Company Confidential

AUI/NRAO
ALMA Antenna
Procurement Summary

April 15, 2005

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Note:

The above Appendices are available for down load at the following url:

http://www.alma.nrao.edu/alma_antenna/

Acronym List

AEC	Alcatel-EIE Consortium (Prototype Antenna Contractor)
AEC	Alcatel European Consortium (Production Antenna Bidder)
AEG	Antenna Evaluation Group (Joint)
ATF	Antenna Test Facility (New Mexico)
ATWG	Antenna Technical Working Group (Joint)
AUI	Associated Universities Inc.
BEC	Business Evaluation Committee (AUI/NRAO)
CAC	Contract Award Committee (ESO)
CCB	Configuration Control Board (ALMA)
CfT	Call for Tenders (ESO)
CSC	Contract Selection Committee (AUI/NRAO)
ESO	European Southern Observatory
FEA	Finite Element Analysis
JAO	Joint ALMA Office
JATG	Joint Antenna Testing Group
JTET	Joint Technical Evaluation Team (Joint)
LRU	Line Replaceable Unit
MTBF	Mean Time between Failures
MTTR	Mean Time to Repair
NRAO	National Radio Astronomy Observatory
QA	Quality Assurance
PRT	Proposal Receipt Team (AUI/NRAO)
RFP	Request for Proposals (AUI/NRAO)
VRSI	VertexRSI (Prototype Antenna Contractor/Production Antenna Bidder)

1. Introduction

Production antennas for ALMA represent the single largest procurement for the ALMA project. Because of the critical nature of the procurement, planning and execution of the procurement process has been carefully coordinated and managed within the North American Executive by a high level Contract Selection Committee, appointed by the NRAO director. The CSC is charged with receiving the reports of the various groups evaluating all proposals, opening and evaluating the price proposals, seeking additional advice from technical experts and interacting with the proposers to clarify their proposals. In addition, the CSC coordinated its review with the ESO Contract Awards Committee and the JAO. Ultimately, the CSC makes a recommendation to the NRAO Director and the AUI President regarding procurement of the production antennas.

This summary describes the process undertaken by the CSC and the conclusions leading to its final recommendation.

2. Procurement Objectives

Procurement of the production antennas has been split between the two Executives each delivering one half of the total number of antennas for the baseline array. Because each Executive has its own procurement rules, terms, conditions, and approval processes, two parallel but separate procurements have been initiated.

The primary objective of these procurements is to provide ALMA antennas that satisfy the technical requirements of the program at the lowest possible cost. In February 2003, the ALMA Board approved a resolution stating that the Executives should "procure the production antennas to a single design which has been prototyped and evaluated." This limited the procurement to antennas whose design is substantially similar to one of the two prototype antennas procured by the Executives as part of the Design and Development phase and tested at the ALMA Test Facility (ATF).

In addition to the Board direction of a common design, both Executives recognize that the lowest cost for each Executive will occur if the same supplier provides antennas for both Executives. This maximizes the available economies of scale and minimizes duplication of non-recurring costs.

A final objective of the procurement is to execute a contract that holds the contractor fully responsible for delivering antennas that meet the ALMA specifications. Thus, while the basic elements of the design proposed by the contractor are required to be

demonstrated at the ATF, this will not be a "build-to-print" contract. In fact, because the Technical Specification and interface definitions for the production antennas differ from the prototype in several details, the Statement of Work calls for a design phase during which the contractor will complete detailed design. Compliance with all technical specifications must be demonstrated by the contractor at the Critical Design Review and by acceptance tests prior to delivery of each antenna.

3. Procurement Process

The procurement of production antennas has followed AUI/NRAO standard procurement process. Potential bidders were invited to attend a meeting prior to the release of an RFP to explain the procurement process. An RFP was developed that included a Technical Specification, Statement of Work, Terms and Conditions and Instructions to Bidders. The Statement of Work and Technical Specifications were developed jointly with ESO and approved by the ALMA CCB and JAO. The RFP was sent to qualified bidders who were invited to submit proposals. The proposals were then evaluated on technical, management and cost basis. Business due diligence was performed on the proposers. Finally, a recommendation was made to the NRAO Director and the AUI President. The overall flow of the parallel AUI/NRAO and ESO procurement processes is shown in Figure 3.1 below.

Within this standard process, significant effort was made to coordinate with the parallel procurement underway at ESO. Wherever possible, identical business terms and conditions were used in both procurements. A major portion of the evaluation of each proposal was carried out by joint committees that reported finding to the relevant selection committees established by each Executive.

