B. ATACAMA LARGE MILLIMETER ARRAY

B.1 Overview

FY 2010 will be a year of major ALMA construction progress. The most significant FY 2010 event will be the achievement of closure phase at the high-elevation Array Operation Site (AOS) in Chile. By the end of FY 2010, ALMA will be capable of aperture synthesis and imaging with six or more antennas. FY 2010 will also establish the steady state, full-production delivery of Back End (BE) and Front End (FE) units to Chile and to the Europe and East Asia Integration Centers. Road and power infrastructure construction will continue and move strongly forward. A dozen Vertex antennas will be accepted in Chile, recovering significant schedule. The third correlator quadrant will be installed at the AOS Technical Building. NA ALMA personnel will be heavily engaged in assembly, integration, and verification and commissioning activities.

FY 2010 will also see significant progress in preparations for ALMA Operations and Early Science, including initiation of the NA ALMA Mirror Archive; deployment of the ALMA Helpdesk and User Portal; the initiation of NAASC staff rotations to Chile to support ALMA commissioning; submission of a NSF proposal for FY 2012-16 ALMA Operations; significant user software testing; an Operations Readiness Review; creation of improved end-user documentation and web resources; user tutorials and workshops; and continued simulation and tool development for observation planning and data analysis.

B.2 Construction

The major FY 2010 activities for each NA ALMA Construction Integrated Project Teams (IPT) are described below.

Management IPT: A regular schedule of project-wide schedule, budget, and configuration control board meetings was inaugurated in FY 2009 and will be firmly established by early FY 2010. This will maintain tight control of ALMA resources and provide for their optimal allocation across the project. The Annual ALMA External Review will be conducted in November 2009. A comprehensive cost-to-complete (CTC) exercise will be conducted in late FY 2009; its outcomes will be implemented in FY 2010. Three Schedule Reviews are scheduled in FY 2010; each will include a CTC update.

Santiago, Chile Office: The Office of Chilean Affairs in Santiago supports the legal and business affairs of AUI/NRAO in Chile. Activities on behalf of the North America component of ALMA construction in Chile will include the construction of roads and utilities for the AOS power, and fiber optic distribution to the antenna pads. This office will continue its administrative activities at the ALMA site, including support of the Vertex activities, and contracts for security, catering, cleaning and camp maintenance. Assembly, Integration, and Verification (AIV) tasks will be supported as front end, back end, and correlator equipment and personnel continue to arrive from NA. With local labor legally under the purview of AUI/NRAO, the Office of Chilean Affairs will continue its oversight of ALMA Human Resources activities, including contracts, payroll, and travel support. The Office of Chilean Affairs has to directly monitor and interact with the newly-formed labor union of local staff AUI employees. The Fiscal Department will manage payment of purchases made in Chile via the NRAO for ALMA construction and operations. This office is also responsible for local property management, and NRAO import/export activities for ALMA. Continuing site protection activities will include supervision of ALMA mining claims, external claims monitoring (e.g., water and geothermal claims), monitoring of RFI-related activities, and functioning as the channel for formal government and community contacts. The office will also continue supporting the relocation and cultural immersion of expatriates and their families to Chile.

Site IPT: In FY 2010, the NA Site IPT will execute the contracts for the AOS road construction, and the construction of the AOS power and fiber optic network. Roads and utilities were prepared for two antenna foundations in FY 2009 to enable closure phase with three antennas in early FY 2010.

The NRAO is also responsible for the AOS design and construction, including the Technical Building, the Transporter Hangar, roads, power distribution, and communications. The AOS antenna foundations were transferred to ESO via the rebaselining process. The final stage of the road construction, the top surface, will be bid in early FY 2010 and executed during FY 2010-11.

Antenna IPT: In FY 2010, the Antenna IPT will obtain full acceptance of twelve Vertex antennas, units 5 - 16, a major step toward realizing ALMA and enabling science. Vertex will recover significant schedule in FY 2010 and be close to their original proposed schedule by the end of FY 2010.

In FY 2010, the Antenna IPT will also obtain full acceptance for the first Nutator unit, which will be delivered and accepted at the Operations Support Facility (OSF) in early FY 2010. Nutator units 2 - 5 will be delivered to the OSF in Q3 FY 2010; and units 3-6 of the Optical Pointing Telescope will be delivered to the OSF in Q1 FY 2010.

