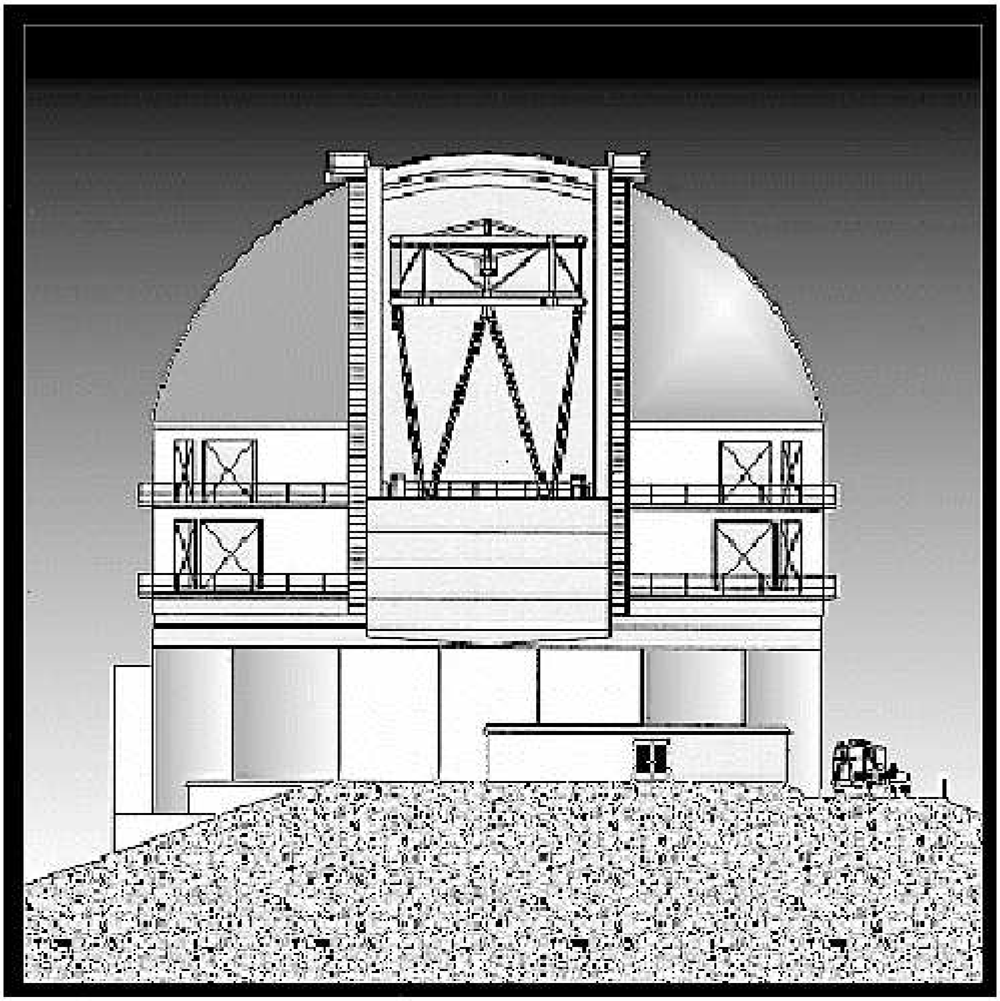
GEMINI
8-M Telescopes
Project

SPE-C-G0038

Controls Work Package Description Outline



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REVISION CHART

Draft 1	for review within Controls Group
Draft 2	for review within Project
Draft 3	for review by developer
Draft 4	for review by Controls Working Group
Version 1	under change control

REVISION LIST

All changes to this document, once under change control, will be listed here.

PREFACE

The purpose of the work package description is to serve as the current agreement between the Gemini Controls Group and the Institution responsible for performing the work package. This document covers the following areas:

- Work Package Overview
- Work Package Organization
- Managerial Process
- Requirements
- System Design Description
- Analysis / Simulation
- System Integration and Test Plan
- Test Reports
- User Documentation

The intent is that, during a three month period prior to finalizing this agreement, the Gemini Controls Group and an identified team within the Institution to whom the work package has been assigned will flesh out this document and reach agreement on the above areas.