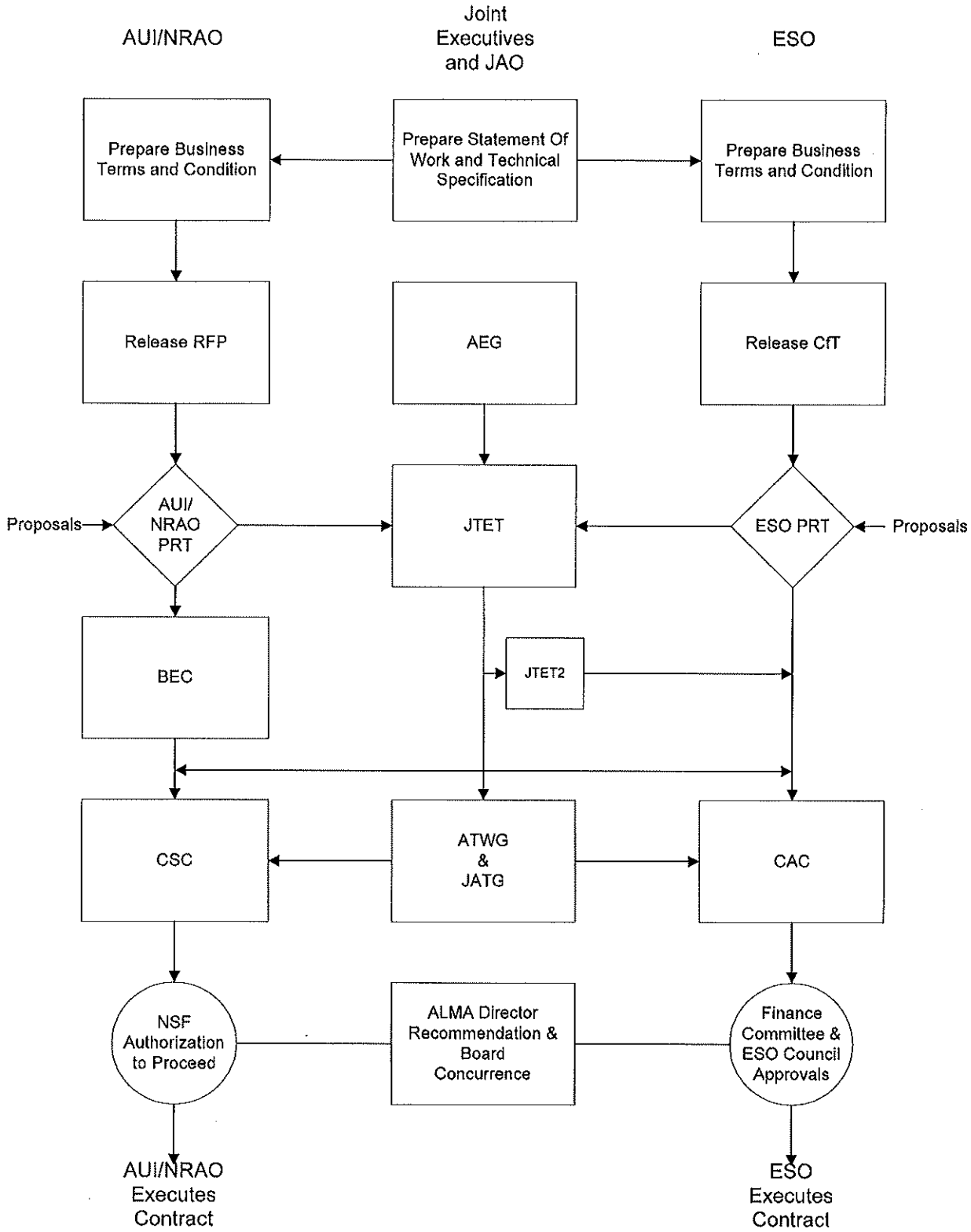

Figure 3.1: Antenna Procurement Process

A crucial difference in the procurement process between AUI/NRAO and ESO is the limitations imposed by each Executive on what entities could submit bids for supplying production antennas. By ESO procurement rules, ESO limited the bidding to *qualified* companies or consortia from ESO member states. ESO qualified member state companies based on responses to a Preliminary Enquiry process. ESO did not require for qualification any specific experience with ALMA prototype antennas or previous experience with radio astronomy antennas. US companies were not invited to submit bids to ESO.

