Gran Telescopio CANARIAS

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List of acronyms and abbreviations

ADC	Atmospheric Dispersion Corrector
AO	Adaptive Optics
A&G	Acquisition and Guiding
CESA	Compañía Española de Sistemas Aeronáuticos
CIMNE	
DCI	Document Control Interface
FoV	Field of View
GCS	GTC Control System
GCST	GCS Testbed
GTC	Gran Telescopio CANARIAS
HET	Hobby Eberly Telescope
ILS	Integrated Logistic Support
IOC	Input Output Controller
LSA	Logistic Support Analysis
M1	Primary Mirror
OCYT	Spanish Research and Technology Office
ORM	Observatory of Roque de los Muchachos
PI	Principal Investigator
PM	Project Manager
PO	Project Office
SAC	Science Advisory Committee
VLT	Very Large Telescope
WBS	Work Breakdown Structure
WP	Work Package

CONTENTS

1. INTRODUCTION

This document shows the current status of the Gran Telescopio CANARIAS (GTC) project. It is prepared by the GTC Project Office (PO) for the members of the panel participating in the GTC Project Status Review Meeting to be held in La Laguna June 29th to July 1st, 1998. It is meant to be also useful to interested readers wanting to know what has been achieved so far and what is planed for the immediate future regarding the GTC project. The document does not contain any details about the GTC subsystems. The interested reader is addressed to the specific documentation where the different subsystems are analyzed or where different aspects of them are studied in detail.

This is the first project status report to be made by the PO. Any comments or suggestions to improve the content or the structure of this document are welcome.

A general overview of past activities and the current status is presented. Then the different aspects of the project are presented following the work package structure described in the GTC Work Breakdown Structure (WBS).

2. PROJECT STATUS OVERVIEW

The GTC Project was formally initiated in summer 1996 after its initial approval in February 1996. Prior to that a Feasibility Study was produced in 1995. An extensive site testing campaign was also initiated at the Observatory of Roque de los Muchachos (ORM) to identify a suitable site within the Observatory for the GTC.

The Preliminary Design of the GTC was finished during the second half of 1997. A document entitled “Gran Telescopio CANARIAS. Conceptual Design” was produced and widely distributed.

An activity to identify potential suppliers of the GTC subsystems, initiated during 1995, was intensified in parallel with the development of the Conceptual Design. Long discussions were maintained with suppliers to identify their capabilities and their major concerns with our design ideas. It was then possible to identify the design drivers on price and supply schedule to arrive to a realistic schedule and budget.

Contacts with other large telescope projects (like Keck, Gemini and VLT) were also maintained to gain knowledge on their experience and recommendations.

After the Conceptual Design phase, the Preliminary design phase was initiated in all GTC subsystems. The objectives of this phase are to analyse the functional requirements of every subsystem to arrive to specifications for contracting out the Detailed Design, Manufacture and Installation, or their direct supply, well in accordance with the scientific requirements. During this phase, a good development of error budgets and subsystem interfaces is a must to ensure a correct management of every subcontract.

In parallel with these activities, an intensive search of potential international partners was also carried out to ensure the full funding of the project. At that time only 50% of it was contemplated by Spain.

In March 1998, the Spanish Prime Minister Office, through the Director of the Research and Technology Office (OCYT), gave final approval to the project, funding it jointly with the Canarian Regional Government and inviting international partnership up to a level of one third of the project.

This decision dissipated any concern about the funding of the project and, at the end, has facilitated the identification of potential international partners. Letters of Intent to participate in the project summing up to 60% of it have already being received during the last two month.

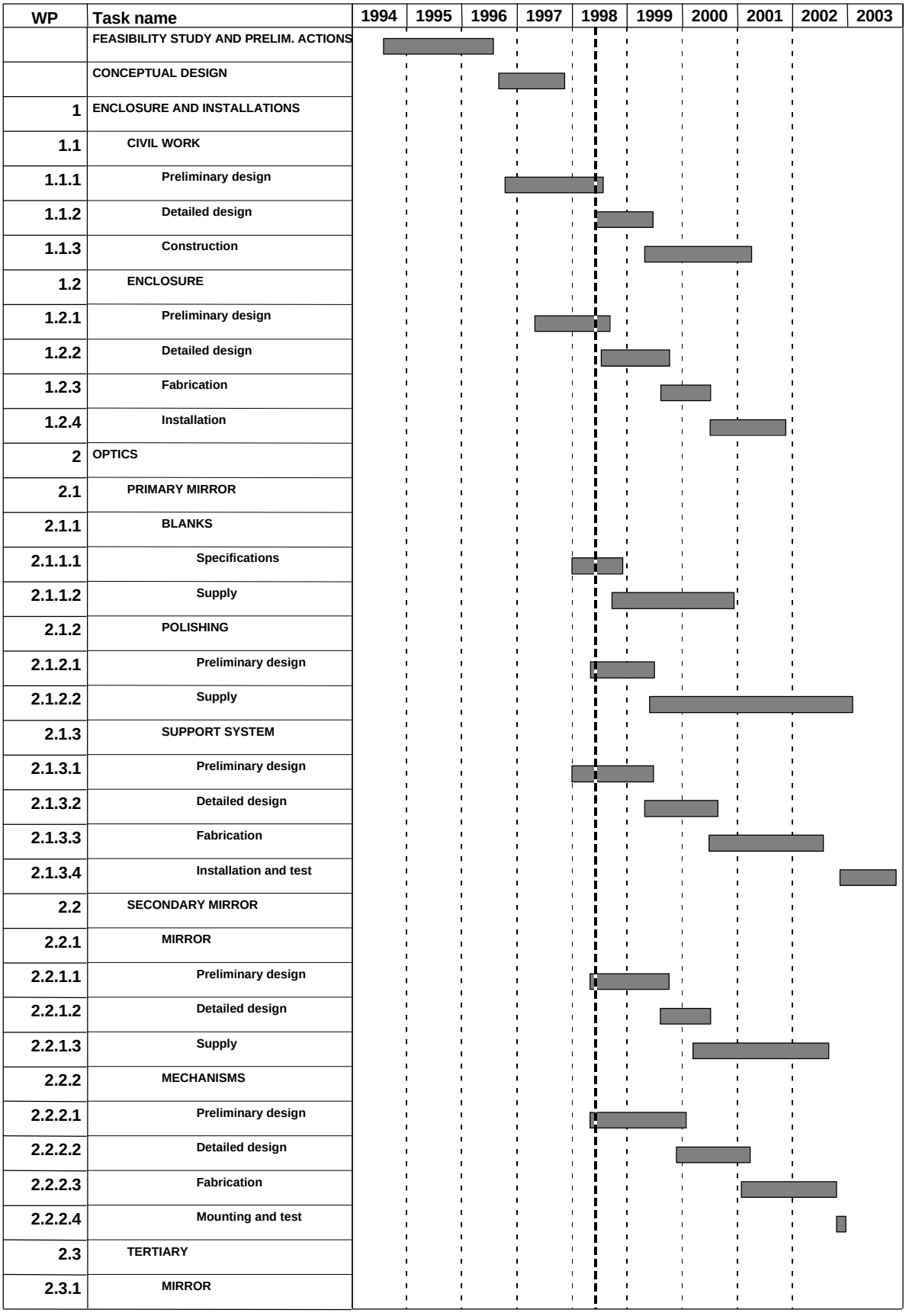
The budget of the project is presented here. The current level of expenditures is at the level of 5% of the total budget.