Front End IPT: In FY 2010, the NA ALMA Front End (FE) IPT will complete the commissioning and verification of the Front End Test and Measurement System at the NRAO Technology Center (NTC) in Charlottesville by commissioning a complete second test station built during FY 2009 with two full test stations in Q3 FY 2010. This will accelerate Front End testing and constitute a backup for integration and testing.

The FE IPT will complete a Critical Design Review for the entire FE assembly in Q1 FY 2010. The third through sixth NA FE assemblies will be completed and delivered to the OSF. Support will be provided for use of the FE assemblies in ALMA antennas, including interferometry at the OSF.

The Local Oscillator (LO) Warm Cartridge Assemblies through unit 40 for ALMA bands 3, 6, 7, and 9 will be delivered throughout FY 2010. The first 25 production FE Support Structures will be delivered to the OSF in Q2 FY 2010. During FY 2010 the FE will deliver Band 3 cartridges #21-44 and Band 6 cartridges #15-38.

Back End IPT: In FY 2010, the Back End (BE) IPT will deliver Antenna Articles 11 through 38 to the OSF. Each Antenna Article consists of an analog rack and a digital rack for an ALMA Back End. Sufficient Data Receiver Articles (DRXA) to populate the final quadrant of the correlator will be delivered to the Correlator IPT in Q2 FY 2010. The DRXAs input the electronic data stream from each antenna's fiber optic output, then de-code and re-format this data stream for input to the correlator.

Eight additional Line Length Correctors (LLC) and Subarray Switches (SAS) will be delivered for the Central LO Article (CLOA) 1, allowing it to accommodate 16 antennas. These LLCs and SASs are required to maintain phase stability between the ALMA antennas. The CLOA1 is used by the Bi-lateral and ALMA-J arrays; these specific LLC LRUs are funded solely through ALMA-Japan (ALMA-J). LO Photonic Receiver Articles (LPRA) 9 through 40 will be delivered to the FE IPT in FY 2010; fifteen of these will be built using ALMA-J funds. The LRPAs create the tuning signal for the ALMA Front Ends.

Design and construction of the Single Dish Timing Rack is an increase in scope for the Back End IPT. This equipment will provide the timing necessary to simultaneously test up to four antennas at the OSF. The Single Dish Timing Rack will be delivered to the OSF in Q1 FY 2010.

Correlator IPT: The ALMA Correlator IPT will complete the checkout of the second quadrant of the correlator, which was delivered and installed in FY 2009. The third quadrant will complete testing and be delivered and installed in the AOS Technical Building in late FY 2010. The fourth quadrant will complete assembly and be partially tested in Charlottesville. The operational software and firmware needed for initial operation in Chile will be further enhanced and refined. The Correlator IPT will also support the 2-antenna correlators for AIV activities at the AOS and the OSF.

Computing IPT: The NA Computing IPT will concentrate on supporting Assembly, Integration, Verification and Commissioning (AIVC) in Chile as ALMA transitions from single-baseline interferometry at the OSF to multi-baseline interferometry at the AOS, including support for new devices such as the water vapor radiometer, production optical telescope, nutator, etc. In addition, the Computing IPT will continue the longer-term development required for the later stages of commissioning and operations. This includes preparing a first-generation scheduling simulation tool to support the first call for proposals in 2010, more advanced pipeline data reduction heuristics, e.g., to support mosaicing, and improved quick look and device displays. ALMA software release R7.0 will occur in Q1 FY 2010; release R7.1 is scheduled for Q3 FY 2010.

CASA will continue to support AIVC and focus on the Priority 1 and 2 requirements for Early Science, while also working to improve the performance of large dataset sizes on single nodes and across a cluster, as will be required for pipeline processing. CASA release 3.0, the first non-beta release, will occur in Q1 FY 2010.

The Computing IPT will continue to add the hardware to support real-time array operations of the array, e.g., the full complement of antenna real-time computers will be procured in Q2 FY 2010.

