that such a global project needed a well defined framework but one that allowed adaptive development of the implementing details to suit the existing workings of the two Executives and the current project phase. Instead, the framework appears to permit obstructive arrangements to undermine the good start which has been made by the Executives and the ALMA Board. Furthermore specific requirements and understandings expressed by the ALMA Director upon acceptance of the post have apparently not been implemented.

ALMA cannot succeed if the Joint ALMA Office and the two Executives continue to operate in an individual manner or worse, in an adversarial relationship. There must be one unified ALMA management structure consisting of the JAO and the Executives together tackling the intrinsic challenges of ALMA. The AMAC recommends that the internal structures and reporting lines be more clearly defined in the Project Plan to realign the power and authority of the ALMA Director in order that he feels, and indeed is, fully responsible for the implementation of the project.

• The crucial positions of JAO Project Manager, JAO Project Scientist and JAO Project Engineer remain vacant at this time. In addition the Antenna IPT Leader has left just as antenna evaluation and production procurement reach the critical stage. ALMA management has not advanced since the last AMAC meeting, rather it has grown weaker. This situation has arisen despite the extensive efforts of the JAO Search Committee. The challenges

of the ALMA project together with the conditions set for employment appear to be narrowing the field of potential experienced candidates.

The AMAC recommends that the ALMA Board urgently re-examine the approach and conditions assumed in the searches. Suggestions that the search criteria for the post of JAO Project Manager be reduced from that of an experienced leading project manager to one of a supporting and co-ordinating manager taking a more secondary role are not endorsed by the AMAC. We recall that past AMAC advice argued strongly against such an approach. The ALMA Director will have an extremely demanding schedule as the project progresses and it is essential that the JAO team has sufficient depth to support the Director. In fact the Executives may consider the recruitment of two persons to fulfil the JAO Project Manager function, an experienced manager and a deputy with one based in either North America or Europe, and the other based in Chile.

As an interim measure the AMAC strongly advises the two Executives to consider the secondment of suitably qualified personnel from other projects until such time as the posts are filled.

As a final point the AMAC wish to re-iterate a previous recommendation that the JAO be defined to include the ALMA Director, Project Manager, Project Scientist, Project Engineer, Project Control, Regional Project Managers and the System Engineering organisation. Such a structure would facilitate the clear and concise working of the JAO management team. This definition and the attendant coherent management teaming has not yet taken place.

4. The methods used to track conformance to schedule and cost

The Acting JAO Project Controller, Richard Simon, presented a detailed statement of the current status relative to the extensive hierarchy of milestones defined by ALMA. The AMAC has commented previously on this detailed "inchstone" method of project planning and whilst recognising that it formed a good basis for initiating a true control system it was not, by itself, adequate for measuring ALMA progress and would be unworkable as a basis for the inevitable project replanning. In fact the detailed and diligent presentation of ALMA status demonstrated that in nearly every major Work Breakdown Structure area, ALMA is falling behind schedule.

In particular:

• The concerted efforts of the Project Control Manager could not confidently quantify the current status as the existing system does not measure the earned value of the completed or partially completed milestones. During the presentation it became apparent from the charts that expenditure data was not included in the analysis. Subsequent discussions identified that the crucial data on expenditure was not available to the ALMA Director. With the denial of this cost information to the JAO, the system is certainly not able to address a true measurement of work accomplished with its proper earned value. This "compartmentalised" data crucial to the successful control of the project must be made available to enable the JAO to fulfil its function. • The AMAC strongly recommended implementation of a proper earned value control system in the last report and referred to this in previous reports. The Project Plan commits to the implementation of such a system. The AMAC is concerned to learn that in the months since our last review, despite our recommendation and the endorsement of the ALMA Board, no significant progress has been made in implementing such a system. The project undertaking at the previous review was to implement such a system by this review, and to have it fully operational by early 2004. An RFP has only just been issued for an outside group to perform a four month design study. The tender does not yet seek the implementation of a system despite the fact that such systems are off the shelf and in common usage elsewhere.

The AMAC strongly reaffirms the previous recommendation that such a system be urgently deployed throughout the ALMA project. Such a system should take due cognisance of the project control systems in current use by the two Executives and interface cleanly to provide an ALMA wide control and management system. This advice is fully consistent with the lessons leaned in previous projects and in the laboratories managed by several members of the AMAC. Once again the AMAC recommends that at the next AMAC review, ALMA demonstrates the first operation of a project control system employing earned value milestones based on actual cost data derived from awarded contracts.

5. The project's response to the most recent AMAC report

As noted above the principle recommendations of the AMAC regarding ALMA management and project performance measurement have not been adopted or accomplished .

Recommendations regarding the integration of the System Engineering tasks into the JAO, due to the intimate interaction required between this function and the project management, have also not been implemented. Open positions in both the JAO and the System Engineering IPT contribute to this. Commitment to this structure has not been presented formally. The AMAC strongly recommend that the technical reporting lines of the system engineering IPT members be directly to the ALMA Director.

