ALMA Operations
Risk Management Plan

Department:	ALMA
Organization	**ALMA Operations**
Product or Process:	**Risk Management Plan**
Process Owner:	

Version	Date	Author	Change Description
V1	9/10/2010	McKinnon, Lonsdale, Wingate	Initial

1. **Introduction to** Project Risk Management Plan Overview

All organizations, or projects, are susceptible to risks that jeopardize the organization's ability to achieve its mission. Risk management is the process of identifying and prioritizing these risks so that the organization's management can focus its resources towards eliminating those risks which are both high impact and highly likely to occur in a cost-effective manner.

The purpose of this document is to describe the risk management plan for North American ALMA Operations. Section 2 describes the methodology used for risk management. Section 3 lists the responsibilities for the members of the risk management team for NA ALMA Operations. The routine process for managing risks and updating the risk register is described in Section 4. Section 5 assesses the highest priority risks and their mitigation strategies within each category of NA ALMA operations having a high priority risk.

2. Risk Management Methodology for NA ALMA Operations

The risk management methodology for NA ALMA Operations is based on the standard process used in project management for risk mitigation. The process consists of five steps:

a. Identify risk issues and concerns.

b. Analyze the risks for their impact and probability, and then prioritize them.

c. Develop plans to decide what, if anything, is to be done about each risk.

d. Track the risks by monitoring triggers which indicate that the risk has occurred or is likely to occur in the near term.

e. Control risks by executing mitigation plans and actively removing risk from the risk register.

Risks are identified across NA ALMA Operations. These risks may have links to other elements of the ALMA Observatory, such as ALMA Construction, and of NRAO, such as Observatory Science Operations (OSO).

The probability and impact of the risk can be estimated from cost estimates, quantity estimates, decision trees to depict complex interactions, and professional judgment. The probability and impact of the risks are reviewed and agreed upon by the risk management team.

The process of analyzing risk helps identify risks that have a common root cause. These risks can be reduced or eliminated by addressing the common cause. Additionally, the analysis step may identify one element of NA ALMA Operations that is subject to multiple high risk items, in which case more management assistance will be needed in this area.

The risk priority, or rating, is determined by a Composite Index (CI = PxI), which is the product of a probability index (P) and an impact index (I). The indices range from zero to five, with five being the highest probability, or impact. The CI, then, lies in the range 0-25. A risk rating of low, medium, or high is assigned to a risk based on its numerical value of CI (see Table 1). The relative priority of the risks can be illustrated with a figure that plots probability index against impact index. The risks having the highest priority appear in the top right corner of the figure

(see, for example, Figure 1).

Composite Index Range	Risk rating
0-8	Low
9-16	Medium
17-25	High

Table 1. Risk Rating Determined from Composite Index

The plans developed for each risk depend upon the risk rating, or priority. The risks having both high probability and large impact will have highest priority. For these items, active measures will be taken to prevent the risk from occurring or detailed contingency plans may be developed for dealing with the risk should it occur. A low priority risk may be researched further, monitored, or accepted. The cost of risk mitigation strategies must be managed within the approved budget for NA ALMA Operations. The general methods for treating risks are summarized in Table 2.

Risk Treatment	Description
Tracking	Monitor for future action
Avoidance	Eliminate, withdraw from or not become involved
Reduction	Optimize: mitigate
Sharing	Transfer: outsource or insure
Retention	Accept and budget

Table 2. Methods for Risk Treatment

Each risk has an owner who monitors the risk trigger, notifies the risk management team that the risk has occurred, and implements the corrective actions needed to minimize the impact of the risk. The owner must be cognizant of his or her risk's interdependencies with other elements of the Observatory.

The list of risks is kept in a risk register. It contains a risk identifier (a coded number), a brief description of the risk, the risk's impact and probability, the risk's CI, and the risk treatment. The risks to the whole of NA ALMA Operations currently originate from ten (10) broad categories or elements, and the risk register is organized according to these categories. They are:

1. Science
2. Construction Inheritance
3. Site Operations
4. Chile Science Operations
5. NA Science Operations
6. Operations Computing
7. Management and Budget
8. Hardware
9. Education and Public Outreach
10. Safety and Security

3. Responsibilities

The risk management team consists of the Head of the North American Science Center (NAASC), NAASC group leaders, the NA ALMA Project Manager, the NRAO Program Manager, and an OSO representative. All team members can be risk owners. The responsibilities of the team members are