System Engineering and Integration IPT: A restructuring of the Systems Engineering and Integration IPT (SE&I) is underway after completion of prototype system integration that will result in the following adjustments: System Engineering (ESO task), Product Assurance (NRAO task), System Verification (NRAO task) and Assembly, Integration & Verification (JAO task). The proposed adjustments of System Engineering (SE) and Product Assurance (PA) will increase staffing and modify the reporting structure. PA and AIV will continue to report directly to the Project Engineer and indirectly to the Project Manager. SE will report directly to the Project Manager. The new sub-group for System Verification will report to the Project Engineer. The staffing increases will result in three new PA positions and three new SE positions in Chile, and one new PA and one new SE position in NA. The currently open and funded NA software quality-assurance position is being evaluated for possible transfer to Chile.

Work will begin in Q1 FY 2010 on updating the ALMA Product Tree and documentation structure to support producing a requirements traceability matrix. For FY 2010, PA will support an external evaluation of project-wide quality processes and resources. A team consisting of one external member, the ALMA PA Manager, and the JAO PA Manager will perform the audits and generate reports for evaluation by management.

SE&I will work with the Computing and Science IPTs to develop dynamic interferometry and other functionality at the OSF.

Science IPT: In FY 2010 the ALMA Science IPT will continue executing its plans for commissioning activities as the first astronomical validation begins at the AOS. Activities at the OSF, including support for the Antenna IPT preparing production antennas for handover to AIV, as well as support of the AIV team as production antennas and other components are evaluated, will continue. Although most production ALMA interferometric system elements have been implemented at the OSF, some testing support will still be necessary for antennas and for more recently integrated components, such as calibration devices, water vapor radiometers, optical pointing telescopes, and

nutators. A primary FY 2010 milestone will be the demonstration of phase closure with the implementation of the first three antennas at the AOS. Accomplishment of this milestone will mark the start of commissioning.

As ALMA functionality builds, the array at the AOS will become increasingly capable. By the end of FY 2010, aperture synthesis and imaging with six or more antennas will be available. At this point, the antennas within the array will be located on short baselines. Two phase correction techniques will be tested and demonstrated: (a) fast switching between calibrator and target object, and (b) atmospheric water vapor content measured with the 183 GHz radiometers, modeled and applied at the frequency of observation.

Community involvement with ALMA will continue through NAASC workshops and at other venues, including interferometry schools.

National Astronomical Observatory of Japan (NAOJ) Partnership (SPO-7)

The NRAO is responsible for several work packages funded by NAOJ. Both the *Goods and Services Master Agreement* with Japan and the *Goods Supply Contract* that will supply Back End electronics and Warm Cartridge Assemblies for the Atacama Compact Array (ACA) are in place. The required work is underway and will continue into FY 2010.

Goods and Services Master Agreement

The NRAO will deliver four types of ACA Front End components to NAOJ: components to complete and commission the East Asia Front End Integration Center (EA FEIC); components to build and test cartridges for Bands 4 and 8; components to integrate and test FE assemblies at the EA FEIC; and, under separate agreement, components to develop Band 10 cold cartridges.

Goods Supply Contract

This work covers the "Signal Transmission, Conversion and Evaluation System" described in the MOU on Execution of the Goods Supply Contract. This contract requires that the NRAO develop and deliver the ACA antenna-based Back End components (16 sets), extend the central reference equipment to accommodate the ACA, and to supply at least one Warm Cartridge Assembly for each band (3, 4, 6, 7, 8, & 9), increasing the number up to a maximum of 16 for each band, depending on funding.

The following will be delivered in FY 2010: Antenna Articles 12-19 (completes requirements); LO Photonic Receiver Articles for units 17-24 (completes requirements); and Subarray Switches and Line Length Correctors 9-16 for Central LO Article I.

B.2.1 Major Milestones

Table B.2.1: FY 2010 ALMA Construction Milestones

Program (IPT)	Project	Q1	Q2	Q3	Q4	Notes
Management	AAER	1				
	Cost to Complete	2				
Site	AOS Utilities Construction	3		4		
Antenna	NA Antenna Acceptance	5,6, 7	8,9,10	11, 12, 13,	14,1 5,16	
	Nutator Acceptance	17,		18		
	OPT Delivery	19				
Front End	FE Assembly CDR	20				
	Integrated FE Delivery	22	23,	24	25, 26,	
	FEIC Cartridge Delivery	27, 31, 35	28,32, 35	29, 33, 35	30,3 4,35	
	FE Support Structure Delivery		21			
Back End	Antenna Article Delivery	36	37	38	39	
Correlator	Quadrant Delivery	40			41	
Computing	ALMA Software Releases	42		43		
Science	Phase Closure and synthesis images		44		45	