The overall schedule of the project is also displayed below.

GTC Project Budget

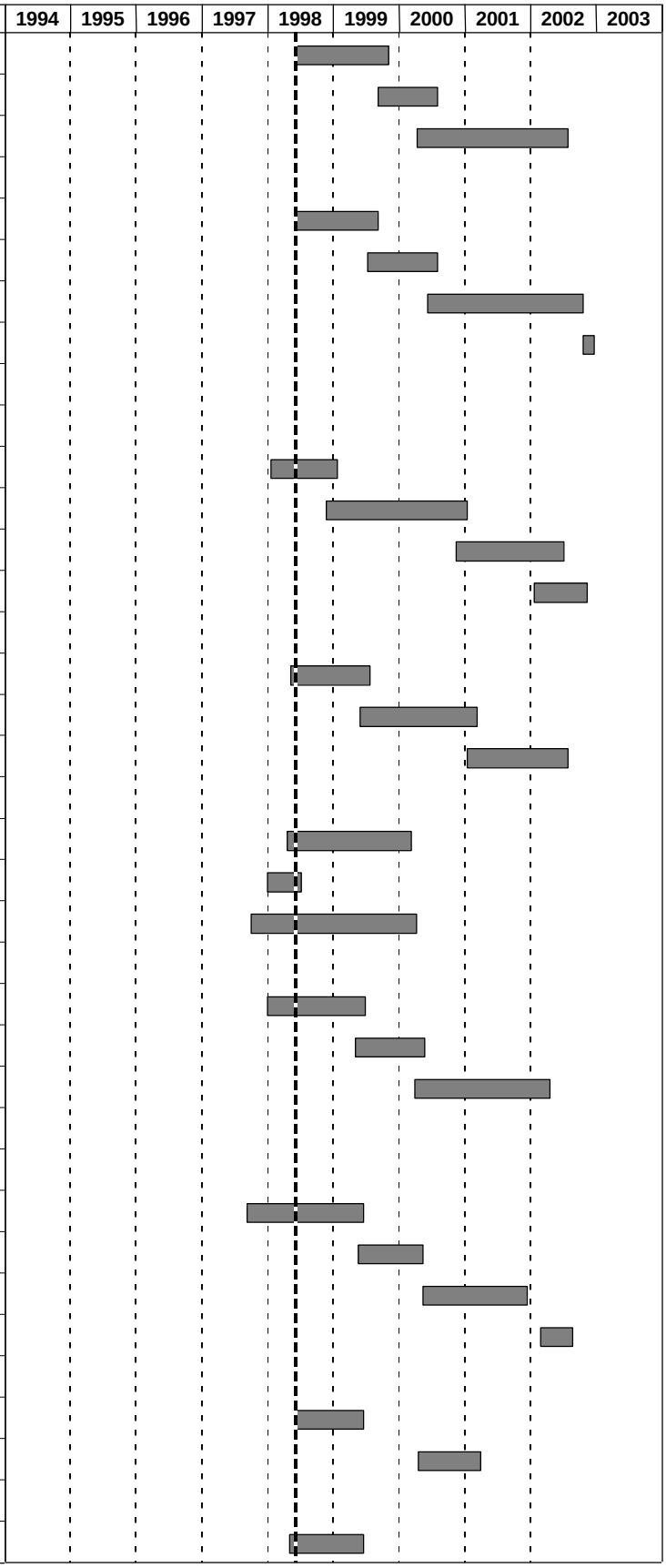
Work Packages			MPtas (1997)
1.- Enclosure and installations			2400
1.1.- Civil work		900	
1.2.- Enclosure		1500	
2.- Optics			4830
2.1.- Primary mirror		3680	
2.1.1.- Blanks	980		
2.1.2.- Polishing	1800		
2.1.3.- Support System	900		
2.2.- Secondary mirror		300	
2.2.1.- Mirror			
2.2.2.- Mechanisms			
2.3.- Tertiary mirror		100	
2.3.1.- Mirror			
2.3.2.- Mechanisms			
2.4.- Mirror coating & cleaning		100	
2.4.1.- Mirror coating			
2.4.2.- In situ cleaning			
2.5.- Stray light		50	
2.6.- Correctors		0	
2.7.- Adaptive Optics		0	
2.8.- Calibration, A&G System		600	
3.- Telescope			1570
3.1.- Mechanical structure			
3.2.- Hydrostatic bearings			
3.3.- Driving systems			
3.4.- Encoding systems			
3.5.- Instrument rotator			
4.- Control system			500
5.- Instrumentation			1650
5.1.- Preparatory actions		30	
5.2.- Instrument #1		585	
5.3.- Instrument #2		585	
5.4.- Detectors Systems		450	
6.- Project management			1800
6.1.- System Engineering			
6.1.1.- Configuration control			
6.1.2.- Documentation control			
6.1.3.- Integrated Logistic Support			
6.1.4.- Integration and test			
6.1.5.- Quality control			
6.1.6.- System simulation			
6.1.7.- Operation and maint. prep.			
6.1.8.- Other system eng. act.			
6.2.- Project management			
6.3.- Scientific direction			
6.4.- Administrative management			
6.5.- Project direction			
TOTAL			12750
10% contingency			1275
TOTAL (incl. Contingency)			14025