1. NAASC Group leaders and risk owners
    a. identify risks to the project, assess their impact and probability, and recommend corrective action to reduce or eliminate the risk
    b. take action to mitigate risks where required
    c. update status of identified risks
2. NAASC Head
    a. monitors overall risk to NA ALMA Operations
    b. ensures corrective actions are being taken to address high priority risks
    c. ensures risks are being actively retired by monitoring updates to the risk register
    d. ensures mitigation actions are managed within the constraints of the approved ALMA NA Operations Budget
3. NA ALMA Project Manager: communicates risk interdependencies between the NA ALMA Construction Project and NA ALMA Operations
4. NRAO Program Manager: assures all interdependencies between NA ALMA Operations and other elements of the NRAO are captured and communicated to NRAO Senior Management.
5. OSO Representative: communicates risk interdependencies between ALMA and OSO activities
6. Risk controller
    a. maintains the risk register
    b. solicits input from risk owners on risk status

4. Risk Management Process

The risk register will be updated by the risk management team on a quarterly basis. Progress on each risk item is recorded in the notes and comments sections of the register. Any changes in risk probability and impact, as determined by the team, will also be recorded during the updates. Those risks that are deemed retired by the team will be listed as such on the register, but will remain on the register for historical reference. Team members will identify new risks over the course of their work. These risks will be added to the risk register with team concurrence on the risks' impact and probability. A change control record will be kept describing all changes that are made with each update to the register.

5. Risk Assessment and Management

The risk register for NA ALMA Operations was developed, and the highest priority risks for each of its elements were determined in accordance with the methodology described in Section

2. High priority risks were identified in the categories of Construction Inheritance, Site Operations, Chile Science Operations, NA Science Operations, and Operations Computing. The risks for these categories are summarized in the CI risk charts below (see Figures 1-5). The highest priority risks and their mitigation strategies are described below. The treatments, owners, and interdependencies for these risks are identified in the risk register.

Construction Inheritance

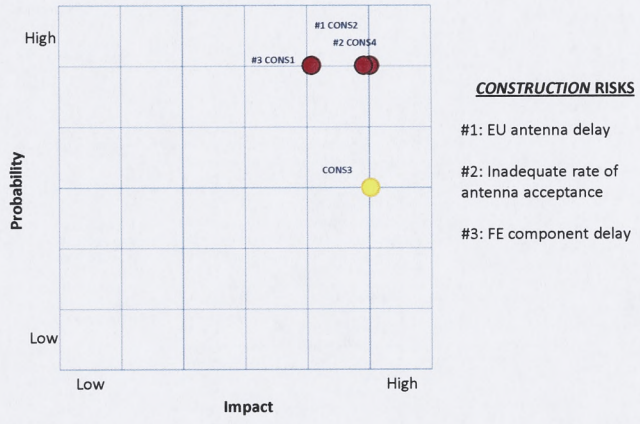

Figure 1. Composite Index Risk Chart for Construction Risks

The ALMA Construction Project actively manages its risk through its own risk management plan and risk register. Some of these risks, however, may carry over into the operational phase of ALMA and are carried in the risk register for NA ALMA Operations. The Construction Inheritance category contains three high risk items: Front End component delay, European antenna delay, and inadequate rate of antenna acceptance.

CONS1 – Front End component delay

The source of this risk is that the delivery of components for the antenna front ends is delayed. Its threat is to the delay in the completion of the array and thus a delay in science observations. The risk is being mitigated within the construction project through corrective actions, such as expediting the delivery of vendor components, working overtime, paying premiums for component delivery, and requesting waivers on components performance specification. As a contingency, the scope of timing of the delivery schedule could be revisited and optimized, or even more resources could be added to the Front End group. These contingency measures will require additional funding.

CONS2 – European antenna delay

The source of this risk is the delivery of the European antennas is delayed. It poses a threat to the completion of the project and thus a delay in science observations. It is being mitigated by adding staff to the production of the antennas and in the oversight of the production, both by the antenna manufacturer and by ESO. Short of accepting the delayed delivery rate, there are no other contingency measures to be taken.

CONS4 – Inadequate rate of antenna acceptance

The source of this risk is the AIV team cannot keep pace with testing, verifying, and integrating the delivered antennas into a working array. Its threat is also to the completion of the project and the start of science observations. The risk can be mitigated by optimizing the scope of AIV tests and assigning additional staff to the AIV work. Possible, yet undesirable, contingencies to this mitigation strategy would be to accept the antennas as delivered or to continue with testing as currently planned and accept the antenna delay.