Milestones:

1. Provide AAER materials and presentations
2. Complete cost to complete exercise
3. Complete Phase II of AOS utilities construction
4. Complete Phase III of AOS utilities construction
5. Acceptance of NA Antenna #6
6. Acceptance of NA Antenna #7
7. Acceptance of NA Antenna #4
8. Acceptance of NA Antenna #8
9. Acceptance of NA Antenna #9
10. Acceptance of NA Antenna #10
11. Acceptance of NA Antenna #11
12. Acceptance of NA Antenna #12
13. Acceptance of NA Antenna #13
14. Acceptance of NA Antenna #14
15. Acceptance of NA Antenna #15
16. Acceptance of NA Antenna #16
17. Acceptance of Nutator #1
18. Delivery to OSF of Nutators #2-#5
19. Delivery to OSF of OPTs #3-#6
20. Complete CDR of FE assembly
21. Delivery to OSF of 25 FE Support Structures
22. Delivery to OSF of Integrated FE #2
23. Delivery to OSF of Integrated FE #3
24. Delivery to OSF of Integrated FE #4
25. Delivery to OSF of Integrated FE #5
26. Delivery to OSF of Integrated FE #6
27. Delivery to FEIC of Band 3 cartridges #21-24
28. Delivery to FEIC of Band 3 cartridges #25-32
29. Delivery to FEIC of Band 3 cartridges #33-36
30. Delivery to FEIC of Band 3 cartridges #37-44
31. Delivery to FEIC of Band 6 cartridges #15-19
32. Delivery to FEIC of Band 6 cartridges #20-24
33. Delivery to FEIC of Band 6 cartridges #25-34
34. Delivery to FEIC of Band 6 cartridges #35-38
35. Delivery to FEIC of LO Warm Cartridge Assemblies
36. Delivery to OSF of Antenna Articles #11-18
37. Delivery to OSF of Antenna Articles #19-22
38. Delivery to OSF of Antenna Articles #23-31
39. Delivery to OSF of Antenna Articles #32-38
40. Deliver to AOS second quadrant of Correlator
41. Deliver to AOS third quadrant of Correlator
42. ALMA Software Release R7.0
43. ALMA Software Release R7.1
44. Demonstration of phase closure at AOS
45. Obtain aperture synthesis images with 6 antennas

Note, table does not include Japan Partnership deliverables.

B.3 Operations

B.3.1 North American ALMA Science Center

Science Operations

The North America ALMA Science Center (NAASC) supports internationally-approved ALMA regional core operations and North American (NA) support operations beyond the core elements. Core tasks include international project coordination, commissioning and science verification (CSV), observing preparation, observing support (Astronomer-On-Duty in Chile, quality assurance), and post-observation support (offline software and archive). Activities beyond these core tasks include organizing the Canadian contribution to NA ALMA Operations, the ALMA North American Science Advisory Committee (ANASAC), community development (visitors programs, workshops, tutorials), postdoctoral and student programs, and NAASC Education and Public Outreach (EPO).

The generation of a proposal to NSF for FY 2012-16 NA ALMA Operations and the NAASC will be a major FY 2010 activity. A proposal draft is due Q3 FY 2010; a review is expected Q4 FY 2010.

International Coordination
During Q1 FY 2010 the NAASC will work with the Joint ALMA Observatory (JAO) to update the ALMA Operations Plan (AOP) and budget and propagate any changes to the NAASC. With JAO staff and ALMA Regional Center (ARC) Managers, the NAASC will participate in the Science Operations Integrated Project Team (IPT) via periodic telecons and face-to-face meetings. Tasks will include a review of ALMA Science Operations implementation plans in early 2010, NA User Portal test and deployment, including interfaces to the NA Science Archive, ALMA Helpdesk, and proposal review tools; and a Science Operations Readiness Review in late 2010. NAASC personnel will also participate on the international search committees to recruit JAO Operations Astronomers.