The GTC project schedule



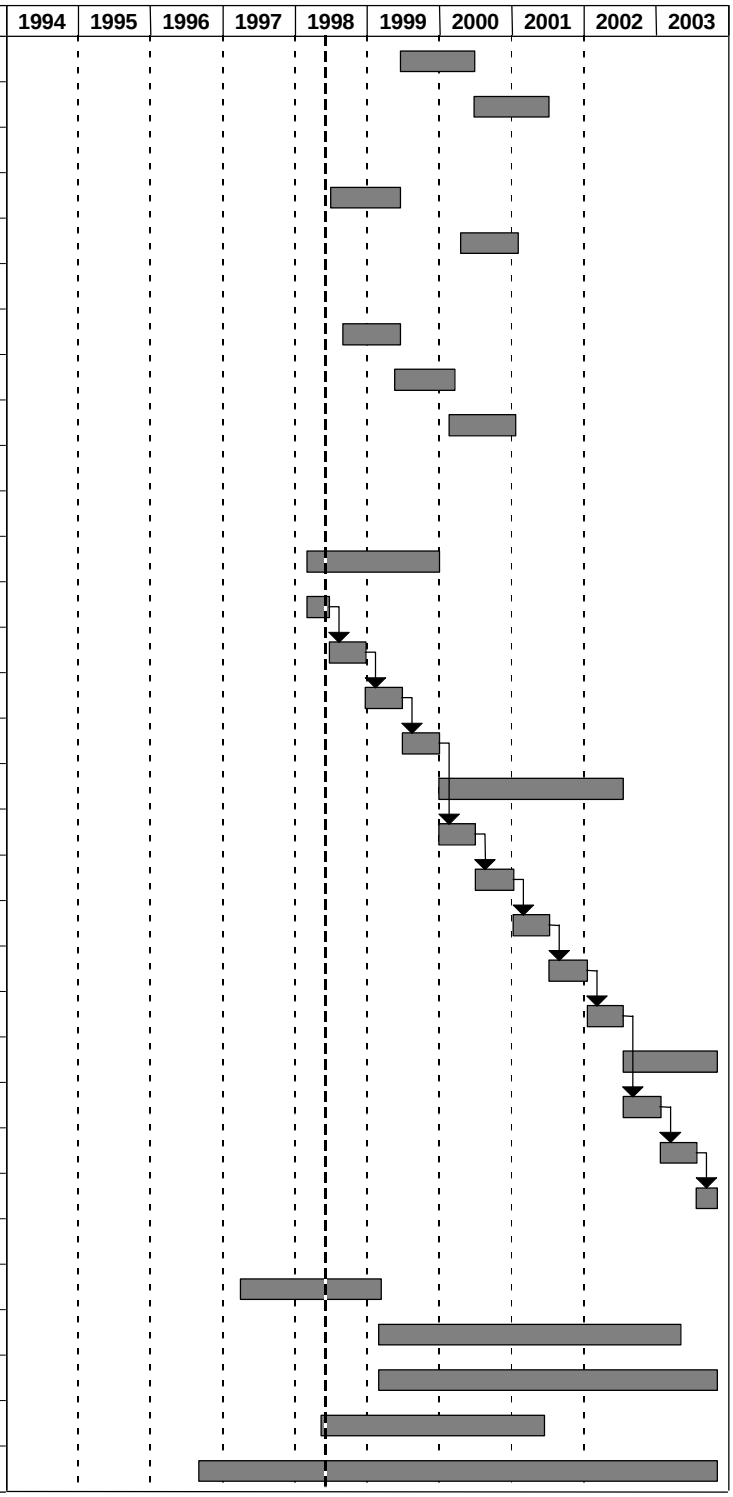
The GTC project schedule (cont.)

WP	Task name
2.3.1.1	Preliminary design
2.3.1.2	Detailed design
2.3.1.3	Supply
2.3.2	MECHANISMS
2.3.2.1	Preliminary design
2.3.2.2	Detailed design
2.3.2.3	Fabrication
2.3.2.4	Mounting and test
2.4	COATING AND CLEANING
2.4.1	COATING
2.4.1.1	Preliminary design
2.4.1.2	Detailed design
2.4.1.3	Fabrication
2.4.1.4	Installation and test
2.4.2	CLEANING
2.4.2.1	Preliminary design
2.4.2.2	Detailed design
2.4.2.3	Fabrication
2.5	STRAY LIGHT
2.5.1	Preliminary design
2.6	CORRECTORS
2.7	ADAPTIVE OPTICS
2.8	CALIBRATION, A & G SYSTEM
2.8.1	Preliminary design
2.8.2	Detailed design
2.8.3	Fabrication
3	TELESCOPE
3.1	MECHANICS STRUCTURE
3.1.1	Preliminary design
3.1.2	Detailed design
3.1.3	Fabrication
3.1.4	Installation and test
3.2	HYDROSTATIC BEARINGS
3.2.1	Preliminary design
3.2.2	Fabrication
3.3	DRIVING SYSTEMS
3.3.1	Preliminary design



The GTC project schedule (cont.)

WP	Task name
3.3.2	Detailed design
3.3.3	Fabrication
3.4	ENCODING SYSTEMS
3.4.1	Preliminary design
3.4.2	Supply
3.5	INSTRUMENT ROTATOR
3.5.1	Preliminary design
3.5.2	Detailled design
3.5.3	Fabrication
4	CONTROL SYSTEM
4.1	GCS development process
4.1.1	Elaboration
4.1.1.1	Iteration E1
4.1.1.2	Iteration E2
4.1.1.3	Iteration E3
4.1.1.4	Iteration E4
4.1.2	Construction
4.1.2.1	Iteration E5
4.1.2.2	Iteration E6
4.1.2.3	Iteration E7
4.1.2.4	Iteration E8
4.1.2.5	Iteration E9
4.1.3	Installation
4.1.3.1	Iteration E10
4.1.3.2	Iteration E11
4.1.3.3	Iteration E12
5	INSTRUMENTATION
5.1	PREPARATORY ACTIONS
5.2	INSTRUMENT #1
5.3	INSTRUMENT #2
5.4	DETECTORS SYSTEMS
6	PROJECT MANAGEMENT



3. ENCLOSURE AND INSTALLATIONS (WP 1)

This WP summarizes all the work packages related with the Enclosure and the installations of the GTC. By the enclosure we understand the telescope building, formed by a fixed concrete base and a metallic-rotating dome. The rest of the installations are all the support areas, distributed within the base of the enclosure, within the auxiliary building an those required to be external of the buildings.

3.1 Civil work (WP 1.1)

The Civil Work includes the foundations and structures of the buildings, the terrace and retaining walls, the access road and the main services for the operation and maintenance of the GTC, such as electricity, water, air conditioning, etc.

The Civil Work is in the critical path of the project and will be the first subsystem to start the detailed design phase in summer 1998, followed by the construction phase, planned to start in summer 1999.

The preliminary design has been carried out with the collaboration of IberEspacio, a Spanish engineering company and the canarian architect Felix J. Bordes. All the documents from the preliminary design are available at the PO. However, most of the requirements of the subsystems were not yet established by that time and others have change with the evolution of the project. The PO has updated this information.

At the moment, efforts are concentrated in the elaboration of the Civil Work specifications and other documentation necessary for the Civil Work PDR to be held the first of July. The Civil Work specifications document incorporates all the information coming from the preliminary design, the control interface documents (DCIs) and both general and particular requirements for the installation.