Consistent with the original prototype philosophy intended to minimize technical and programmatic risk, AUI/NRAO limited the competition for the production antennas to those entities that materially contributed to one of the prototypes. The requirement could also be met by consortia that included the companies that supplied the prototype antennas. AUI/NRAO accepted bids from both US and European companies and consortia. Specifically, the AUI/NRAO RFP contained the following language regarding limitations for bidders:

> *The AUI ALMA antenna procurement process started in 1999, with the solicitation for the prototype antenna. This solicitation specifically reserved the right to award the production antennas to the successful prototype Contractor. Participation in the AUI antenna procurement is limited to those Proposers/entities that have made a substantial contribution to either the AUI or the ESO prototype antenna. Substantial contribution means that, in the sole judgment of AUI, the entity has had significant participation in the design, development, and fabrication of a prototype antenna. The companies that meet this requirement are: VertexRSI, Vertex Antennentechnik, Alcatel or EIE.*
>
> *This procurement provides an opportunity for business arrangements with any of the above mentioned companies. These companies may find it advantageous to partner with other companies to strengthen their Proposals with regards to manufacturing, logistics support, program management, or other criteria.*

The overall procurement process was managed by the NRAO ALMA Business Manager with the participation of the NRAO ALMA Project Manager, the NRAO Antenna IPT Lead and the AUI Corporate office.

In order to fully evaluate and rank the proposals received, the NRAO Director established a number of committees with expertise in specific areas. Each committee had a specific charge and generated a final written report. Those reports are provided in the appendices of this report.

Additionally, the two Executives agreed to establish a Joint Technical Evaluation Team (JTET) to evaluate the technical merits of all proposals received by the Executives. The

JTET included a core team and additional technical experts drawn from both Executives as well as outside experts.

Finally, as part of the original evaluation of the prototype antennas, the ALMA project established the Antenna Evaluation Group (AEG). The AEG evaluated the science performance of both prototype antennas and provided a report to the JTET.

4. Proposal Receipt Team Process

The Proposal Receipt Team (PRT) was appointed by the NRAO Director to receive the ALMA Antenna Proposals on 30 April 2004, and determine whether the proposals were immediately responsive or non-responsive regarding timeliness and form of response.

Proposals were received from the following two companies; VertexRSI and Alcatel (representing the Alcatel European Consortium (AEC) which included Alcatel, EIE and MAN).

The PRT secured the price proposal without unsealing. The price proposals remained sealed until after the Contract Selection Committee received the reports of the technical and business review committees.

The AUI/NRAO PRT consisted of:

Dick Hames (AUI Counsel)
Ted Miller (NRAO Head Observatory Business Service)
William Porter, Chair (ALMA NA Business Manager)
Marc Rafal (ALMA NA Project Manager)

5. Joint Technical Evaluation Team Process and Summary Results

The Joint Technical Evaluation Team (JTET) was charged jointly by the two Executives. A JTET core team was appointed to draft a consensus report evaluating the proposals received by both Executives. The Core Team was supported by a committee of technical experts in specific areas to assist with detailed analysis.

The JTET evaluated the technical proposal, management proposal, project plan and schedules submitted by each Proposer. Pursuant to procedures agreed in advance by the Executives, the JTET completed its evaluation without access to the cost proposals secured by the PRT.

In order to comply with ESO procurement practices, the JTET was required to limit its evaluation in two important ways not normally followed by the AUI/NRAO process.

- An initial evaluation of the proposals was conducted without access to performance measurements of the two prototype antennas. Once this report was completed, information about the prototype performance was provided to the Core Team from which an epilog to the original report was produced.

- The JTET was constrained to seek clarifications from the Proposers' only though written questions and answers. The JTET could not meet with or visit the Proposers facilities.

The membership of the JTET was mutually agreed to by the NRAO Director and the ESO Director General.

The JTET consisted of the following members

Name	ESO	NRAO	Core member	Main specialties
S. Stanghellini	X		X	Project Management, Antenna
V. Gasho		X	X	Mechanics, Maintenance, Antenna
R. Kurz	X		X	Project Management, Schedule, Logistics
P. Napier		X		Antenna Project management, Operation
J. Baars	X		X	Antenna Specialist, Project management
J. Mangum		X		Antenna, Commissioning, Metrology
M. Kraus	X			Mechanics, Maintenance, logistics
D. Woody		OVRO	X	Antenna specialist
R. Hills	Cambridge			
G. Raffi	X			Software & electronic architecture
B. Glendenning		X		Software & Electronic. Architecture
F Biancat Marchet	X			Feedback Control & Electronics, Metrology
R. Freund		X		Feedback Control & Electronics, Metrology
D. Sramek		X	X	Systems, antennas, operation
F. Koch	X			Structures, FEA, Carbon fiber
Lee King		X		Structures, FEA, antennas
A.van Kesteren	X			Electrical Safety, EMC, reliability
J. Zivick		X		Product Assurance
J. Spargo		X		Safety
R. Simon		X		Planning and logistic
B. Porter		X		Management and logistic

The core team and technical experts met face-to-face on two occasions, once in Europe and once in North America. The technical, management, project plans and schedule portions of the proposals were reviewed in detail. The JTET developed a set of written questions for each Proposer seeking specific clarifications required to complete the evaluation process. The core team drafted a report that included a numerical score for each proposal. After the report was delivered to the Executives, the JTET was provided with an Executive Summary of the Antenna Evaluation Group report on the measured performance of the prototype antennas. Based on this additional information, the core team of the JTET prepared an epilog to the original report. The JTET Report and Epilog are included as Appendix A to this report.

