

Site Development

Summary

The site development task is specified in its entirety by all the subtasks to the level-1 task 2.0 of the ALMA WBS.

The ALMA site development task includes development of four functionally, and geographically, separate sites. These are:

1. The array site in the Altiplano of the second Region of Chile near Cerro Chajnantor;
2. The Operational Support Facility (OSF);
3. A communications link, or *highway*, connecting the OSF to the Chajnantor array site;
4. The Administrative office in Santiago.

16.1 Requirements

Development of the array site includes construction of all the civil works on the array site. This includes: the concrete antenna foundations and antenna attachment points (which together are referred to as *antenna stations*); provision for electric power and distribution of that power to all the antenna stations; an array control building for array operation and all centrally-located electronic equipment; an optical fiber communications network between the control building and all the antenna stations; water and sewer facilities for the control building; a maintenance building for repairs that must be done on-site; a residence facility for use in emergencies or in situations where personnel travel from the site cannot be done safely; all needed site and access roads; all site furnishings, maintenance equipment and vehicles. The task does not include the process by which the necessary permissions are secured to make use of the site.

Development of the Operations Support Facility includes construction of the civil works needed for ALMA personnel to operate and maintain the array. The OSF, to be built near the village of San Pedro de Atacama, will be sized to the requirements of a turno staff that is responsible for scientific operations, the technical maintenance and logistic support activities. The task includes construction of an office building, laboratories, residence facility and a building for antenna assembly, along with the equipment and furnishings needed. It includes provisions for adequate electric power, water, sewage disposal, and access roads. Provision for the construction base camp to be used by the civil works contractor is part of this task. It does not include the process by which the necessary permissions are secured to make use of the land.

The OSF-Chajnantor link is an optical fiber communication between these two sites. The development task includes trenching for the link and burial of the optical fiber cable. It also includes procurement of the optical fiber.

Development of the Administrative office in Santiago involves provision for office space for the Administrative personnel needed for ALMA in Chile and the scientific offices and facilities needed for the scientific staff that are resident in Santiago and have functional duties at the OSF. It includes the necessary furnishings but does not include the cost of whatever land may be required to erect the facilities.

16.2 Development Overview

The three ALMA development tasks in northern Chile will be done by commercial contractors under competitive bid. Beginning in 2002, architectural and engineering plans will be developed with commercial firms working in concert with ALMA staff. Those plans will be executed under contract by the successful bidders in 2003 and successive years. The work will be scheduled to meet the requirement that sufficient facilities must be in place, both at the OSF and at the array site, to receive the first ALMA antenna in Chile from the antenna contractor in the third calendar quarter of 2004. That antenna and its successors will be *outfitted* (equipped with ALMA-supplied instrumentation) at the OSF and transported to the array site for commissioning. This means that the first phase of the necessary ALMA infrastructure at the OSF and on the array site, must be in place by the third quarter of 2004. Temporary facilities will be provided to meet the increasing ALMA infrastructure demands until the permanent facilities are completed and available for occupancy.

16.3 Development of the Four ALMA Sites

16.3.1 The Array Site

The telescope site lies at an elevation of 5000 meters (16, 400 feet) in Region II of Chile, at a latitude of 23°S. Geologically, the site is a “bench” on the western side of the Andes range, with excellent drainage and a line-of-sight to nearby community.

Logistically, the site has three important advantages: easy access, proximity to developed communities, and a gas pipeline that traverses the site. It lies near an international highway, the Paso de Jama, that is wide and paved with asphalt sufficient for traffic by heavy commercial vehicles. The site is within a one-hour and a half drive (55 km or 34 miles) east of the tourist village of San Pedro de Atacama; it is within a two and a half-hour drive (180 km or 110 miles) southeast of the mining support city of Calama. Calama is served daily by three Chilean airlines with flights from Santiago. The nearest port to the site is Antofagasta. Antofagasta is a large (population 230,000) city with a wide range of industrial facilities to support heavy industry.

Access to the site will be provided by a highway link to the Paso de Jama. Three options for this access road are being studied: (1) connection from the Paso de Jama on the western side of Cerro Toco and Cerro Chajnantor; (2) connection from the Paso de Jama on the eastern side of Cerro Toco and Cerro Chajnantor; (3) direct connection to the OSF from the array site, without using the Paso de Jama. This latter option is most desirable in the event the OSF is located at some distance intermediate between the array site and San Pedro de Atacama. The ALMA Project baseline is option (1). A second option will be maintained as an emergency link.

Electric power on site can be provided either by local generation from natural gas obtained from the gas pipeline running across the site that is operated by Gas Atacama or from commercial power brought to the site from the power grid west of the Salar via overhead power lines. The ALMA Project baseline is local generation of power with gas turbines purchased and operated by ALMA. The commercial option remains under study. Such an option would allow for an easy connection to the Chilean communications network along the power line.

Potable water is a difficult but solvable problem. There are two options. Water can be obtained from wells dug at the OSF and trucked to the site. Or, according to a consultant's analysis, potable ground water is available from wells dug on the site itself. The ALMA Project baseline is to transport water from the OSF; the option of a local well remains under study.