Site Operations

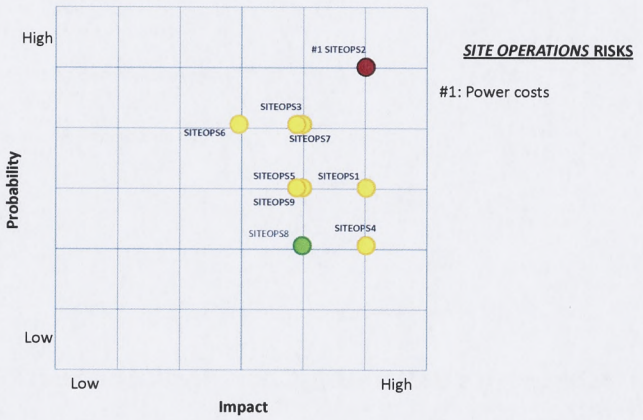

Figure 2. Composite Index Risk Chart for Site Operations Risks

The Site Operations category has a single high priority risk, and that is the escalation of power costs for full ALMA operations. The threat posed to ALMA operations is the array will operate at less than full capacity and the science output of the instrument will be compromised. The threat is being mitigated by implementing a combined cycle option on the turbine generators purchased to power the array. The option recovers heat from the turbine exhaust to power a steam-driven turbine generator. Additionally, this risk, like many others to the operations budget, can be mitigated by reducing the number of operating antennas, limiting observations to certain times of the year and/or day, and minimizing the use of observing modes having high power consumption. These measures come at the expense of reduced science throughput and/or capability. As contingency, we could investigate and implement alternative sources of energy, but at significant capital cost. Also, we could accept reduced observing efficiency until additional funds could be secured.

Chile Science Operations

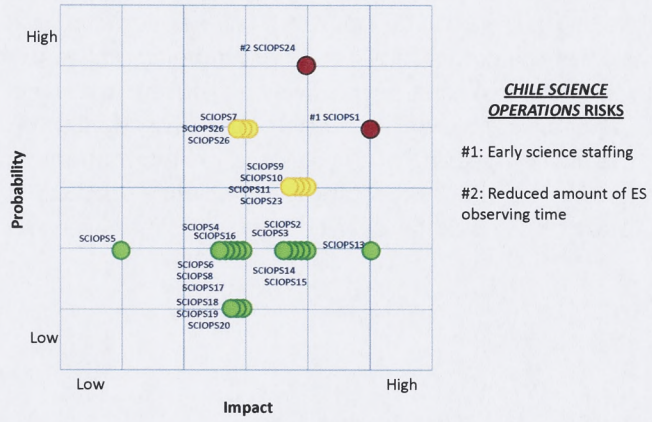

Figure 3. Composite Index Risk Chart for Chile Science Operations Risks

There are two risks with high ratings in Chile Science Operations. These are that the scientist staffing requirements for AIV/CSV and Early Science (ES) activities are concurrent and exceed available resources; and that little observing time will be available for ES observations due to technical problems or due to increased time needed by CSV (Commissioning and Science Verification).

SCIOPS1 – Early Science staffing conflict

The source of this risk is that when Early Science begins there will still be substantial numbers of staff tied up with AIV (Assembly, Integration and Verification) and CSV activities, so that the number of staff available for supporting ES is reduced below plans. This situation is likely to occur if there are substantial delays to the acceptance of antennas by the construction project, which in turn would lead to delays in the pace of commissioning and science verification. The threat that is introduced by this risk is that ES operations will be less efficient because of the reduced staffing level. To mitigate this risk, it is important to complete the ramp-up of the scientific staffing within the Department of Science Operations (DSO) as expeditiously as possible. In addition there is the possibility of sending scientists from the ARCs to Chile to assist the DSO staff with ES operations; however, this reduction in staff at the ARCs would then trigger other risks for science operations at the ARCs. A possible contingency for mitigating this risk is to enlist the help of visiting scientists to temporarily boost ES staffing. The only other realistic contingency is to delay the start of ES until AIV and CSV have progressed significantly. Barring that, the delays in AIV and CSV and the reduction in ES efficiency would have to be accepted.

SCIOPS24 – Reduced amount of ES observing time

The source of this risk is that the CSV activity will require access to the array for a larger fraction of the time during the ES phase than planned due either to technical problems with the array or to delays in CSV. The threat that arises from this risk is that there will be a very small

amount of time for user observations during ES and consequently that the user community will become frustrated and disappointed that ALMA is not able to deliver the data at the rate expected. If the triggering of the risk is not foreseen when proposals are accepted for scheduling, it is possible that a large fraction of users will not get data at all, significantly worsening the frustration of the community and the community image of ALMA. The ultimate resolution of the source of this risk is to aggressively diagnose and correct the technical and/or CSV delay problems. The threat to the frustration of the observers can be mitigated by pro-active recognition of the likely triggering of the risk and prompt communication of the situation to the user community to lower their expectations for science productivity during ES. As a contingency plan, the start of ES could be delayed until the issues are resolved.