This document will also serve to track any changes made to the agreement between Gemini and the Institution. In that sense it will be a living document - however any changes which affect budget, schedule and specification will require formal change control.

ACTION ITEMS

All action items, including TBD, will be listed here.

1. INTRODUCTION

This section of the Work Package Description shall provide an overview of the work package and the product, a list of associated lower level elements, a list of package deliverables, and reference material for this work package.

1.1 WORK PACKAGE OVERVIEW

This subsection shall provide a concise summary of the work package objectives, the product to be delivered, specific items which are not part of the work package, major work activities, major work products, major milestones, required resources, and master schedule and budget.

1.1.1 WORK PACKAGE OBJECTIVES

This paragraph will provide **a** concise summary of the work package objectives in terms of the computer systems, electronic interfaces, cabling, connectors, and software needed to implement the package.

1.1.2 PRODUCT DELIVERED

This paragraph will provide a concise summary of the product to be delivered in terms of its hardware and software parts. It will also provide a summary of the applicable Gemini standards and procedures to which the product will conform

1.1.3 NOT INCLUDED IN WORK PACKAGE

This paragraph will provide a summary of specific items which are not part of the work package. The intent is to clarify the status of items which might be assumed to be part of the work package due to tradition, culture, descriptions, assumptions, etc.

1.1.4 MAJOR WORK ACTIVITIES

This paragraph will provide a concise summary of the major work activities included in the work package. All work packages will, in general, consist of the major activities listed below.

The major work activities included in this work package will be:

- System Design
- Preliminary Design
- Critical Design
- Implementation
- Acceptance Testing

1.1.5 MAJOR WORK PRODUCTS

This paragraph will provide a concise summary of the major work products resulting from the work package. All work packages will, in general, produce the major work products listed below.

The major work products resulting from the above work activities will be:

- Review Documents
    - System Design
    - Preliminary Design
    - Critical Design
    - Implementation Progress
- Acceptance Testing
- Control system simulator
- Functional control system
- Specification control system

1.1.6 MAJOR MILESTONES

This paragraph will provide **a** concise summary of the major milestones that are part of the work package. All work packages will, in general, have the major milestones listed below.

The major milestones of the work package are:

- System Design Review
- Preliminary Design Review
- Critical Design Review
- Delivery of control system simulator
- Implementation Progress Review #1
- Implementation Progress Review #2
- Delivery of functional control system
- Acceptance Testing Review

1.1.7 REQUIRED RESOURCES

This paragraph will provide a concise summary of the resources required to complete this work package.

1.1.8 MASTER SCHEDULE AND BUDGET

This paragraph will provide a concise summary of the master schedule and budget for this work package. The budgetary information is proprietary and will not be released outside of the project and the work package responsible.

The schedule will be represented as a gannt chart.

1.1.9 Relationship To Other Work Packages

This paragraph will provide **a** concise summary of this work package's relationships to other work packages and contracts.

1.2 Associated Lower Level Elements

This subsection shall include all of the elements in the next level of the work break down structure.

1.3 Work Package Deliverables

This subsection shall list all of the items to be delivered to the customer, the delivery dates, the delivery locations, and quantities required to satisfy the terms of the work package agreement. This list of work package deliverables shall not be construed as an official statement of work package requirements.

1.3.1 Deliverable Items

This paragraph will list all the customer deliverables.

1.3.2 Delivery Dates

This paragraph will list the delivery dates for all of the customer deliverables.

1.3.3 Delivery Locations

This paragraph will list the delivery locations for all of the customer deliverables.

1.3.4 Quantities Required

This paragraph will list the quantities required for each customer deliverable.

1.4 Documents Reference

This subsection shall provide a complete list of all documents and other sources of information referenced in the work package description. Each document shall be identified by title, report number, date, author, and publishing organization.

1.4.1 Applicable Documents

This paragraph shall list all documents which are part of this work package description.

1.4. Reference Documents

This paragraph shall list all documents referred to in this work package description.

1.5 Definitions And Acronyms

This subsection shall specify, define, or provided references to the definition of all terms and acronyms required to properly interpret the work package description.