Commissioning and Science Verification (CSV) Support
NAASC scientists take part in CSV to train for operations and obtain hands-on experience with ALMA science data. FY 2010 will see the first NAASC trips to the Operations Support Facility (OSF) to participate in Assembly, Integration, Verification & Commissioning (AIVC). The NAASC will provide 12 person-months support in FY 2010. NAASC staff will attend weekly AIVC meetings via videoconference and assist with CSV data analysis and trouble-shooting. NAASC staff will also retrieve and reduce CSV datasets to become expert in ALMA observing and data reduction, and develop test data sets for tutorials. The NAASC will participate in monthly Science IPT meetings to assess the scientific impact of construction issues.

Canadian Partnership
The Canadian astronomy community is a partner with the U.S. community in ALMA. Canada will contribute 1 FTE to support ALMA core activities, including OSF trips for CSV. They will also contribute significantly to end-user documentation and participate in ALMA tutorials.

User Support
In Q1 FY 2010, the NAASC will deploy a new Science User webpage. ALMA status, tools, and available modes will be posted in a timely manner, tutorials will be advertised, and software tools and documents will be made available. NAASC staff will participate in the 2010 AAS meetings to publicize ALMA and NA opportunities.

Participation in testing and evaluation of ALMA user software will be a key FY 2010 task. NAASC staff will continue testing and exercising the Common Astronomy Software Applications (CASA) offline software, the ALMA Observing Tool, the pipeline, and archive. NAASC staff will participate in the first user tests of other software systems, such as the Phase I Manager and Helpdesk. NAASC

involvement will help ensure Early Science software readiness. Testing and initial documentation of user software will be completed by Q4 FY 2010 and be followed by an Operations Readiness Review. A positive review outcome will be required for ALMA Early Science to start in 2011.

The NAASC is committed to ensure the readiness of the CASA, the offline data reduction and analysis software package being jointly developed for ALMA and EVLA by NRAO. The NAASC also supports the development of the ALMA simulator and will begin to produce a simulation library based on the Design Reference Science Plan. NAASC also participates in setting and prioritizing software development targets, organizing software testing, releases, and tutorials, updating the CASA cookbook, and producing release notes and FAQs. The first full CASA release, which will also be used for EVLA Early Science, will occur in Q1 FY 2010. A second release is expected prior to the ALMA Operations Readiness Review. NAASC staff will take over maintenance of the CASA Cookbook during FY 2010 and will generate data reduction use cases pertinent to ALMA, including paths for importing data from other millimeter observatories.

By FY 2010, the NRAO will have deployed the modern Helpdesk system, Kayako, which is also used by Spitzer and Herschel; ALMA will likely adopt this system. NAASC staff will train with Kayako and work on a configuration that will serve both ALMA and NRAO needs. The NAASC will hire four data analysts to perform Helpdesk "triage" and service to straightforward queries. These analysts will take part in tutorials relevant to ALMA support functions: document and website maintenance, data media mastering and delivery, and logistic support for tutorials and schools. In future years, these analysts will participate in additional training demonstrations and validation of ALMA observing sequences.

By summer 2010, the user software will be mature enough to warrant a significant investment in improved documentation, and CASA tutorials will be held in the spring and summer. Tutorials for the observation tools will be prepared and will likely commence after the Operations Readiness Review.

NA ALMA Archive

Each ARC will maintain a mirror copy of the ALMA archive and pipeline, eventually containing a complete copy of all observational data and pipeline products published to the central ALMA science archive in the Santiago Central Office (SCO). This system will be a copy of the archive system being developed by the construction project for the SCO. The NA archive system and mirroring process must be installed and tested well before the first Call for Proposals in December 2010. In early FY 2010, the NAASC will place orders for the archive equipment and begin hiring the Archive team. The first archive components should be installed by Q3 FY 2010 and will enable testing of data replication with the central archive.

Community Professional Development and the ANASAC

The ALMA North American Science Advisory Committee (ANASAC) remains the primary means of communication between the NAASC and the NA user community and an important resource to the NA members of the ALMA Science Advisory Committee (ASAC). The ANASAC will also provide input to the ASAC on charges from the ALMA Board. The NAASC will sponsor long-term visits from three astronomers in FY 2010.

Talks on ALMA status and science will be made at the 2010 American Astronomical Society (AAS) meetings, and at U.S. and international institutions. NAASC staff will generate material for and give presentations to key community committees, including the ANASAC, ASAC, the NRAO Visiting Committee, the NRAO User Committee, AUI Board of Trustees, and others as needed.