The tendering process to select the engineering company to take charge of the detailed design of the Civil Work and the technical supervision of the construction, will start in July. By the middle of September we expect to start the elaboration of the detailed design.

Geo-technical studies in deep at the site selected for the GTC are planned to start in July. These studies will be conducted to confirm the basaltic stratum found in this site during the preliminary campaign (carried out in 1995) and will be complemented in such a way as to obtain the necessary information for the detailed design of the telescope pier and building foundations.

3.2 Dome (WP 1.2)

The preliminary design of the Dome has been carried out also with the collaboration of IberEspacio. All the documents from the preliminary design are available at the PO.

In relation to the Dome, at the moment we are working on the optimization of the natural ventilation scheme. This work is based on simulations being carried out in a supercomputer center in Barcelona (CIMNE). The preliminary results from this study show that it is necessary to install three rows of windows, as proposed by IberEspacio during the preliminary design phase, and also that a double shutter door (one sliding over the other) is necessary in order to minimize the size of the dome. The results have shown that it may be possible to reduce the total ventilation area, to about 70% of the current proposal.

Our main concerns with the Dome design are the solution proposed for the shutter and the construction of the windscreen in the dome slit. We are also dealing with the conceptual design of a device or element to control the airflow through the ventilation windows.

An evaluation in deep of the viability for the construction of the shutters and windscreen proposed in the preliminary design will start soon. This will be followed by the specifications for the contract to do the detailed design of the dome its fabrication, tests and installation at the ORM. We plan to increase the available human resources in the PO to proceed smoothly with these tasks.

4. OPTICS (WP 2)

4.1 Primary Mirror (WP 2.1)

4.1.1 Blanks (WP 2.1.1)

During the Conceptual design phase three companies were visited as potential providers for the blanks of the primary mirrors segments: Schott Glaswerke (Germany), Corning Incorporated (U.S.A.), and Lytkarino Optical Glass Factory (Russia). In these visits several questions were discussed regarding the thermal characteristics of the materials and delivery problems, depending of the size of the segments. These discussions were very useful for selecting the segmentation approach. It was detected that an option with18 segments could not be delivered by Schott, with the corresponding lost of competition.

It is planned to contract the blanks at the end of 1998. As part of the demonstration program for polishing (see section 4.1.2) the technical specifications of the blanks will be generated, except the thermal characteristics that will be defined by the PO. It is expected to call for tenders in October 1998.

4.1.2 Polishing (WP 2.1.2)

The polishing of 42 off-axis aspheric segments, all of them matched to the same optical figure is a challenge. This problem was solved for the construction of the Keck Telescopes using the stressed mirror polishing technique.

The approach followed by the PO is that polishers should propose the polishing process for our segments starting from their well-known polishing methods. With this objective several optical companies were visited during 1996 and 1997. The companies visited were: KODAK (U.S.A.), Contraves (U.S.A.), Hughes Danbury Optical Systems (U.S.A.), REOSC (France), SESO (France), Zeiss (Germany) and Optika (Russia). Tinsley (U.S.A.) was also contacted, but refused the possibility of polishing the GTC segments. The Steward Observatory Mirror Lab was also visited looking for the use of computer generated holograms as null correctors for the interferometric testing.

The conclusion of the discussions was that there are actually no company with a solid knowledge of how to achieve the optical quality we require. First, the testing problem is unknown for most companies. Second, most of them have proposed processes based on computer controlled polishing, which potentially can introduce high spatial frequency surface errors that make more difficult to meet the optical quality requirements.

To solve the uncertainties the PO will contract at least two demonstration programs. The objective of these programs is to show how to meet our requirements using a mix of analysis and hardware demonstrations. Additionally, each contractor of these programs will provide a

technical specification for the blanks of the segments adjusted to the polishing method that he proposes to use.

We will make the request for proposals for these programs in June 1998. We will follow a negotiated procedure to provide the potential offerors the flexibility to develop cost-effective solutions and the opportunity to propose innovative alternatives meeting our objectives.

4.1.3 Support system (WP 2.1.3)

This work package includes all the optomechanical components maintaining and controlling the shape and position of the segments of the primary mirror. It is subdivided in two subsystems: the segment support subsystem and the active stabilisation subsystem. The function of the first is to maintain and control the shape of the segments. The function of the second is to maintain and control the position of the segments.

Current activities have been concentrated on the active stabilisation subsystem. During the feasibility study carried out in 1995 a good knowledge of the optomechanical problems of a segmented primary mirror was obtained, identifying as critical the active stabilisation subsystem. As a conclusion, a development program about the main components of the segment position control system started to be defined. The goal was to prepare some companies to be ready to provide this critical subsystem.

At mid 1996 this development program started, run by the Spanish companies CESA, ImasDé Canarias, and Galileo Ingeniería y Servicios. The first phase consisted on the development of a prototype of the positioners and sensor that made up this subsystem. This phase was finished in October 1997. The results showed some robustness problems for the positioners and some losses of accuracy for the sensor. However, the results were satisfactory enough to undertake a second phase with the same companies. The objectives of this phase were to produce second generation prototypes solving the problems of the first generation, and to produce a two segment bench to test the control strategies for the active stabilisation. This phase will finish in December 1998, the second generation of components are expected in June 1998.

In May 1997 a study about the control strategies of the active stabilisation subsystem was contracted to La Laguna University. This contract should finish in May 1998, but we expect a delay of two months. At the moment approximately a 50% of the objectives of the work has been achieved. The control strategies developed in this contract will be implemented at the two-segment bench.

The segment support subsystem was not considered critical in 1995. During the conceptual design, and afterward during deeper studies of the image quality, it was identified that the function of segment deformation could be critical. Recently the studies of this aspect have been finished showing better performances than expected initially.

4.2 Secondary (WP 2.2)

4.2.1 Mirror (WP 2.2.1)

A pre-design of the mirror blank using glass or glass-ceramic has been made, which validated the conceptual selection of this kind of mirror.

4.2.2 Mechanisms (WP 2.2.2)

During 1996 and 1997 two Spanish companies undertook conceptual definition of this subsystem. This work was not funded by the PO, but we contributed with technical support for the definition of requirements. As a conclusion some alternatives are opened, which has to be analysed more deeply.

We plan to contract a preliminary design study as soon as possible.

4.3 Tertiary (WP 2.3)

4.3.1 Mirror (WP 2.3.1)

No progress has been made in this WP up to now.

4.3.2 Mechanisms (WP 2.3.2)

No progress has been made in this WP up to now.

4.4 Coating and in-situ cleaning (WP 2.4)

The activities in this WP were made in the context of the conceptual design. Actually, the baseline for the in-situ cleaning process has been selected. The functional requirements of the coating plant are being defined. It is planned to finish this task in October 1998, to then proceed with the technical specification, which will probably be subcontracted.