Development of the buildings and roads on site will be done under competitive bid by commercial firms with expertise building at high elevation in Chile. The site civil works will include:

- Antenna foundations, 250 total. Design of the antenna foundation is a deliverable from the antenna contractors that are building the prototype ALMA antennas;
- Connections among the antenna stations and from the antenna stations to the control building. This includes trenching and laying of the cables. The contractor will supply the electrical cables and the optical fiber cables as specified by the ALMA Project;
- Access roads on site and to each of the antenna stations;
- An antenna assembly hall for maintenance of the antennas on site;
- Array control building with office and laboratory space (1000 square meters total);

The ALMA Project, not including the site civil works contractor, will provide furnishings and equipment for the site buildings and it will provide all needed site vehicles and safety equipment.

16.3.2 Operations Support Facility (OSF)

The OSF is the main focus of ALMA. In the construction phase, it is the location where the antennas will be erected by the antenna contractors and accepted by the ALMA Project. Once accepted, the antennas will be outfitted with instrumentation provided by the ALMA Project. From there they will be transported, by the ALMA Project, to the high array site. In the operations phase of ALMA, the scientific operations of the array will be based at the OSF. The data quality will be verified by ALMA scientists at the OSF and plans will be made for the future observing program. The engineers and technicians assigned to maintenance of the array instrumentation and software will be based at the OSF. Repaired instrument modules will be taken to the array site and defective ones returned from the array site to the OSF for repair. The local ALMA managers will have their offices at the OSF also. The purpose of the OSF is to provide an environment at a sufficiently low elevation, but still close to the array site, where operational personnel can carry out their functions efficiently. The OSF serves to minimize the number of people needing to be present at the array site itself.

Development of the OSF site will be done by commercial contractors working to ALMA Project specifications. Their principal tasks include:

- Construction of office, laboratory, and residential space totaling 9500 square meters;
- Utility infrastructure including site preparation, water, sewer and power distribution;
- Construction of an antenna assembly hall for the simultaneous erection of two antennas; an additional two antenna pads will be provided adjacent to the assembly hall;
- Fabrication and assembly of a construction camp for the contract workers.

The ALMA Project will be responsible for furnishing the buildings and providing the equipment needed for array operations and maintenance.

Electric power at the OSF either will be generated locally by the ALMA Project using gas turbine generators supplied from the Gas Atacama gas pipeline or power will be brought to the site via overhead lines from a commercial provider. The ALMA Project baseline is local power generation.

16.3.3 The OSF-Array Site Link

Operation and real-time performance diagnosis of the array from the OSF requires a robust communications link between the two. The OSF-Array site link is an optical fiber connection for both voice and data communication. It is a buried fiber that will be provided to ALMA specifications, trenched and buried under competitive commercial contract. The ALMA Project will be directly responsible for the transmitters and receivers on both ends of the fiber and for obtaining the

necessary construction and environmental permits. In the event that the decision on the site access road is made requiring a road directly between the OSF and the array site (without use of the Paso de Jama), that road contract will become part of this task. The link would, in this case, be a real highway as well as a virtual one.

16.3.4 Administrative Office in Santiago

The ALMA Santiago office will provide the focus for the Project Administration, interaction with officials of the Republic of Chile, business and procurement functions, human resource functions, and matters relating to imports and exports. It will also provide a location where ALMA scientists who reside in Santiago but work turno shifts at the OSF can conduct their professional research activities.

Site development for the Santiago office includes the following:

- Construction of a 600 square meter office building;
- Provision of the infrastructure for that building;
- Furnishings and equipment for the building.

The first two items will be done under commercial contract, the latter is the responsibility of the ALMA Project. This task does not include purchase of the land needed for the building. It is anticipated that the building will be done in collaboration with an existing facility in Santiago.

16.4 Environmental Impact

An Environmental Impact Study for the ALMA project has been undertaken on a voluntary basis, in line with the criteria established by the Chilean legislation. The study addresses the seven main requirements from the law - physical environment, biotic environment, human impact, construction impact, territorial regulations, cultural impact and the aesthetic perception- .

A preliminary study shows that the project development is rated at a low impact level and that the compliance with the Chilean Regulations can be met without any significant cost overhead.

16.5 Site Development Management

All the civil works will be contracted out, either in Chile and/or on an international competitive basis.

Individual contracts will be supervised by a construction team, under the leadership of a site construction manager. The team will establish the contracts according to the project specification and requirements. It will supervise the construction phase, including the quality control, work schedule and the cost developments. It will be based at SpdA. The team will, essentially, be the

interface between the design and the execution phase and handle the acceptance procedures for the site development.

The design for the site works (road, power and communication network, architecture, etc.) will be sub-contracted separately from the civil work contracts and will provide the basis for the construction tendering documents.

Besides the construction manager, the team will have site construction supervisors, an electro-mechanical engineer, a draftsman, a contract officer and secretarial support. Additional technical support will be provided from the U.S./Europe project office in the area of energy, communications and structural analysis.