Postdocs and Students

The prestigious NRAO Jansky Fellowships are designed to attract and train the best young scientists to radio astronomy research. They can be based at U.S. universities or research laboratories, or any

NRAO facility. The Jansky Fellowship program is managed by the Office of Science and Academic Affairs (OSAA). Since ALMA will be a world-class research facility, attracting the best graduate students and postdoctoral fellows into ALMA-related research is vital. To accommodate the anticipated increased interest by young scientists in ALMA, the NAASC will support three Janksy Fellows in FY 2010, with a fourth expected to start in late FY 2010.

The NAASC also supports an ALMA Postdoctoral research program to help train future millimeter/submillimeter astronomers. Unlike the Jansky Fellows, these postdocs have modest ALMA service duties. The first postdoc of this type was hired in late FY 2009 to evaluate CASA software and develop paths for Sub-Millimeter Array (SMA) data into CASA. A second postdoc will be recruited in FY 2010 to work with *Splatalogue*, the molecular spectral line database.

Education and Public Outreach

The NAASC will cultivate coverage of ALMA in the popular media, champion a public-friendly ALMA web presence at NRAO and internationally, and create non-news thematic content for the public website (see the Education and Public Outreach section). The NA ALMA EPO Program Officer represents NA on the international ALMA EPO Working Group, contributing to the definition and development of EPO resources shared among and created in partnership with the other Executives and the JAO. The NAASC will also collaborate with our partners to prepare and distribute news releases that publicize significant ALMA milestones, and will recruit a science writer to support these goals.

By FY 2010, the NAASC will have deployed a restructured website aimed primarily at the science community. Throughout FY 2010 the NAASC will review and restructure the NRAO and NAASC ALMA web pages to better promote ALMA, especially to non-traditional users, and to provide intuitive access and understanding of ALMA capabilities and tools during Early Science. The NAASC will also enhance the effectiveness of our science conference exhibits as vehicles for demonstrating progress in the development of the observatory and of tools that support users. The NAASC will actively solicit ALMA-related articles for NRAO and other science community newsletters.

ALMA Special Projects

Special projects include two tasks viewed by the NRAO as critical to ALMA success that are not defined in the AOP as part of international operations: (1) SIS mixer development and (2) the molecular and atomic spectral-line database, *Splatalogue*.

SIS Mixer Development

State-of-the-art SIS mixers are key to ALMA receiver sensitivities. Future SIS mixer technology developments will improve ALMA receivers, particularly at higher frequencies. The ultimate goal is a low-noise, wideband, sideband-separating SIS mixer for 780 – 950 GHz (λ = 350 μm). Success in developing new superconducting circuits could lead to SIS receivers for the 1.03 and 1.3 THz atmospheric windows.

Chip availability for repairing SIS mixers in Bands 3 and 6 requires a suitable SIS foundry. In 2009, the University of Virginia Microfabrication Laboratory (UVML) was selected to continue its Band 10 technology development and to manufacture and supply ALMA replacement SIS mixer chips through FY 2013. The UVML is one of two existing U.S. foundries and has developed a stable, repeatable process for making Nb-based SIS mixers. The UVML represents a capital investment of approximately $10M in research and test equipment and years of the technological expertise required to maintain a working R&D facility and a stable SIS mixer-fabrication process. Loss of support for the UVML group would result in the irreversible loss of technology essential to ALMA.

During FY 2010 the UVML will continue development of Nb/Al-AlN/NbTiN SIS junctions. This work supports 1.5 FTE engineering research staff and a graduate student, and includes funds for targets and substrates and clean-room time. While UVML develops the new materials and fabrication processes, the NRAO Technology Center (NTC) will prototype the 350 μm mixer to optimize a new mixer design. A quadrature hybrid, essential to sideband-separating and balanced mixers, on a thin silicon membrane has been fabricated and successfully tested at 385 - 500 GHz using a vector network analyzer at Virginia Diodes, Inc.

Splatalogue

The NAASC supported creation of the *Database for Astronomical Spectroscopy: Splatalogue*, the most complete publicly-available database of molecular transitions from centimeter to submillimeter wavelengths. This database is essential for the use of ALMA as a spectral-line instrument, and for other facilities operating between several hundred Hz to 10+ THz. In FY 2010, the NAASC plans to work closely with our international partners to integrate Splatalogue into ALMA subsystems such as CASA, and to define a common protocol for spectral line databases.