Overall, the two proposals submitted to AUI/NRAO were evaluated by the JTET to be of similar quality with similar numerical scores of 62 for AEM and 59 for VRSI out of a possible score of 135. In both cases, the JTET found that the proposed antennas would likely meet the primary science driven performance specifications. Sufficient detail was not provided to assess compliance with a number of less critical engineering specifications. In the case of the AEM, the JTET noted that the proposal took explicit exception to some engineering requirements of the transporter interface and substantially missed the schedule requirements of the Statement of Work.

The JTET was significantly concerned in both cases with the documentation provided to demonstrate an adequate management structure and detailed planning for serial production. In the case of Vertex, there was inconsistent treatment of the plans for producing 64 antennas in the proposals submitted by VRSI to AUI/NRAO and by VA to ESO. In the case of AEM, it was not made clear what roles and responsibilities would be assumed by each consortium member.

Prior to the completion of the JTET report, the JTET developed a series of written questions for each Proposer. Questions for each Proposer were combined with the questions developed by the BEC (see below) and sent to each Proposer. The written responses were considered in the final JTET report.

6. Business Evaluation Committee Process

The Business Evaluation Committee (BEC) was appointed by the NRAO Director to (1) perform the pre-proposal due diligence investigation of the anticipated proposers, (2) to issue a due diligence report to AUI prior to proposal receipt, (3) to evaluate the proposers' business proposals, (4) to provide AUI a ranked business scoring of the proposers, and (5) to support the Executives, as necessary, in negotiation of a final antenna agreement. The BEC submitted its report to the CSC.

The committee consisted of:

Frank Federmann (Former AUI Chief of Internal Audit)
Jim Gibb (NRAO Fiscal Division Head)
Dick Hames (AUI Counsel)
Ted Miller (NRAO Head of Observatory Business Services)
Mauricio Pilleux (ALMA Business Manager, Chile)
William Porter, Chair (ALMA North America Business Manager)

The BEC met twice by telephone and twice face-to-face to establish committee procedures, to accomplish a due diligence review of the proposing firms, and to thoroughly evaluate their proposals and their capabilities to perform the ALMA project. Each BEC member reviewed all information individually after which the BEC met to draw a committee consensus on scoring and to draft this report. The scoring of the two Proposers was in accordance with (1) the evaluation criteria stated in the RFP, and (2) the scoring system developed by the BEC prior to receipt of the proposals.

The BEC evaluated the proposals on the basis of evaluation criteria set forth in the section 1.9 of the Request for Proposal and shown on the ALMA Antenna Procurement Business Evaluation Score-sheets. These criteria included Evaluation Criteria 1 (EC1), i.e., the capacity of the industrial setup to reliably produce 32 or 64 antennas over the duration of the project, and Evaluation Criteria 3 (EC3), i.e., related experience and past performance of the Proposers. Evaluation Criteria 2 (EC2), was the technical performance of the antenna design, and was therefore outside the scope of the BEC's review.

The total scores for the two Evaluation Criteria considered were 134 for VertexRSI and 100.9 for AEM out of a possible score of 200.

On the whole, the VRSI and AEM proposals as received were considered adequate, at best. Neither proposal as received fully addressed the RFP. The BEC generally viewed the VRSI proposal as being the stronger and more credible of the two proposals. The VRSI proposal more clearly addressed the critical issues of schedule and organizational structure and was judged to be more complete than the AEM proposal. The VRSI proposal garnered an 18% scoring advantage over the AEM proposal in the "Capacity" evaluation section (EC1). There was an even more significant scoring advantage of 37% in the "Related Experience" section (EC3).

Prior to the completion of the BEC report, the BEC developed a series of written questions for each Proposer. Questions for each Proposer were combined with the questions developed by the JTET (see above) and sent to each Proposer. The written responses were considered by the CSC (see below).

7. Contract Selection Committee Results

The AUI/NRAO Contract Selection Committee (CSC) was appointed by the NRAO Director and charged to (1) receive and review the reports from the ALMA Joint Technical Evaluation Committee and the AUI/NRAO Business Evaluation Committee, and (2) recommend to the NRAO Director and the AUI President the successful antenna proposer with whom a contract should be pursued.