The requirements imposed by the coating and in-situ cleaning processes to the Civil Work have been defined.

4.5 Stray light (WP 2.5)

The objective of this WP is to analyse and evaluate the need of baffling stray light at the secondary and tertiary tower. The implementation of the needed solutions is not included in this WP but in the secondary and tertiary WPs. This will be revised in the light of the final solutions to be allocated.

The basic strategies to reduce stray light were selected during the conceptual design. A study with the objectives of pre-dimensioning the baffles and estimating the stray light performance at the focal planes was assigned to Steinbeis Transferzentrum Leuchtentechnik in April 1998.

4.6 Correctors (WP 2.6)

This work package contains the definition of optical corrector (field correctors, and atmospheric dispersion correctors) for the GTC.

Two studies were undertake in the context of the conceptual design. The first one was subcontracted to the IAC to produce possible optical designs for instruments of the GTC. The second and third ones were made within the PO to design some pre-focus large field correctors and to identify types of ADC correctors. The common objectives of both studies were to show that the field curvature of the selected optical configuration was not constraining seriously the

optical design of the GTC instruments. Additionally, these studies have provided the knowledge of how the corrector would use the available space prior to the focus. This space has to be shared with the Acquisition and Guiding Subsystem (and probably with some part of the scientific instruments).

At the conceptual design it was decided that the PO will not provide any corrector for the GTC. If some instrument need the presence of one corrector, the design and fabrication of it will be responsibility of the instrument. No more work on this package is currently planned.

4.7 Adaptive optics (WP 2.7)

The scope of the project does not include the provision of Adaptive Optics (AO) on Day One. However, the PO is working to prepare the GTC to be upgraded with this capability in the future. The PO has produced a pre-design of the optical system of an AO system located near the focus. Additionally the simulations of image quality of the GTC has been complemented with an AO simulation. The results show that the telescope is not limiting the AO within the requirements of the GTC.

Requirements for the Civil Work to foresee the installation of laser guide star equipment have been defined.

4.8 Calibration, Acquisition and Guiding systems (WP 2.8)

This WP is the gathering of the subsystems for the acquisition, guiding, active optics, optical calibration, and instruments for the commissioning of the GTC. Soon, this package will be split into several packages, mainly to separate the instruments for the operation (acquisition, guiding, etc.) and the instruments for commissioning.

On November 1997 the PO assigned to the Universitat Politecnica Catalonia a contract for developing the prototype of an instrument to measure the phasing between the primary mirror segments during day time. This development has passed the preliminary (January 1998) and critical (April 1998) design reviews. It is planned to install this instrument in the two-segments bench of the support system of the primary mirror.

The task of defining the requirements for the acquisition, guiding, active optics and optical calibration is in progress. This task will be finished in August 1998.

A task for analysing the requirements for the commissioning of the GTC is also in progress. This analysis will be presented to the Scientific Advisory Committee.

5. TELESCOPE (WP 3)

This WP summarises all the work packages related to the mechanical structure of the GTC and its mechanisms (hydrostatic bearings, driving system, encoding system and instrument rotator).

The approach followed from the PO on the telescope structure and its mechanisms is to use as much as possible the developments made in other telescopes, mainly at the Keck telescopes. We are not interested in doing new developments if the existing solutions satisfy the GTC scientific requirements. Only changes needed to comply with our requirements where these are different from those of other projects will be addressed. Also, those developments identified as improvements due to the availability of new technologies will be done only if they are within the budget and schedule limits of the GTC project.

The major difficulty with these WP's are due to the current lack of enough man-power within the PO. Efforts are being made to recruit experienced personnel to undertake some of the tasks related with these WP's. Some external consulting contracts have been made and a contract with an engineering firm is under study.

The access to all the Keck's drawings is facilitating the design of this GTC WP's.

5.1 Mechanical structure (WP 3.1)

This WP includes the mechanical structure of the GTC: i.e. the tube and the mount. The top end ring, the secondary spiders and secondary cage, the primary cell, the tertiary tower and the cable rotators are included within this WP.

During the Conceptual Design phase a structural analysis was carried out with the help of an external consultant. On this study the Keck structure was used as input and some modifications were introduced to increase the stiffness. The main modifications where introduced in the solution for the spiders and the secondary cage, and in the primary cell and its connection with the elevation ring.

Some modifications where introduced in the size of the azimuth ring to reduce the size and costs of the azimuth mechanisms. The proposed modifications demonstrated a high reduction in the stiffness of the mount. This is an area where the actual design needs a major modification facing an increase of the actual size of the azimuth ring.

When this work was finished a good analysis tool to derive the requirements on the structure due to the image quality and pointing and tracking requirements was not available. At present, the work is focused on this aspect and on the identification of a formalism to connect the output from the finite element analysis to the image quality requirements. This will permit to fully connect the characteristics of the mechanical structure and driving and bearing subsystems with the image quality (mainly image motion) error budget.

A contract is under study to proceed with the previously initiated structural analysis. We hope to close it in July 1998.

5.2 Hydrostatic bearings (WP 3.2)

Information from other project, specially from the Keck telescopes has been obtained.

We are in direct contact with the most suitable suppliers to obtain data from their hydrostatic bearings systems.

Progress in this WP is heavily connected with the progress with the structural analysis.

5.3 Driving system (WP 3.3)

The driving system is an area were two alternatives are yet open. We have to select between a direct drive solution, like VLT and SUBARU chosen, or a friction drive solution, like the used by the Keck and the Gemini telescopes.

A direct drive solution present a high stiffness that helps on the design of the telescope structure. It also is expected to be more simple to be maintained during the lifetime of the telescope. But it is more expensive that the friction drive solution, even its developing price has been mainly paid by the VLT project. Also some development has to be addressed to fit our

need of a higher diameter than available for the elevation drive. Also, a single supplier is considered by us as to have a high risk on the available budget.

A friction drive solution is expected to be cheaper and simple as a lot of information is available from the Keck telescope. But its performances on stiffness are less attractive. Their adequacy to our requirements has to be confirmed but expected.

The selection of the driving system has a major impact on the design of the structure, mainly on the mount. This is the first point to solve in the analysis of the telescope modelling with the help of the engineering firm to be contracted in July 1998.

5.4 Encoding system (WP 3.4)

Information from other project has been obtained. A similar solution to the used by the Gemini project is planed to be implemented.

We are in direct contact with the most suitable suppliers to obtain data from their encoding systems.

5.5 Instrument rotator (WP 3.5)

No progress has been made in this WP up to now.