ALMA Technical Support

NAASC technical support to the ALMA Observatory for hardware and software delivered by NA is essential. FY 2010, NA software support includes development of the CASA offline software system. The NAASC shares this support with the EVLA, with the NAASC share accounting for 3.5 FTE. These developers generate the software to meet the ALMA offline subsystem requirements; respond to bug reports; and support CASA releases and patches, tutorials, tests, and the ALMA simulator development.

In Q4 FY 2010, 11 software engineers from the ALMA Construction Computing Integrated Product Team will have delivered their software subsystems, primarily Monitor and Control software. These personnel will transfer to Operations to maintain and further develop this software, as required by the international partnership.

By FY 2010, the warranty on the first NA delivered hardware will have expired, and the NAASC must service any NA delivered modules returned from Chile for repair. These will include components built and delivered by NA as part of the bilateral project, and components built by NA and delivered by East Asia via the trilateral project. NTC engineers and technicians working on ALMA Construction will provide this support. All such activity will be unscheduled maintenance, and matrixing this activity to NTC leads to significant savings compared to outsourcing or hiring separate maintenance staff. East Asia will compensate NA for component maintenance associated with their construction deliverables.

ALMA Development Support

This unit supports NA ALMA development efforts, such as workshops. The ANASAC has been charged with recommending how to organize these efforts in NA.

ALMA Chilean Operations

This NAASC program element provides the NA contribution to the Joint ALMA Observatory (JAO) operations costs in Chile, accounting for 57% of the total NAASC budget in FY 2010. Major hiring activities for FY 2010 will include recruiting 6+ operations astronomers and the Santiago archive group, and the implementation of a Computerized Maintenance Management System.

Directly Associated Costs and AUI Indirect Cost & Fee

Directly Associated Costs (DAC) covers the pro-rated share of support activities performed in other NRAO divisions on behalf of NAASC: IT, facilities, Business Services, Human Resources, some Director's Office activities, Science & Academic Affairs.

B.4 Financial & FTE Projection

	FY 2009 Carryover	New NSF Funds Budget (PRL)	Total NSF New Funds (PRL) and Carryover	FTE (PRL)
ALMA Construction (SPO-2)				
Management & Administration		1,967,849	1,967,849	8.4
Site Development		7,309,072	7,309,072	2.0
Antenna Subsystem		17,867,105	17,867,105	7.0
Front End Subsystem		3,581,429	3,581,429	27.1
Back End Subsystem		5,184,409	5,184,409	15.4
Correlator		92,992	92,992	6.0
Computing Subsystem		1,471,839	1,471,839	20.0
System Engineering and Integration		3,367,089	3,367,089	7.9
Science		697,678	697,678	6.3
ALMA Other		1,220,537	1,220,537	-
ALMA Construction carryover	34,983,375		34,983,375	
Subtotal ALMA Construction	**34,983,375**	**42,760,000**	**77,743,375**	**100.0**

The NAASC tasks and budget are consistent with the ALMA Operations Plan (AOP), version D.

	FY 2009 Carryover	New NSF Funds Budget (PRL)	Total NSF New Funds (PRL) and Carryover	FTE (PRL)
ALMA Operations (SPO-8)				
NA ALMA Science Center		1,825,207	1,825,207	13.8
NA ARC total		2,453,552	2,453,552	14.6
Special Projects		459,852	459,852	-
NA ALMA Chilean Affairs		-	-	-
ALMA Technical Support		1,312,836	1,312,836	12.0
ALMA Development		26,621	26,621	0.1
NA Chile Operations		9,711,932	9,711,932	63.2
Directly Associated Costs (DAC)		1,783,000	1,783,000	-
ALMA Operations carryover	3,125,535		3,125,535	
Subtotal ALMA Operations	**3,125,535**	**17,573,000**	**20,698,535**	**103.7**

	FY 2009 Carryover	New NSF Funds Budget (PRL)	Total NSF New Funds (PRL) and Carryover	FTE (PRL)
ALMA Japan (SPO-7)				
ALMA-J Management	-	671,106	671,106	1.3
ALMA-J Front End	-	4,531,882	4,531,882	12.3
ALMA-J Back End	-	667,925	667,925	7.3
Subtotal ALMA Japan (SPO-7)	**-**	**5,870,913**	**5,870,913**	**20.9**