The CSC opened, reviewed, and analyzed the price proposals (in a confidential manner), and combined that knowledge with the evaluation committee reports to determine which proposer to recommend. ESO carried out a parallel process with its Contract Award Committee, independent of the AUI/NRAO analysis.

The CSC consisted of the following members:

Pat Donahoe (chair)	AUI Vice President
Marc Rafal/Adrian Russell *	NRAO ALMA Project Manager
Bill Porter	NRAO ALMA Business Manager
Peter Napier	NRAO EVLA Project Manager
Dick Hames	NRAO/AUI Counsel

* Marc Rafal was replaced on the CSC when Adrian Russell assumed the role of Project Manager.

In addition, the CSC engaged the following technical experts:

Victor Gasho/Marc Rafal*	NRAO Antenna IPT lead
Jeff Mangum	NRAO Antenna Evaluation Group Lead
Tedde Blunk	Procurement Consultant
Lee King	Antenna Structural Consultant

* Victor Gasho was replaced by Marc Rafal when the latter assumed the position of NRAO Antenna IPT lead

The CSC began substantive evaluation of the two proposals on 23 June 2004. At that time, the CSC had available to it the following materials:

1. Complete proposals of VertexRSI and AEM
2. The JTET Report and its Epilog
3. The BEC Report
4. The AEG Executive Summary for prototype antenna test results
5. Written responses from the proposers to the questions submitted by the JTET and BEC.

In addition to the materials available to the JTET and the BEC, the CSC evaluated the Price Proposals of each Proposer. The Price Proposal included the price information for the basic proposal and all options offered. Business terms and conditions were also provided.

The CSC evaluated all of the available information and scored the offers according to criteria set prior to proposal receipt. Overall, the CSC concluded that the AEC offer was substantially deficient and that discussions and negotiations would not likely result in an acceptable proposal. The reasons for this conclusion were that the AEC proposal failed to adhere to important aspects of the Technical Specification and the Statement of Work (first antenna delivery, transporter interface), failed to provide a fixed price offer as required by the RFP, had a significantly higher offer price and contained numerous exceptions to AUI/NRAO business terms and conditions. As a result, the CSC recommended that no further discussions/negotiations with AEC were advisable. A letter was sent to AEC 29 August 2004 informing them that AUI/NRAO intended to negotiate with its competitor and would only contact AEC should those negotiations be unsuccessful.

While the VertexRSI proposal was ranked substantially higher than the AEC proposal, the CSC noted certain deficiencies in that proposal as well. Unlike the major deficiencies of the AEC proposal, the VertexRSI proposal was deficient primarily due to omission of detailed information, much of which was already available from the Complete Design Documentation supplied as part of the prototype contract. As a result it was the CSC consensus that they could have been substantially resolved had the JTET had the opportunity to meet with VertexRSI to seek needed clarifications.

With the concurrence of the NRAO Director and AUI President, the CSC undertook a series of discussion/negotiations with VertesRSI to determine if the deficiencies noted by the CSC could be resolved. As a result of this interaction, the CSC was sufficiently satisfied with the progress to ask VertexRSI to submit a revised offer.

On 14 September 2004, the CSC issued an interim report to the NRAO Director and the AUI President. That report, included as Appendix E, recommended, subject to satisfactory resolution of specific technical uncertainties (life cycle costs and a difference between the VertexRSI finite element model and certain test measurements) and successful negotiations, that AUI proceed with procurement of production antennas from VertexRSI.

8. Resolution of CSC Questions

Based on the analysis done by the JTET and BEC, the CSC identified a number of issues requiring resolution by Vertex. In response to written questions and a series of face-to-face meeting with the CSC, VertexRSI provided written responses to each of the issues.

The issues generally fell into two categories; management and technical performance. A detailed listing of the issues and how they were successfully resolved is available in Appendix B.

Management

The management issues generally were the result of insufficient or inconsistent information supplied as part of the proposal. The issues fell into the following general categories:

- Insufficient clarity regarding plans for manufacturing in a 32 + 32 scenario. In particular, what facilities would be used and how the effort would be organized if AUI/NRAO contracts with VertexRSI and ESO contracts with VA.
    - VertexRSI provided detailed plans for a unified management structure with all phases of both contracts controlled from their Kilgore, Texas facility under a single project manager.
- What detailed planning was done to provide confidence that the production schedule can be met
    - VertexRSI provided a detailed network schedule for the production of antennas.
- What in-plant manufacturing logistics, quality and safety control plans are in place at the contractor facilities
    - VertexRSI provided a description of their existing in-plant logistics, quality and safety programs. These programs have a long history of success in production rates similar to the ALMA requirements.
- What planning was done regarding the transport to Chile
    - VertexRSI provided a summary of the planning carried out to insure that sufficient transport carriers were available. In addition, they provided an analysis of the facilities available at the port in Chile and analysis of the impact of those facilities on the carrier requirements.
- What key personnel would be assigned to this effort and what are the reporting relationships
    - VertexRSI provided names and vitae for a number of key personnel and identified the reporting relationship including the relationship between VRSI and VA personnel.