The progress in implementing the AMAC recommendation regarding the investigation of production engineering techniques to ensure a smooth and economical transition from prototype to full production has been remarkable. The techniques have been applied to elements of the Front End, Back End and Correlator with considerable success. The presentation by Marc Rafal, the North American Project Manager, predict lowering of the costs and improvement in repeatability arising from the application of commercial fabrication to in-house prototypes, the use of Commercial Off The Shelf (COTS) components wherever possible and the restriction of in-house tasks to those requiring expert knowledge. The AMAC commends the project on the progress in this area.

The recommendation to the project to carry out a comprehensive reliability, maintainability and availability analysis, in particular with respect to the production antennas before the procurement package is released, now appears to have been left to the bidders to solve. In the opinion of the AMAC the system engineering team should carry out this task for the end to end system in order to identify potential single point failures and correct them as far as possible, before procurement contracts are signed.

6. System engineering effort and the need for formal reviews

The system engineering effort is gradually building up and represents a good start on the required effort. The AMAC recognises that shortfall in manpower is slowing down the realisation of many of the system engineering tasks and it is essential that this area is given top priority in the near term.

Reliability and Single Point Failure analysis has not yet been completed but is in progress. This task should be completed in time to influence the design as later changes could prove costly. Risk management is an area which has not yet received attention. The AMAC recommend that risk management be approached both from the engineering perspective as well as from the programmatic perspective. A Risk Mitigation plan should be issued derived from the current system design and addressing potential impacts on the scheduled milestones. Safety engineering has been well addressed but will require more effort as work progresses in Chile. These tasks are the responsibility of the system engineering group and additional experienced personnel covering risk management and safety should be recruited to the group.

Concerning the introduction of a formal external system design review process, the AMAC notes that there exists already an internal design review process. The AMAC does not see the need for an independent external review but recommends that the Board for the planned reviews include members external to the ALMA project wherever possible. Such reviewers should have a background in major astronomy or engineering projects to minimise the learning curve needed by review board members.

7. Current plans for procurement of production antennas

The strategy for the procurement of the production antennas was presented by the ALMA Director and the Acting Antenna IPT Leader, Stefano Stanghellini and was found by the AMAC to be basically sound. The two Executives are working hard to reconcile the desire for a unified procurement approach to different sets of legal processes in North America and Europe.

The AMAC was concerned that the delays in the antenna evaluation programme may impose additional risk to the project and may result in a delay in the selection process. The current programme envisages the completion of the internal evaluation programme of the AEC antenna by the Antenna IPT by end December 2003 with the final results from the Antenna Evaluation Group (AEG) due in May 2004. As the RFQ for the production antennas is scheduled for release at the end of October 2003, the AMAC is concerned that the final specification may not be fully mature, leading inevitably to costly changes downstream once the final evaluation is complete. Further the AMAC was concerned to learn that the details of the proposal evaluation criteria and the evaluation process had not

been fully worked out, even though the release of the RFQ was only weeks away, and the industrial briefings planned for the near future.

The AMAC strongly recommends that the Antenna IPT be given additional support from persons experienced in such large scale procurement and that the RFQ be held until the package is deemed fit for the purpose of such a crucial procurement. The AMAC also recognises the need to maintain programme schedule but due attention should be given to a later release of the RFQ package and a more streamlined evaluation sequence aimed at minimising delay in contract placement.

8. Current plans for the procurement of front ends

The AMAC was most impressed by the progress in evolving from the in-house manufacturing approach of the past to the commercialised procurement needed for a project of this size and complexity. The resulting cost savings are also a welcome feature of the industrialised procurement process. The progress in design of the in-house prototypes was also on schedule.

9. Software preparation, particularly for data reduction

The AMAC received a comprehensive presentation of the status of the software preparation from the Computer IPT Leader. It was apparent from the details that the software development effort was running essentially to schedule for the data pipeline. In particular, the Science IPT together with the Computing IPT has been able to formulate an ALMA Design Reference Science Plan (DRSP), a step which is ahead of most projects at this stage, and the plan is to test the software capabilities against this reference set. The first ALMA dedicated software release took place on 1st October and detailed testing is currently underway.

10. Other issues

The AMAC wishes to complement the Site Development IPT on the progress in running the access road from the highway via the OSF to the AOS together with the progress being made on surveying the antenna locations at the AOS and the design of the OSF facilities.

The Transition Plan from construction through testing to operations has progressed well since the previous review but still needs further development. In particular operations in Chile have not been resolved in detail as regards the philosophy of testing at the manufacturing site versus testing at the OSF. An efficient transition from a developmental to an operational system would benefit from the introduction of milestones with metrics to evaluate the progress towards an operational capability. The AMAC recommends that this procedure be adopted for ALMA.

The AMAC recommend that consideration be given to issuing a "knowledge

transfer" document covering the basic design and maintenance philosophy of the system, operations and personnel training, spare parts inventory and fault finding. Such a logistics plan is essential to retain the engineering knowledge throughout the duration of the project operational phase.

Finally the AMAC welcomed the positive progress of the negotiations with Japan for joining the ALMA project. The approach adopted whereby the contribution of Japan takes the form of "value added" items such as the compact array and additional receive bands is sound. The AMAC does caution the Board that the basic bi-lateral project be on a firm footing prior to agreement of the details and timescales of the Japanese contribution.