2 WORK PACKAGE ORGANIZATION

This section shall specify the process model for the work package, describe the work package organizational boundaries, identify organizational boundaries and interfaces, and define individual responsibilities for the various work package elements**.**

2.1 PROCESS MODEL

This subsection shall define the relationships among major project functions and activities by specifying the timing of major milestones, baselines, reviews, work products, project deliverables, and sign-offs that span the project. The process model must include package initiation and package termination activities. This process model will be represented as a gannt chart in addition to any written descriptions below.

2.1.1 MILESTONES

This paragraph will specify the timing of the major milestones.

2.1.2 BASELINES

This paragraph will specify the timing of the major baselines

2.1.3 REVIEWS

This paragraph will specify the timing of the major reviews

2.1.4 WORK PRODUCTS

This paragraph will specify the tinting of the major work products.

2.1.5 WORK PACKAGE DELIVERABLES

This paragraph will specify the timing of the major work package deliverables.

2.1.6 WORK PACKAGE SIGN-OFFS

This paragraph will specify the timing of the major work package sign-offs.

2.2 ORGANIZATIONAL MODEL

This subsection shall describe the organizational structure of the work package. The structure of the work package will be shown as an organizational chart in additional to any written material.

2.3 ORGANIZATIONAL BOUNDARIES AND INTERFACES

This subsection shall describe the administrative, managerial, technical, and scientific boundaries between the work package and each of the following entities:

- the parent organization(s)
- the customer organization(s)
- Subcontracted organizations
- other interacting organizations

2.3.1 PARENT ORGANIZATION

The parent organization of the work package responsible will be described.

- administrative representative will be the parent organization's contracting officer
- managerial representative will be the national project manager
- technical representative will be the Work Package Responsible (WPR)
- scientific representative will be the national project scientist

2.3.2 CUSTOMER ORGANIZATION

The customer organization is the Controls Group of the Gemini Project.

- administrative representative will be the Gemini Contracting Officer
- managerial representative will be the Gemini Work Package Responsible
- technical representative will be the Gemini Work Package Responsible.
- scientific representative will be the Gemini Project Scientist

2.3.3 SUBCONTRACTED ORGANIZATIONS

The identity of any subcontracted organizations will be specified here. If the identity is not known at present then a description of the bills of organizations which will be involved in subcontracting must be described.

If specific subcontracted organizations are known at this time then, if possible, their representatives should be listed below.

- administrative representative
- managerial representative
- technical representative
- scientific representative

2.3.4 PARTNER COUNTRIES ORGANIZATIONS

The partner country organizations are the respective national Gemini Project Offices.

- administrative representative will be the national project manager
- managerial representative will be the national project manager
- technical representative will be the national project engineer or national project manager
- scientific representative will be the national project scientist

In specific instances the national project managers may delegate all or part of their authority to national work package managers. In an analogous manner the national project scientists may delegate all or part of their authority to national work package scientists.

The intent in this delegation is to delegate technical and/or scientific authority over broad groups of related work packages, not over individual work packages.

2.3.5 WORK PACKAGE SUPPORT FUNCTIONS

This subsection shall describe the administrative and managerial interfaces of the package support functions.

2.3.5.1 CONFIGURATION MANAGEMENT

The responsibility for configuration management rest with the work package responsible up until delivery to Gemini. The standards for configuration management are contained in the Gemini Software Configuration Control Plan.

The administrative and managerial interfaces for configuration management will be between the GWPR and the WPR.

2.3.5.2 QUALITY ASSURANCE

The responsibility for quality assurance rests with the work package responsible up until delivery to Gemini. The standards and procedures to ensure quality assurance are contained in Section 4 of this document.

The administrative and managerial interfaces for quality assurance will be between the GWPR and the WPP.

2.3.5.3 VERIFICATION AND VALIDATION

Preparation for verification and validation is the responsibility of the work package responsible. Verification and validation will be handled at each of the reviews conducted by Gemini.

The administrative and managerial interfaces for verification and validation will be between the GWPR and the WPR.

2.4 WORK PACKAGE RESPONSIBILITIES

This subsection shall identify and state the nature of each major work package function and activity, and identify the individuals who are responsible for these functions and activities.

3. MANAGERIAL PROCESS

This section shall specify the management objectives and priorities; work package assumptions, dependencies, and constraints; risk management techniques, monitoring and controlling mechanisms to be used; and a staffing plan.