Each of these areas was addressed by VertexRSI to the satisfaction of the CSC. VertexRSI presented a single coherent organizational structure that identified a single point of integrative responsibility for the production of all ALMA antennas. At the request of the CSC, VertexRSI submitted a final version their responses to these points, representing the end point of all discussions, as part of their BAFO. This is included as Appendix H.

Detailed plans were presented showing the production of each antenna, transport to Chile and assembly at the OSF. VertexRSI has a well established in-plant manufacturing

logistics system that it uses successfully to plan and monitor fabrication of all parts. It also has well established quality and safety procedures.

The CSC was particularly impressed with the quality of the key personnel it interacted with at the face-to-face meetings.

Technical Issues

While not specifically addressed by the JTET report, the CSC noted that the Executive Summary of the AEG Report identified that some of its measurements suggested that the carbon fiber back up structure (BUS) may not be as stiff as predicted by the finite element analysis (FEA). If the BUS were sufficiently less stiff, the surface and wind pointing specifications could be in jeopardy. The CSC requested that the VertexRSI evaluate the AEG data and provide an analysis.

The Executives jointly established an Antenna Technical Working Group (ATWG) that further analyzed the available data. This group ultimately identified additional tests that would provide clarity on the subject. The report of the ATWG is included as Appendix F and summarized in Section 11 below.

In a number of cases, clarifications were available in the final design documentation for the prototype antenna and not explicitly included as part of the VRSI proposal. At the request of the CSC, VertexRSI included the entire final design documentation as part of its clarifications.

Finally, VertexRSI affirmed that it understood all of the changes in the Technical Specification as compared to the prototype antenna and that their offer complied with each of those changes. In the case of the transporter and foundation interface changes, VertexRSI offered optional price reductions should ALMA choose to revert to the original interface specifications.

9. Negotiations and BAFO

There were three face-to-face meetings between the AUI Contract Selection Committee (CSC) and VertexRSI (VRSI) for the purposes of discussion and clarification of technical issues and pricing of the VRSI proposal which successfully addressed all of the issues. Details of the resolution of these issues are provided in Appendix B.

The first meeting was held 27-28 July 2004, at VRSI's facilities in Kilgore, Texas. Topics of discussion and clarification included (a) the VRSI approach to project management and organization, (b) ISO management and procurement management of contractors and subcontractors, (c) QA procedures and documentation, (d) Earned Value

Management System (EVMS) implementation, (e) VRSI resource management, manufacturing planning and scheduling, and cost management, (f) commitment of key personnel to the project, (g) transportation management and logistics, (h) review of the APEX antenna issues, (i) shifting from a prototype project approach to full production management, (j) review of items that have a significant cost impact, (k) tilt meters, (l) error budget with and without metrology, (m) antenna mass, (n) surface panel etching, (o) the prototype antenna FEA model, (p) safety and lock-out/tag out procedures, (q) MTBF component data and MTBF calculation, (r) HVAC coolant, (s) the on-site assembly plan, (t) Chilean taxes, (u) the acceptance plan and table of compliance, (v) the antenna transporter ICD, (w) the legal relationship between VRSI and General Dynamics, and (x) electrical power demand/consumption.

The second meeting was held 18-19 August 2004, again at VRSI's facilities in Kilgore, Texas. The purpose of the meeting was to review and discuss VRSI's written response to the issues raised in the earlier (July) face-to-face meeting and investigate additional issues including (a) site erection facility safety plan, (b) environmental safety plan, (c) hazardous waste handling/disposal, (d) treatment of archeological sites, (e) Chilean subcontractors, (f) antenna delivery schedule, (g) azimuth hard stop questions, (h) PLC interlocks, (i) transporter interface, (j) MTTR values, (k) antenna lubrication, (l) LRU specifics, (m) risk analysis, (n) reflector overhaul requirements, (o) ACU monitoring points, (p) BUS deflection and error budget, (q) tilt meter update, (r) VRSI management resources, (s) a performance guarantee, (t) gear and pinion drives, (u) QA/SF reporting requirements, (v) site emergency assistance, (w) cost drivers and cost reduction, (x) servo testing, (y) the hexapod mount design, (z) subreflector focus switching, (aa) site pad excavation costs, (bb) cabinet access for CFE nutator equipment, (cc) direct equipment purchase, (dd) price phasing, (ee) reduction of recurring costs, (ff) price indexing, (gg) construction material price history, (hh) pricing for negotiable items/reductions, and (ii) the aluminum subreflector spacer.