NA Science Operations

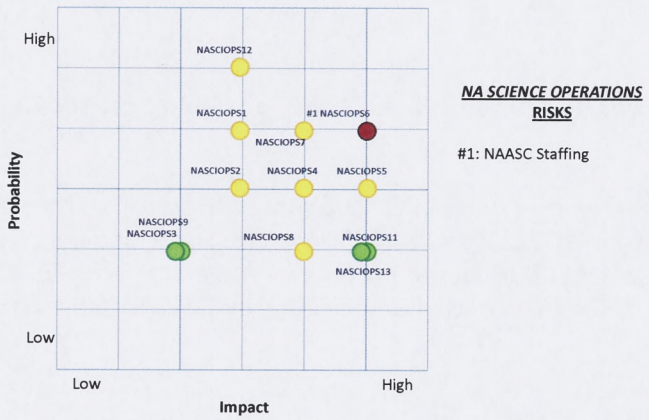

Figure 4. Composite Index Risk Chart for NA Science Risks

There is one risk with high rating in NA Science Operations (NASCIOPS6 – NAASC staffing). This risk is NAASC staffing is inadequate, either because hiring fails to keep pace with NAASC ramp-up, or staff takes long term personal leave.

The source of this risk is that there is a shortfall in the planned staffing profile, and therefore that the staffing levels at the NAASC are not high enough to meet the requirements of the operating plan. The threat that is triggered by this situation is that the NAASC services to the user community will be reduced, such as reduced levels of training, increased response times to helpdesk tickets and reduced visitor support levels. There is also a threat of staff burnout if the staffing reduction leads to unavoidable periods of high workload, such as technical assessments of proposals and the verification of scheduling blocks, both of which must occur within short time windows. This risk can be mitigated by pro-active hiring strategies to complete the NAASC staffing ramp-up. If there are slower than anticipated hiring timescales, or if a staff member takes an unexpected long personal leave, the risk can be mitigated by temporarily bringing in NRAO staff from other divisions to compensate. As a contingency, the NAASC could hire more temporary staff and postdocs, and solicit sabbatical visits by experienced scientists.

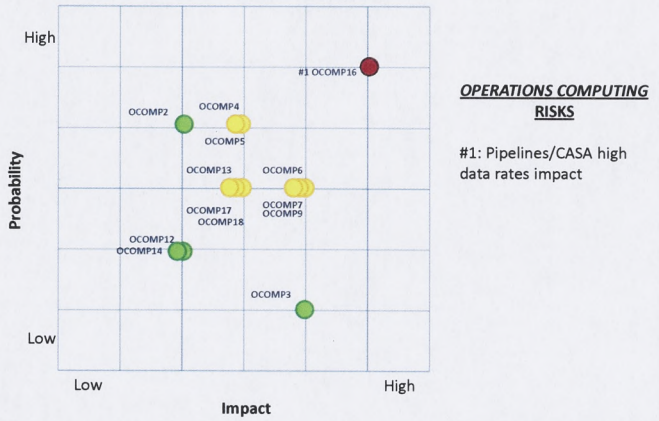

Figure 5. Composite Index Risk Chart for Operations Computing Risks

There is one risk with high rating in Operations Computing (OCOMP16: CASA/pipeline software algorithms). This is that the CASA algorithms when scripted into a pipeline do not run fast enough to allow the ALMA pipeline to keep up with the pace of observations. The source of this risk is that pipeline processing will not keep up with the pace of observing. The pipeline must at least operate as fast as the observations are taken due to inadequate software optimization. The risk is highest for peak data rate projects. The construction project did not support a contingency call to alleviate this potential. The threat is that high data rate projects will "jam up" the pipeline, and consequently the release of high data rate projects to observers will be delayed. There is also a threat that users will be unable to effectively re-process large data sets due to unreasonably long processing times. This risk can be mitigated with two approaches: optimization of the software algorithms and use of innovative processing solutions. R&D effort is needed on parallelization of multi-channel data sets by splitting the data by channel or time. This will require re-allocating CASA staff to the task or hiring personnel with HPC expertise. Solutions are also possible through purchase of faster processors, depending on the price/performance ratio attainable. As for contingency, large NA data sets can be processed using the NAASC cluster instead of in Santiago. There is also the possibility of outsourcing large processing tasks to supercomputing resources, which in turn requires some R&D into porting of CASA to the supercomputer.

In addition, to these risks ranked high, all other risks ranked medium and low are tracked within the register for each of the categories.

APPENDIX A

Risk Register

Risk Management Plan Approvals

Prepared by:

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Project Manager

Approved by:

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Project Sponsor

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Executive Sponsor

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Client Sponsor