6. CONTROL SYSTEM (WP 4)

Late last year a basic framework for the development of the GTC Control System (GCS) has been established. This framework is mainly characterised by and iterative and incremental approach. The GCS development cycle has been divided in 12 iterations, each one delivering and increment of the whole GCS functionality. Currently the GCS development process is reaching the end of its first “formal” iteration (E1), which has started in January 1998 and will finish at the end of June 1998. This iteration constitutes the first quarter of the Elaboration phase. The last week of this iteration will be dedicated to review the different development artefacts produced.

Although strong emphasis is made in the GCS development plan in early implementation, test and integration of those GCS functions that can help to diminish the more risky areas, the by-products of the first iteration are mainly related with the elicitation and specification of the GCS requirements. It should be bear in mind that the design of the subsystems the GCS has to control is in a very preliminary status, so requirements are inherently unstable.

This iteration is somewhat atypical, as the control group has been staffed up at the same time. The team that will perform the two following iterations is nearly in place, the two remaining posts are been filling just now. The experience gained in this iteration will provide invaluable feedback to the planning of successive iterations.

Some basic functions are expected to be available by the end of E1 (although they depend on the availability of hardware at the GTC installations):

- Basic connection handling between different system tiers.
- Basic infrastructure software installed, configured and running.
- Ability to perform some performance tests

- Ability to perform some basic calls between workstations and Input Output Controllers IOC.

During E1 the process for the procurement of hardware and software for the phase I of the control system testbed (GCST) has started and is just about to finish. Possible providers have been identified and the different elements are in the ordering process. This task has been more time consuming than expected, given that it included a market survey, and that the required equipment involves the participation of several providers. We hope that in the future this process goes much faster. The definition of the functionality that will provide GCS Testbed (GCST) has already stated. First issue of the plan will be available by the end of June, as Phase I will start just after the end of iteration E1 (probably in concurrence with the two-segments bench of M1).

At the same time the procurement of the two-segments bench of M1 prototype hardware and off-the-shelf software has been performed. The hardware used for this prototype should be able to been reused in the GCST Phase I and successive phases. Some preliminary work on the two-segments bench of M1 control system has started. The deadline for the finishing of deliverables of this package will be around September 15. So the hardware and software procurement process has already started. The requirements of this package are currently been discussed with the optics group.

Some of the objectives of this iteration in order to minimise GCS risks are:

- To get feedback about development process implementation and team dynamics.
- To get feedback about the integration of new members in the team.
- To get feedback about the hardware and software development and implementation platforms.
- To get feedback about the accuracy of planning.
- Early contacts with both hardware and software providers.

7. INSTRUMENTATION (WP 5)

This WP summarises all the work packages related with the Scientific GTC Day One Instruments. The WP has been split into four packages. WP 5.1 includes the preparatory actions related to instrumentation. WP 5.2 and 5.3 includes the activities for the instruments themselves. The approach followed by the PO on the procurement of the instruments is similar to other projects: an announcement of opportunity will be published and international consortia are expected to apply as possible tenders for designing, building and commissioning the instruments. Two proposals will be selected and contracts will be signed with the consortia to develop the instruments under the control and supervision of the PO. Finally, WP 5.4 contains the tasks to manage the procurement of the GTC detectors.

7.1 Preparatory actions (WP 5.1)

This package consists of activities, related with the GTC instrumentation plan, that have been carried out in order to motivate Spanish groups to participate in the development of the GTC Day One instruments to promote the formation of strong international consortia, and to give the necessary steps to assure the success of the announcement of opportunity and the selection of Day One instruments. The main actions undertaken follow:

- Establishment and keeping contacts with scientists in different Spanish research institutions, and universities (since April 1997).

- Organisation of the First GTC Instrumentation Workshop (October 1997). The goals of this meeting were to discuss the Instrumentation Plan for the GTC, and to be a meeting point for all astronomers in the Spanish Scientific Community who are interested in the development of the first generation of instruments.

  The GTC Project invited all Spanish senior astronomers as well as some graduate students to participate in this meeting. The answer to the announcement was enthusiastic: 82 astronomers attended the meeting and around 30 more participated via e-mail.

  During the meeting, the instrumental needs to achieve the scientific interests in our community were discussed. The instruments of other Large Telescope Projects already in operation, like Keck I and II, or those that are being designed or built (VLT, Gemini, Subaru, HET...), were revised. The work of some Spanish groups in current instrumentation was presented.

  The scientific projects which should drive the instruments and their requirements were discussed in 4 working groups: optical spectroscopy, optical imaging, infrared, and high spatial resolution techniques. These groups were working during the next months to prepare letters of intention.

  A document with the summary of the meeting was produced and distributed. A summary with the instrumentation plans of other projects was also produced.

- Reviewing the instrumentation in other large telescopes: Twenty two documents have been compiled. The idea was to provide the instrumentation groups with these documents to save efforts and to optimise resources. All documents are update to January 1998.

- Announcement for Letters of Intent (November 1997). The GTC Project announced the opportunity to propose instrument concepts for the first generation of instruments. The development of feasibility studies was planned to have a duration of ten months, beginning in mid February 1998. Contracts for fixed remuneration would be signed with the successful applicants in order to produce feasibility studies and to promote the formation of international consortia. The announcement was open to any consortia, lead by a Spanish Institution. Collaborative efforts with other institutes and universities in other countries were encouraged.

Funding proposals for feasibility studies (among the letters of intent, February 1998). Six proposals were funded by the GTC Project Office from the received letters of intent. In this moment, five contracts have been signed to perform different feasibility studies for Day One GTC Instruments. The goal of these studies is not only the feasibility studies by themselves, but also the common analysis, made in collaboration between the project office and these group, of some important interfaces between instrumentation and other GTC subsystems. The current studies are based on the proposals:

- *Proposal to design and build an optical intermediate dispersion spectrograph for the GTC.* PI: Ramón García López (rgl@ll.iac.es)

- *OSIRIS Optical System for Imaging and low-Resolution Integrated Spectroscopy.* PI: Jordi Cepa Nogué (jcn@ll.iac.es)

- *COSMOS – A scientific and instrumental program for the Gran Telescopio de Canaria.* PI: Marc Balcells (balcells@ll.iac.es) & Rafael Guzmán (rguzman@astro.yale.edu)

- *A High Resolution Near-IR Integral Field Spectrometer for GTC.* PI: Almudena Prieto (aprieto@ll.iac.es)

- *A proposal for CANari-CAM: An 8-25 micron Imaging-Spectrograph.* PI: Mark Kidger (mrk@ll.iac.es)

The current activities in this WP are:

- Pursuit the contracts signed to perform the feasibility studies of the instruments, and keep a strong collaboration with these groups.

- Working in the interfaces with several sub-systems: civil work, mechanical rotator, A&G system and Telescope mechanics interfaces are currently under study.

- Preparation of a proposal for the management of the GTC Guaranteed Time. This proposal, that is being studied by the SAC, is expected to be approved by the GRANTECAN Project Board before opening the Announcement of Opportunity.