The third meeting was held on 6 October 2004, at the offices of Parsons, Brinckerhoff, Quade & Douglas in Dallas, Texas to review and understand the revised offer pricing submitted by VRSI on 8 September 2005, in response to the AUI request.

10. Price History and Price Negotiations

The prices offered by both bidders were significantly higher than anticipated or budgeted. The offer from VertexRSI was significantly lower than the offer from AEC. While the offer from VertexRSI was clearly the lowest in a highly competitive procurement, the reasons for the higher than anticipated price required explanation. The CSC conducted an analysis of the VertexRSI offer to identify the justification for the price offer.

The anticipated price, and the resulting budget allocation, was based on information supplied by the two prototype antenna vendors. As part of the contracts for each

prototype, the vendors were required to supply estimates of the production cost for serial production of antennas identical to the prototype antennas. Based on those submissions, the ALMA Project, in 2001, budgeted $2.9M (FY2000US$) per antenna.

The following factors increased the cost of the antennas as compared to the 2001 estimates:

- Changes in the Technical Specifications, including key interfaces, were changed for the production antennas. The interfaces to the ALMA supplied foundations and transporter were modified as were the specified operating system for the antenna control system. These changes required a significant Design and Development phase not anticipated in the prototype estimates.
- The prototype estimates assumed the ALMA Project would provide facilities in Chile for the erection of the antennas at the OSF. These facilities included an assembly hall, board and lodging for contractor personnel and the required utilities, all at no cost to the contractor. The RFP stipulated that the Project would provide the contractor a defined space at the OSF but required the contractor to erect and later remove whatever facilities they required. In addition, the contractor was required to reimburse the project for the cost of both board and lodging and utilities.
- The prototype estimates were based on the cost of materials and labor used in the construction of the prototype antennas. These materials were predominately procured in 2000. Since those estimates were made, the prices of the major commodities used to construct the antennas have increased by a large percentage. The major commodities that impact the production cost of the antennas include steel and oil in addition to the cost of labor. Steel makes up a significant portion of the 100 ton mass of the antenna. Oil is the major constituent of the carbon fiber used to construct the backup structure and feed legs. In addition, transportation costs are directly affected by oil costs.

The original offer by VertexRSI is compared to the prototype estimates in Table 9.1 below. Note that the non-recurring costs were not anticipated in the prototype estimate for the reasons outlined above.

Figure 9.1 below shows the recent history of commodity prices for both steel and oil. The prices for these commodities have increase more than 40% between the time that the prototypes were built and the timeframe of the original bids for the production antennas. As predicted by these graphs, the prices for these commodities have continued to rise since the bids were received.

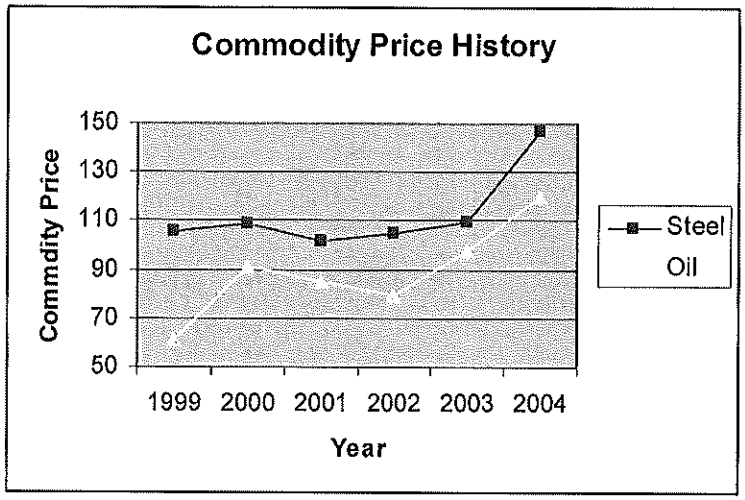

Figure 9.1: Commodity Prices

To help contain the cost increase, VertexRSI offered an indexed price in addition to their fixed price bid. The indexed offer provided a reduced floor price that was adjusted according to a formula based on published commodity prices. Under this option, a ceiling price equivalent to the fixed price offer limits the total cost of the contract but provides an opportunity to realize savings should commodity prices fall below the record highs of the past several years. The Indexing formulation is included in the draft contract available separately.

Over the course of negotiations with VertexRSI, the CSC explored the economic consequences of a range of Statement of Work and Technical Specification changes to obtain the most cost effective solution project wide. In addition, Vertex made price concessions. The history of the offers is shown in Table 9.1 below.