3.1 MANAGEMENT OBJECTIVES AND PRIORITIES

This subsection shall describe the philosophy, goals, and priorities for management activities during the work package. Topics to be specified may include, but are not limited to, the frequency and mechanisms of reporting to be used; the relative priorities among requirements, schedule, and budget for this project; risk management procedures to be followed; and a statement of intent to acquire, modify, or use existing software.

3.1.1 PHILOSOPHY

This paragraph shall describe the philosophy for management activities during the work package.

3.1.2 GOALS

This paragraph shall list the goals for management activities during the work package.

3.1.3 PRIORITIES

This paragraph shall list the priorities for the goals listed above.

3.1.4 REPORTING

This paragraph shall describe the reporting mechanisms and frequencies.

3.1.5 REQUIREMENT PRIORITIES

This paragraph shall list the priorities for the requirements of this work package.

3.1.6 WORK PACKAGE WORK BREAKDOWN STRUCTURE

The WBS will be developed to two levels in order to track cost and schedule for the work products required for each milestone review. The first level of the WBS shall be the milestone reviews and the second level shall be the work products required for those reviews. The WBS shall be described and maintained in Microsoft Project.

3.1.7 WORK PACKAGE SCHEDULE

The work package schedule shall be described and maintained using Microsoft Project. The work package schedule contained herein shall be at a high level and it will be the work package responsible's choice what scheduling process to use internally. The work package schedule herein will be updated on a biweekly basis.

3.1.8 Work Package Budget

The work package budget will be described and maintained using Microsoft Excel. The work package budget contained herein shall be at a level sufficient to monitor progress from on milestone to the next. The work package budget herein will be updated on a monthly basis.

3.1.9 Risk Management Procedures

The tracking of areas identified as risks will be the duty of the Work Package Responsible. The method of tracking will be by creating a risk tracking document for the specific area of the work package in question. This document will identify the risk, assess its possible impact, and track the risk through increased reporting and communication with the GWPR. In some situations the project may put a staff member on the developer's site for more frequent monitoring of progress.

The contents of this tracking document will be communicated to the GWPR on a biweekly basis.

3.2 Assumptions, Dependencies, And Constraints

This subsection shall state the assumptions on which the work package is based, the external events which the work package depends upon, and the constraints under which the work package is to be conducted.

3.2.1 Assumptions

This paragraph shall state the assumptions on which the work package is based.

3.2.2 Dependencies

This paragraph shall state the external events on which the work package depends.

3.2.3 Constraints

This paragraph shall state the constraints under which the work package is to be conducted.

3.3 Risk Management

This subsection shall identify and assess the risk factors associated with the work package. The major risk areas to be identified and assessed are:

- contractual and partnership risks
- technological risks
- Size and complexity risks

- personnel risks
- customer acceptance risks

For each risk identified the impact of the risk must be assessed and a contingency plan described.

3.4 MONITORING AND CONTROLLING MECHANISMS

This subsection of the WPD shall define the reporting mechanisms, report formats, information flows, review and audit mechanisms, and other tools and techniques to be used in monitoring and controlling adherence to the WPD. Work package monitoring shall occur at the first level of the work breakdown structure. The relationship of monitoring and controlling mechanisms to the work package support functions shall be delineated in this subsection of the WPD.

3.4.1 REPORT MECHANISMS, FORMAT, AND INFORMATION FLOW

There will be biweekly teleconferences between the GWPR and the WPR These meetings will have a set agenda and will be minuted by the project. Copies of the minutes and action items will be distributed to the GWPR, WPR, National Work Package Manager, and the National Work Package Scientist.

3.4.1.1 BIWEEKLY MEETING AGENDA

- follow-up on action items from previous meeting
- progress from previous meeting
- specification items
- schedule items
- budget items
- risk management items
- other business

3.4.2 REVIEW MECHANISMS

The reviews will be part of the milestone reviews. The milestone reviews shall be conducted by Gemini and Gemini will invite interested parties to serve in an advisory position to the project.

3.4.3 AUDIT MECHANISMS

The audit mechanisms shall control both Gemini's exposure to potential cost or schedule risk and provide a means of tracking actual costs versus budgeted costs.