- Preparation of the Announcement of Opportunity for Day One Instrumentation

7.2 Instrument #1 (WP 5.2)

This working package includes the design, building and commissioning of the first GTC instrument. Most of the tasks is this WP will be carried out for the consortia responsible for the instrument. No progress has been made in this WP up to now since the activities (starting with those related to the Preliminar Design) will begin after the selection of the first Day One instrument (March 1999).

7.3 Instrument #2 (WP 5.3)

This working package includes the design, building and commissioning of the second GTC instrument. Most of the tasks is this WP will be carried out for the consortia responsible of the instrument. No progress has been made in this WP up to now since the activities (starting with those related to the Preliminar Design) will begin after the selection of the second Day One instrument (March 1999).

7.4 Detectors systems (WP 5.4)

This package contains the activities to carry out for the managing and procurement of the GTC detectors. For this year, the only planned tasks (starting date: June 1998, finishing date March 1999) are the identification of the needs from the different GTC sub-systems (capturing the user requirements) and the study of alternatives for optical and infrared detectors. This includes not only a comparative study of technical solutions, but also a managing study, including the possibility of participating in the existing consortia whose goal is to get the new generation of large format detectors. A report including the costs of the different kind of detectors and the schedule to get them will be one of the outputs of these tasks. At the same time, the contracted feasibility studies for GTC instruments and the answers to the Announcement of Opportunity

will provide the PO with the user requirements for the detectors from the instrument's point of view.

8. PROJECT MANAGEMENT (WP 6)

8.1 System Engineering (WP 6.1)

8.1.1 Configuration control (WP 6.1.1)

The objectives of this work package are:

- To produce and maintain the Project configuration management procedures and tools. These procedures are:
  - Configuration identification
  - Configuration control
  - Configuration information
  - Configuration audits

These procedures explicitly include the interface management.

- To perform the configuration management according to those procedures.
- To produce and maintain the GTC system error budgets.
- To produce and maintain the terms glossary of the GTC system.

At present, Project configuration management procedures have been produced and are in force. Also, some basic tools have been implemented: a data base stores all the information related to configuration elements (requirements, documents and drawings, changes, etc.). This information is available to the PO through an intranet.

As the last step of the Project conceptual design, the functional baseline was edited and frozen (the functional baseline consists of the documents GTC System Specification and User Requirements Specification). It contains all the system level requirements that drive further design phases (preliminary and detailed design). Any change to the functional baseline has to be approved by the Configuration Control Committee. Since the first edition of the functional baseline, several configuration changes have been approved and implemented.

The first issues of the GTC system product tree and interface diagram have been edited. They contain all the subsystems and interfaces between subsystems until third level of decomposition and are available to the PO through the intranet. Also, several interfaces affecting to the Civil Work have been defined in the corresponding Interface Control Documents.

The System Error Budgets document has been edited. This document contains the image quality, pointing, open-loop tracking and IR background error budgets. Every item in each budget is described and the established allocation is justified. Also, it is estimated the difficulty in reaching the allocated value and the subsystems requirements related are identified. Error budgets are continuously maintained along the Project.

Finally, a system glossary of terms has been produced and it is available through the intranet. The glossary contains all the Project common-use terms and it is continuously maintained along the Project.

8.1.2 Documentation control (WP 6.1.2)

The objectives of this work package are:

- To produce and maintain the Project documentation management procedure and tools.
- To perform the documentation management according to that procedure.

The documentation control procedure has been edited and it is in force. All documents, drawings and meeting minutes are managed according to this procedure.

Also, a physical archive containing hard copies of the documents, drawings and minutes has been implemented. It is complemented by a computer archive that contains the computer copies of the in-house generated documents and drawings, as well as the available files corresponding to external items.

All the information related to documents is stored in the data base mentioned in the WP 6.1.1 (Configuration control) and it is available to the PO through the intranet. Such information can be cross-referred to the configuration information. Also, it is possible to access directly any document by means of the intranet.

8.1.3 Integrated Logistic Support (WP 6.1.3)

The objectives of this work package are to design the GTC in such a way as to make it effectively and economically supportable, as well as to develop the necessary elements for supporting it. A goal is to reach an optimum compromise between the cost of developing the GTC, including the support elements, and the cost of the support itself.

Also, some results of this work package will be input data for the WP 8.1.7 (Operation and maintenance preparation).

During the conceptual design phase, the operational and support requirements and the ILS preliminary plan have been established. Currently, as a part of the Logistic Support Analysis (LSA), the major maintenance and operation tasks have been identified. Also, those support elements (cranes, carts, workshops, etc.) affecting the civil work and the dome are being defined. Finally, a system reliability model is being performed. This is a main tool to assign reliability requirements to the GTC subsystems.

8.1.4 Integration and test (WP 6.1.4)

The objectives of this work package are:

- To identify and define the key aspects regarding system integration and testing (restrictions to the GTC design, responsibilities, safety, transport, ORM environment and regulations, storing, etc.).
- To assist the Project Manager in developing, maintaining and executing the detail GTC integration and testing plan.
- Provisioning of the necessary support common elements to carry out the integration and testing. These elements will be defined within the scope of the WP 6.1.3 (Integrated Logistic Support).

At present, a preliminary identification of those key aspects regarding system integration and testing has been made. This constitutes the starting point to reach the objectives of the work package.

8.1.5 Quality control (WP 6.1.5)

This work package has the following objectives:

- To design the PO quality assurance plan.
- To produce the PO Quality Manual.
- To produce the procedures that develop the Quality Manual.
- To give seminars in the PO in order to help the project staff in the execution of the procedures.

The quality system of the PO has been designed and the Quality Manual has been produced. Also, the following procedures have been edited and the related seminars have been performed:

- Elaboration of Procedures
- Elaboration and Control of Specifications
- Design reviews
- Configuration Management (configuration identification, control, information and audits)
- Documentation control
- Contracts and procurement
- Non-conforming Management
- Project Control
- Risk Management
- Communication in the PO
- Personnel Management
- Accounting
- Back-ups
- Quality Audits

Only two procedures are about to be finished:

- Tests and Inspections
- Transport, Handling and Storage

8.1.6 System simulation (WP 6.1.6)

The goal of this work package is to develop and maintain an end-to-end system simulation, which provide a tool for assistance in technical decisions and for early identification of problems mainly during the design and integration phases of the Project. This simulation will include a dimensional model, as well as another model to evaluate the image quality and the pointing and tracking performance.

Only preliminary studies have been carried out in order to evaluate the necessary resources to produce the simulation. The required man-power is being contracted.

8.1.7 Operation and maintenance preparation (WP 6.1.7)

The scope of this work package is to produce the Operation and Maintenance Plan of the GTC, including aspects regarding safety during operations.