Offer Date	Validity	Prices		Notes
30-Apr-04	31-Oct-04	$209.2 $185.0 $174.6 $156.5 $217.5 $192.2	32 FFP 32+32 FFP 32 indexed (floor w/no cap) 32+32 indexed (floor w/no cap) 32 w/20μ option FFP 32+32w/20μ option FFP	Original Bids
8 Sep-04	31-Oct-04 Extended to 15-Dec by 29-Oct letter	$201.4 $192.6 $152.8 $172.5 $136.9 $160.0	32 FFP 32 FFP optimized schedule 25 optimized schedule (floor) 25 optimized schedule (ceiling) 25+25 optimized schedule (floor) 25+25 optimized schedule (ceiling)	Bid Confirmation
15-Dec-04	31-Mar-05	$152.1 $178.5 $141.7 $165.6	25 (floor) 25 (ceiling) 25+25 (floor) 25+25 (ceiling)	Bid extension
31-Mar-05	30-Jun-05	$170.8 $183.0 $153.0 $169.7	25 (floor) 25 (ceiling) 25+25 (floor) 25+25 (ceiling)	Bid Confirmation

Table 9.1: Price History

11. ATWG and JATG Reviews

During the summer of 2004, members of the CSC met with the JAO and ESO CAC in a series of face-to-face meetings held alternately near the Dulles and Heathrow airports. These meetings also included the Director General of ESO, the Director of NRAO and the AUI President. These meetings, and additional teleconferences, facilitated careful coordination of the procurements.

As part of the coordination process, the two Executives established two joint committees to provide advice on the remaining technical issues for both antennas. The first, the Antenna Technical Working Group (ATWG) analyzed all available data to better

understand and predict the performance of the two prototype antennas. The ATWG was unable to definitively resolve some key questions of antenna performance with the then-available data.

As a result, the Executives then created a Joint Antenna Technical Team (JATG) led by the JAO Project Manager to carry out additional tests on the prototype to resolve the remaining technical issues.

During late 2004 and early 2005 the JATG reanalyzed existing data and conducted a revised test program on the two prototype antennas at the ALMA Test Facility to clarify issues raised in 2004 about their ability to meet the ALMA antenna technical specifications. Performance data from the prototype antennas was used to demonstrate that the production antenna designs submitted to the project in mid 2004 would meet ALMA requirements.

The tests included:

- New radio holographic measurement and setting of the main reflector of both prototype antennas;
- New optical photogrammetry of both prototypes;
- Radiometric Out-Of-Focus beam mapping and beam cuts on the Vertex prototype;
- Optical pointing tests on the AEC prototype;
- Laser quadrant detector measurements on Vertex;
- Fast-switching tests to examine surface stability under accelerations encountered during normal operations;
- Examination of the need for cabin thermal regulation of the Vertex cabin structure.

Limits on structural deformations that would affect the scientific performance of the production antennas were derived from the tests and cross-compared between the different techniques. These include: astigmatism of the main reflector, non-homologous deformation of the reflector surface due to gravity; temperature effects; and wind and gravity deformation of the antenna backup structure. In many cases the performance of the antenna prototypes was compared to the vendor finite-element models to examine the accuracy of the antenna engineering models.

Based on all available data and the ATF testing done by the AEG and the JATG, it was the consensus view of the JATG that both prototype antennas meet the ALMA antenna specifications under direct consideration (surface accuracy at all elevations, all-sky absolute pointing performance) under the environmental conditions encountered during the testing, and that the production antennas based on these designs can also be expected to meet these specifications.

The full JATG report is included as appendix G.

12. CSC Final Recommendations

On April 15, 2005 the CSC met to determine whether the technical clarifications cited in its September 14, 2004 interim recommendation to the NRAO Director and AUI President had been sufficiently addressed. Based on the information and analyses contained in the JATG report, the CSC concluded that the Finite Element Model issue had been sufficently addressed. With respect to the life-cycle costs, the CSC noted that the RFP did not specifically cite power consumption. Nevertheless, it recommeded that during the design process pay careful attention to power consumption because of its implications upon operations costs.

Accordingly, the CSC recommended to the NRAO Director and the AUI President that authorization be sought from NSF to execute a contract with VertexRSI contingent on the following;

- ESO receives similar authorization from its Finance Committee
- The ALMA Director recommends and the ALMA Board concurs with the selection
- Successful final negotiations with VertexRSI held jointly with ESO and the JAO

Appendix A: JTET Report
Appendix B: Vertex Actions Regarding JTET Identified Deficiencies
Appendix C: AEG Report
Appendix D: BEC Report
Appendix E: CSC Recommendations
Appendix F: ATWG Report
Appendix G: JATG Report
Appendix H: VRSI Addendums to Proposal

Note:

The above Appendices are available for down load at the following url:

http://www.alma.nrao.edu/alma_antenna/