Each WBS entry shall be assigned a unique identification number which identifies the Work Package as well as the WBS item within the Work Package. These identification numbers shall be referred to as a BIN.

Gemini will control risk by the use of purchase orders or the equivalent. Each such purchase order will be used to authorize the partner to start work on specific set of WBS items. In general each purchase order will authorize the partner to start work on a sufficient number of WBS items in order to proceed to the next milestone review. The purchase order shall set a maximum limit beyond which the partner may not charge Gemini. Gemini shall hold back 25% of the purchase order amount pending successful completion of the relevant milestone review.

All bills submitted to Gemini and any invoices or equivalent submitted to Gemini for credit against national contributions must reference a BIN that is on a currently issued purchase order. Any and all of these bills / invoices shall require the signature of both the Gemini Controls Manager and the Gemini Work Package Responsible before being approved for payment / credit.

3.4.4 RELATIONSHIP TO WORK PACKAGE SUPPORT FUNCTIONS

These are covered in the Gemini Software & Controls Configuration Control Plan.

3.5 STAFFING PLAN

This subsection of the WPD shall specify the numbers and types of personnel required to conduct the work package. Required skill levels, start times, duration of need, retaining, and phasing out of personnel shall be specified. The start times and duration may be expressed as a gannt chart if desired.

3.5.1 NUMBER AND TYPE

This paragraph shall specify the number and type of staff required over the duration of the work package.

3.5.2 SKILL LEVELS

This paragraph shall specify the skill levels required for the different types of staff required.

3.5.3 START TIMES

This paragraph shall specify the start times for all the staff required.

3.5.4 DURATION AND PERCENT ALLOCATION

This paragraph shall specify the duration each staff is required for and the percentage of that staff member allocated during that duration.

3.5.5 METHOD OF OBTAINING

This paragraph shall specify how each staff member will be obtained; secondment of existing staff, new hire, temporary hire, etc.

3.5.6 Training

This paragraph shall specify what training, if any, will be required for individual staff.

3.5.7 Retaining

This paragraph shall specify the means by which staff members will be retained for the duration of the work package.

3.5.8 Phasing Out

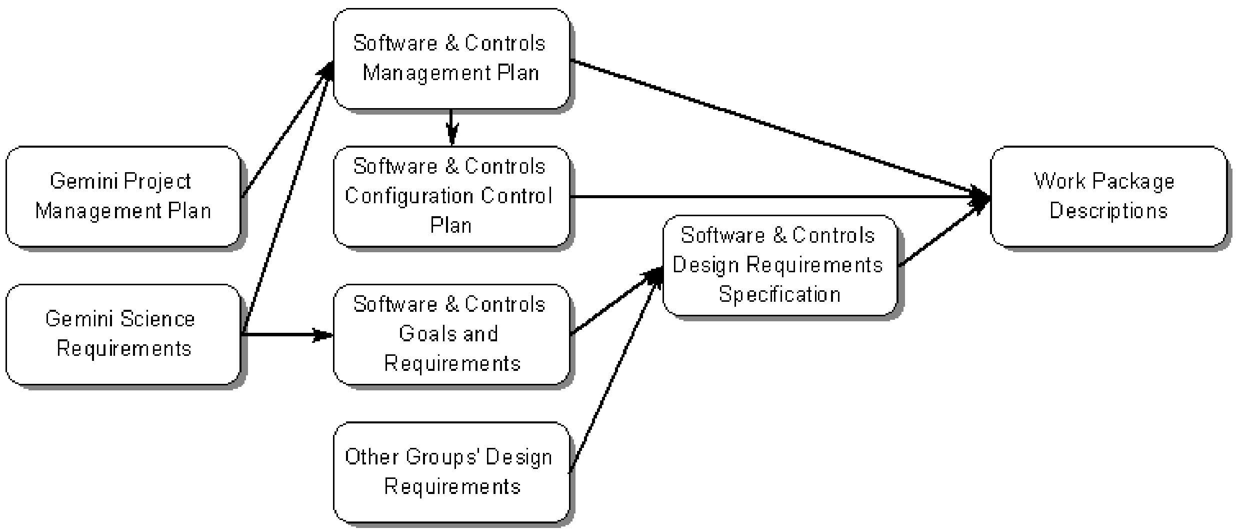
This paragraph shall specify how individual staff will be phased out of the work package.