This work package has not been started yet.

8.1.8 Other system engineering activities (WP 6.1.8)

Currently, this work package has the objective of defining the electromagnetic compatibility regulations to be followed in the PO to specify the different GTC subsystems.

The electromagnetic compatibility regulations has been selected and are being applied. Therefore, the current scope of this work package has been covered.

8.2 Project management (WP 6.2)

There is not yet a full time Project Manager (PM) in the GTC PO. The Project Director is intensively working towards identifying an adequate PM. Some candidates are being evaluated. The major difficulty found with this activity has been the lack of confidence of the candidates on the final funding of the project. The significant change made in April on the funding of the project is expected to solve this difficulty.

The philosophy underlying the management policy of the interim PM has been to share the project management activities between the PM and the heads of the different technical groups (System engineering, Optics, Telescope, Control system and Instrumentation). The Head of the System Engineering Group has shared with the PM a large part of the work load on the management of the project.

The initial project schedule and budget was prepared by the current Project Director during the Feasibility Study of the project at the end of 1995. It was refined in close co-operation with the heads of the technical groups along the development of the Conceptual Design phase that was ended in 1997. Now the project scope, schedule and budget are kept under control mainly by the heads of technical groups as WP managers, overseen by the PD who establish the milestones to be achieved and the budgetary limits.

A Project Plan Control Procedure has been established since the end of 96. It establishes the procedures to be followed by the PO to create, follow up and finish all tasks in every WP. It defines the responsibility and duties of the participants on the different WP tasks. A weekly Project Plan Control meeting is celebrated between the Project Director (as interim PM), the Project Scientist, the Project Administrator and the Heads of every technical group. There a

detailed analysis of the progress on every task is made, solutions are identify and conflicts are solved.

A Risk Management Procedure has been recently established where the risks on the project are identified and controlled at all levels of the PO, from every group in the PO and up to the highest level of management. It is too soon to see the results from this activity.

Communication inside the PO is a key aspect where a lot of efforts have been focused. Additionally to the formal meetings to discuss project matters like project management or more technical aspects of the different subsystems or their interfaces, the members of the different groups meets frequently to treat matters of their common interest. Also, informal meetings are organised between all the members of the PO where all matters can be objects of discussion or general information. Or where every member of the PO exposes to the others his/her current activity and concerns. Computer communications is intensively used to communicate between the PO members but also to share any type of information to any interested individual in the PO. Any effort spent in improving the communication throughout the PO will never be enough to avoid the risk of misunderstanding or lack of information between the multiple interrelated tasks of the PO activities.

Also communication between the PO members and experts outside the PO, mainly in other large telescope projects, is highly encouraged. The presence of our personnel in conferences and meetings of interest for the different aspects of the project is facilitated and their participation desired.

8.3 Scientific direction (WP 6.3)

A Scientific Advisory Committee (SAC) has been established that has meet twice so far. The recommendations made by the SAC can be seen in the Minutes of these meetings.

The Top-level Science Drivers for the GTC have been established by the Scientific Advisory Committee, after consultation with the community at large. These have led the conceptual design of the GTC up to the point where it stands at present.

The technical requirements that have come from the Scientific Drivers represent a difficult technical challenge justified by the expectations to be upon completion of the GTC at the forefront of astronomical observations.

Several choices have been required to meet the Science Drivers. In particular, a single secondary mirror configuration has been adopted to allow quasi-simultaneous access to scientific instruments located at the Cass. and Nasmyth foci. This has influenced the adopted optical configuration of the GTC, specially the resulting F ratio and field of views at the different foci. We are confident that the final values for these fields of view are adequate for most scientific programmes, leaving additional room for other required tasks like guiding, wavefront sensing, etc.

The Project Office has up to now been reluctant to perform a study of a design that would allow the complete removal of the tertiary mirror, as suggested by the SAC. The current design calls for a deployable tertiary. It has the drawback that introduces a given amount of unwanted obscuration and shadowing in the Cass. FoV.

A document has been written outlining the different modes of observing that the GTC should cater for. These are input for the design of the control system.

A document containing an analysis of the required chopping frequencies for IR background subtraction has been completed. As a result the secondary mirror chopping frequency requirements have been relaxed.

Current topics that are been analysed include, a study of the different emissivities expected depending on the different coatings being contemplated for the GTC, as well as the GTC scientific verification plan, and a study of the conditions under which visitor's instruments could be installed at the GTC

The monitoring campaign to select the location of the GTC has been finished. A recommendation for selecting the GTC Site has been made, based rather in the orography and geology of the terrain than in the seeing, meteorology or water vapour measurements. Nonetheless, the results of these campaign are very encouraging, with median seeing of 0.6 arcsec and median precipitable water vapour column of around 4mm. The selected site is the one named Site 2, located down the slope of Site 1.

8.4 Administrative management (WP 6.4)

All the administrative matters necessary to support the PO are under the responsibility of the Administrative Manager. Accounting, contracts and administrative and operational support are the activities of this group.

A good accounting system well matched with the WBS and its tasks subdivision is a valuable tool to keep the expenditures under control. It facilitates to the project management the follow up of expenditures against the planed costs. The GTC accounting system follows strictly these concepts.

It is also imperative to keep informed the different funding sources on the specific expenditures made with their funds. That is not an easy task but is well implemented in the GTC accounting procedures. Close contact with all of this sources is maintained to ensure they feel well informed and with enough control on project expenditures.

All the procurements made by the GTC PO are followed up by the Administration group and a procedure is established to help this activity. The many tender actions to be initiated from the PO are also under the responsibility of the Administrative Manager and his group. This group has the needed legal support to help the Project Manager and the technical groups to initiate any contract and to follow any problems that could arise along its life.

The administrative and operational support activities keep the members of the PO well supplied on their working needs to perform their work. Secretarial support and basic office needs and the support of the PO building are the main tasks on this aspects.

8.5 Project direction (WP 6.5)

The activity of the Project Director has been concentrated in:

- The setting up of the PO and its continuous growth identifying and contracting the human resources needed to the tasks of the PO.

- Supporting the IAC Director in identifying and animating potential international partners to participate in the GTC project. The Project Scientist has supported a large part of this activity.

- The Interrelation with the project financial sources to establish the framework for receiving and justifying the funds allocated to the project.

- The communication of the project with the external world (administrative, scientific and technical institutions, industries and press)

- Facilitating a fluent relationship between the PO and other organisations, like other large telescope projects, ensuring a rapid learning curve.

The major difficulties have concentrated in the adequating the PO staffing needs with the rapid evolution of the project, and in the negotiations with the funding institutions to convince them to allocate the needed funds according to the project spending profile.

A large effort has been spent to isolate the PO activities from the difficulties and potential disruptions coming from outside.