



Integration & Commissioning

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Integration Challenges



- ◆ **Remote Site & Challenging Access**
 - Ability to Get Equipment, Systems, Materials On-Site
 - Logistics for Labor Force and US Based Project Team
 - Distance to System Providers
 - Emergency Preparedness and Response
 - Self Sufficiency wrt Roads, Site, Lodging, Food, etc.
- ◆ **Altitude (Hypoxia)**
 - Personnel Safety & Efficiency
 - Complexity of Integration Tasks
- ◆ **Scale of Telescope and Facility**
 - High Work, Large Components and Systems
 - Access & Crane Capacity
 - Personnel Safety

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Major Integration Phases & Stages



- ◆ Site Preparation & Road Development
- ◆ Base Support Facility Construction
- ◆ General Construction of Summit Facilities
- ◆ Dome and Mount Integration
- ◆ Controls and Electronics Installation
- ◆ Mirror/Reflector Assembly and Alignment
- ◆ Engineering 1st Light Activities
- ◆ Instrument Installation
- ◆ First Light
- ◆ Commissioning

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Safety



- ◆ Altitude: Poses Significant Health and Efficiency Risk
 - Oxygen Use Will Probably be Mandated for Project Personnel and Contractors
 - Personnel Medical Exams Required
 - Buddy System & Personnel Safety Systems/Processes Carefully Implemented and Maintained
- ◆ Remote Location
 - Must Have Good Emergency Plan in Place
 - Transport, First Responders, Equipment at Site at All Times
 - Evacuation Plan and Communications with Emergency Services

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Preparation for Integration



◆ Subsystem Design & Requirements

- Modular Design: Allows Trial Assembly of Complex Modules to Remain
- Trial Assembly and Fit Check of Subsystems Before Leaving Manufacturer
- Alignment: Use of Pinning & Metrology & Adjustment on Site



Assembly,
Integration
for

◆ Shipping and Handling

- Modules to Fit Standard Railroad Cars
- Minimum Deck Load to Remain
- Contractors Responsible On-Port...Most Have Limited Experience



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Preparation for Integration (cont.)



◆ Manufacturers Provide Assembly/Test Plans

- Step-by-Step, Delivered Pre Final Acceptance Test

◆ Manufacturers Provide Technical Support to Integration

- May Be More Than One Person at Different Stages
- Contracts Do Not Include Full Installation
- Allows Use of One Labor Force Under Project Direction

◆ Control System Interfaces Validated at Mfg

- Project Supplies Telescope Control System Software
- Interface Validated at Final Acceptance Testing
- Should Re-Create Easily On-Site

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Preparation for Integration (cont.)



- ◆ **Facility Inventory**
 - Inventory Identified via Survey of Existing Telescopes
 - Full Equipment/Materials Lists Prepared
 - Procurement in US, Shipped in One Container
 - Enables Full Population of Facilities When Completed
- ◆ **Supplementary Tools for Integration**
 - Contractors Supply Many of Their Own Tools
 - Rental or Purchase of Others Required as Appropriate
 - Special Tools Either Project Purchase or as Part of Contracts for Major Subsystems

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Support to Integration



- ◆ **Manlifts, Cranes, Hoists, Scaffolding**
 - CCAT Will Purchase Large Manlift (~125 foot)
 - Investigation of Construction Cranes in Next Phase
 - ◆ Possible That a Large Hammerhead Crane May be Used
 - CCAT Will Purchase Required Materials Handling Equipment & Small Crane
- ◆ **Housing & Meals for Workers**
 - Investigation of Support via ALMA Facilities
 - Use of Rented Trailers & Catering Alternative
 - CCAT Personnel Transferred to Chile Will Adhere to Operations Plan...Work Turno from Residences
 - Support Facility to be Completed Early in Process



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Labor for Integration



- ◆ **CCAT Personnel Hired in Chile**
 - Facility Manager, Administrative Manager
 - Others May be Repatriates from Project Team
- ◆ **CCAT Personnel Transferred to Chile**
 - Majority of Technical Staff Will Spend Time in Chile
 - Permits Continuity of Management from Design Through Manufacturing, Shipping, and Integration
- ◆ **Majority of Labor Provided Under Contract**
 - Likely to be Extension of General Construction or Steel Erection Contracts
 - Enables Selection of “Best” Workers to Continue on Beyond General Construction



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Labor for Integration (cont.)



- ◆ **Local Trades**
 - Hired as Necessary to Support
 - ◆ Wiring, Cabling, Conduit, Termination
 - ◆ Plumbing, Equipment Installation
- ◆ **Contractor Support to Integration**
 - Assembly Plans Required as Deliverable Item
 - Contracts Include Technical Support to Integration
 - ◆ Same Personnel as Directed Trial Erection and Testing
 - ◆ May Vary at Different Stages of Integration
 - ◆ Provides for Retention of Corporate Knowledge

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Stages of Integration



- ◆ **Site Preparation & Support Facility Construction**
 - Developed in Parallel
 - Objective: Have Support Facility Available Part-way Through General Construction of Summit Facility
- ◆ **Complete Summit Facility**
 - Provides Infrastructure to Support Integration
 - Facility Includes Interface to Dome and Mount
- ◆ **Integration of Dome & Mount**
 - Actual Sequence TBD...Likely in Parallel
 - Use Same Crane
 - Rotation of Dome & Mount Enabled Early to Support Follow On Integration

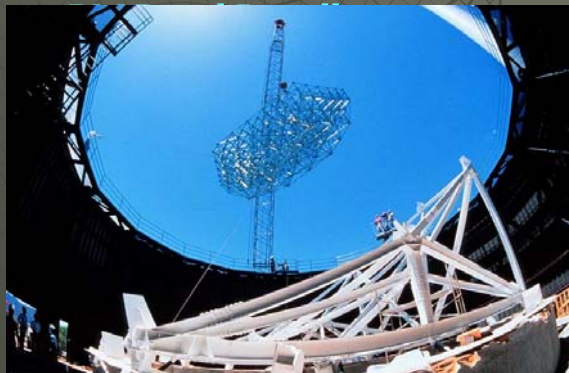


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Stages of Integration (cont.)



- ◆ **Primary Mirror Truss**
 - Assembled in Sections on Ground?
 - Lifted Into Place When Mount is Sufficiently Completed



Dome
el (Hamar)
on
s
1st Light



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Control System Integration



- ◆ **TCS Software Provided to Subsystem Contractors Early in Development**
- ◆ **Interface to and Operability with TCS Part of Final Acceptance Test During Trial Assembly**
- ◆ **Control Integrated at Telescope as Each Subsystem is Added**
 - Facility Components: e.g. Environmental Controls, Power Monitoring, Weather, Emergency Systems, etc
 - Dome Control & Mount Control
 - PM Segment Control
 - M2 & M3 Control
 - Sensors & Instruments

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Commissioning



- ◆ **Project Team Includes Personnel Who Will Transition to Operations**
- ◆ **Early Hiring of Operations Personnel During Integration**
- ◆ **Project Team Retained for 1 Year After 1st Light**
- ◆ **Monitoring of Operational Statistics Inherent Capability of Control System**
- ◆ **Commissioning Culminates in Final Acceptance Testing**

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Summary



- ◆ **Integration Plan is Based on Previously Successful Approaches**
- ◆ **Unique Challenges for CCAT**
 - Altitude & Remote Location
 - Extremely Large Telescope for Required Precision
 - Logistics of Personnel Relocation and Turno
 - Logistics for Contract Labor Force
 - Logistics for Health and Safety Services
- ◆ **Integration Plan will be Further Developed During Engineering Concept Design Phase**