4 REQUIREMENTS

This section shall contain, either specifically or by reference, the requirements of the controlled mechanism (if any).

A requirement is defined in IEEE-610.12-1990 as:

- a condition or capability needed by a user to solve a problem or achieve an objective
- a condition or capability that must be met or possessed by a system or system component to satisfy a contract, standard, specification, or other formally imposed documents
- a documented representation of a condition or capability as in the first two definitions The general flow of information between the various documents is as illustrated below.



4.1 FLOW DOWN OF SCIENCE REQUIREMENTS

This subsection shall contain a list of all applicable requirements that flow down from the Gemini Science Requirements document. They shall be referenced by the appropriate section numbering contained within the Gemini Software & Controls Goals and Requirements document.

4.2 FLOW UP OF EXISTING ENGINEERING REQUIREMENTS

This subsection shall reference all applicable requirements that flow from the design requirements imposed by the group responsible for the mechanism. They shall be referenced by document title, document identification number, and appropriate section numbering contained within the document.

5 SYSTEM DESIGN DESCRIPTION

5.1 CONCEPTUAL DESIGN DESCRIPTION

The conceptual design description shall present a high level description of the system being designed. This design shall be sufficient for presentation at the preliminary design review of the underlying mechanism.

This section shall contain the system concept, essential model, and implementational model.

5.1.1 *SYSTEM CONCEPT*

This subsection shall contain a concise description of the system in terms of its control, subsystems, and hardware.

5.1.1.1 CONTROL CONCEPT

These paragraphs shall present a brief description of the control concept for the work package. This should describe the major control interfaces between the work package and its environment.

5.1.1.2 SOFTWARE CONCEPT

These paragraphs shall present a bullet outline of the software subsystems contained in the work package and a brief description of each one.

5.1.1.3 HARDWARE CONCEPT

These paragraphs shall present a bullet outline of the hardware subsystems contained in the work package and a brief description of each one.

5.1.2 ESSENTIAL MODEL

This subsection shall describe the essential model. The essential model shall be presented in the environmental model and behavioral models

5.1.2.1 ENVIRONMENTAL MODEL

This section shall describe the environmental model. The environmental model shall be expressed as a context diagram and an external event list.

5.1.2.1.1 CONTEXT DIAGRAM

The context diagram for the enclosure control system shall be contained in an Appendix.

5.1.2.1.2 EXTERNAL EVENT LIST

The external event list shall be contained in an Appendix.

5.1.2.2 Behavioral Model

This subsection shall present the behavioral model.

5.1.2.2.1 System Response To External Events

The system response to external events shall be contained in an Appendix.

5.1.2.2.2 Classification Of External Events

The classification of external events shall be contained in an Appendix.

5.1.2.2.3 Preliminary Transformation Model

The preliminary transformation model shall be contained in an Appendix.

5.1.3 Implementational Model

This subsection shall describe the implementational model. The implementational model shall be presented as the processor allocation, task allocation, and module models.

5.1.3.1 Processor Allocation Model

The processor allocation model shall be contained in an Appendix.

5.1.3.2 Task Allocation Model

The initial task allocation model shall be contained in an Appendix.

5.1.3.3 Module Model

The module model will be produced by the developer as part of the work package.

5.2 Detailed Design Description

Detailed design descriptions are to take the conceptual design down to detailed subsystem and component descriptions. It should include assembly and detailed drawings.

5.3 Specifications

This subsection shall include all specifications, which include or reference the detailed drawings, which are to be used in the manufacture of the subsystem or components.

Specification is defined in IEEE 610.12-1990 as *"a document that specifies, in a complete, precise, verifiable manner, the requirements, design, behavior, or other characteristics of a system or component, and, often, the procedures for determining whether these provisions have been satisfied".*

5.3.1 Software Specifications

All software produced for the Enclosure Work Package shall conform to the standards set forth in the Gemini Software Requirements Specification, Document SPE-C-G0014.

The purpose of the SRS is to define the operational requirements for the Gemini Control System software. The goal of the SRS is to provide **a** functional tool for guiding the development of controls and data acquisition systems in a manner consistent with their operation within the Gemini System. It establishes both general criteria and specific functional requirements for software and controls design in the Gemini Project.

This section is to contain the software specifications and will be produced by the developer after the implementational model is completed.

5.3.2 Control Specifications

This subsection shall detail the specifications for the control systems to be delivered as part of this work package. These requirements should include, but should not be limited to, requirements in the following areas:

- sample rates
- gain and phase margins
- power amplifier voltage and bandwidth limitations
- power amplifier mean time between failures at load requirements
- actuator torque requirements
- actuator power requirements
- actuator thermal resistance and other thermal characteristics
- resolver and other sensors quantization and noise characteristics
- resolver and other sensors bandwidths
- friction and other disturbance torques
- settling times and other bands
- disturbance characterization and disturbance rejection factors
- robustness requirements over expected system uncertainty and variation
- analysis of CPU burden and effect upon control loops of resulting delays
- FEA analysis of control loop limit cycle interactions with structure

- requirements on limit cycle frequencies and amplitudes resulting from interaction of quantization, friction, and other nonlinearities[1]

5.3.3 INTERFACE SPECIFICATIONS

This subsection shall detail all software, hardware, and electrical interfaces required.

All hardware and electrical interfaces shall conform to the standards defined in the Gemini Electronic Design Specification Document, SPE-ASA-G0008.

All software interfaces shall conform to the standards defined in the Gemini Software Requirements Document SPE-C-G0014.

The details for each interface can be found in the Gemini Pointing Control System Design Requirements Document [SPE-C-G0010].

5.3.3.1 SOFTWARE INTERFACES

These paragraphs shall detail or reference the software interfaces external to this work package.

5.3.3.2 HARDWARE INTERFACES

These paragraphs shall detail or reference the hardware interfaces external to this work package.

5.3.3.3 ELECTRICAL INTERFACES

These paragraphs shall detail or reference the electrical interfaces external to this work package.

[1] This is included as power amplifiers are often the weak link and so over designing is an inexpensive means of providing reliability. One should consider whether forced cooling will be required. For instance will limit-cycles cause damage of life time of structure ?

6 ANALYSIS/SIMULATION

This section shall contain, either directly or by reference, the descriptions and results of any analysis performed or planned as part of the design work. Where appropriate, this may be a part of the design descriptions described above. Significant analysis performed should be published in the form of a separate technical report and referenced or attached in the appropriate design description document. It is expected that appropriate levels of analysis are available for the PDR and CDR.

7 SYSTEM INTEGRATION AND TEST PLAN

This section shall include the plans for integration and test of the system.

7.1 INTEGRATION PLAN

Plans and procedures for integration of subsystems should normally be started prior to a CDR, but may be finalized prior to assembly of the system. During assembly, deviations to this plan and problems encountered should be noted. Any deviations to the functional specification and subsystem specification will fall under formal change control and must be approved.

7.2 TEST PLANS

Acceptance test plans will be required for each system to be delivered. Acceptance testing at the location of integration and on-site may be required. Under certain circumstances, there may be different plans for on-site testing. This will be reviewed on a case by case basis. The acceptance test plans must be approved by the appropriate group manager and project manager along with the organization performing the work.

8 TEST REPORTS

Test reports shall be supplied for any testing of prototypes made during the design phase and after completion of any acceptance tests performed. in addition, critical tests performed during manufacture which are identified to be of specific interest to the project will be documented. The test reports should clearly describe the tests performed (in some cases this may be part of the acceptance test plans) and summarize the key results. A detailed list of test results should also be included in an appendix.

9 USER DOCUMENTATION

The following should be supplied upon delivery of the system:

- users manual
- detailed interface descriptions / drawings (as built)
- maintenance and safety manual
- drawings and parts list (as built)

A. CONTEXT DIAGRAM

This appendix shall contain the context diagram for the work package.

B. RESPONSE TO EXTERNAL EVENTS

This section shall contain a description of the work package response to external events.

C. PRELIMINARY TRANSFORMATION DIAGRAMS

This section shall contain the preliminary transformation diagrams.

D. Processor Allocation Model

This section shall contain the processor allocation model.

E. TASK ALLOCATION MODEL

This section shall contain the task allocation model.