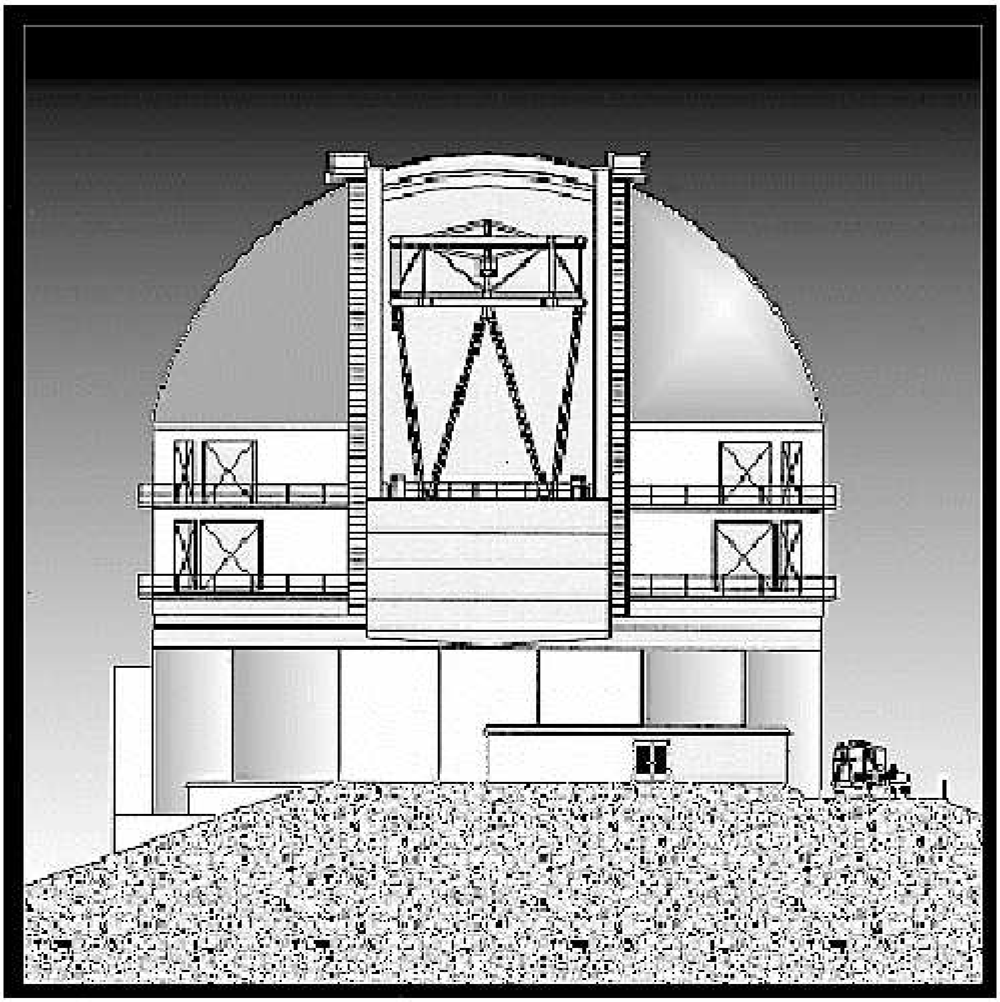
GEMINI
8-M Telescopes
Project

REV-S-G0062

Systems Review #3 Reviewer's Comments and Project Responses



September 9, 1996

GEMINI PROJECT OFFICE 950 N. Cherry Ave. Tucson, Arizona 85719
Phone: (520) 318-8545 Fax: (520) 318-8590

Gemini System Review #3
Reviewer's Comment #1

Topic: M1 Assembly	**Reviewer:** W. Van Citters

Issue/Concern:

(1) I am concerned that there are still a number of tests/design issues still pending post-CDR. To me they could have final design impact. This could be allowable if there were considerable slack in the M1 schedule. Answers that details will be clear in "a couple of weeks" don't work when there are only three weeks of slack in the 2 year schedule.

(2) Test rig: What is "next phase" for? CDR is over - we are entering fab on a sub-system with 3 weeks of slack. Maybe this is all fine but I am very concerned.

(3) Can results be put into a summary matrix which presents requirements, test results, error margins?

(4) CDR - Hose lifetime concerns recalled by Fred G. - no satisfactory answer.

Recommended Action:

Responsible Person: Stepp	**Due Date:**

Response to comment #1:

(1) The continued schedule delays in finalizing design details, particularly on the M1 Support System, are a real issue. We are finding ways to work around the areas that are still changing, but there is no question that there is a risk that changes will be required to the mirror cell structure, which could incur cost penalties and possibly schedule delays. However, the interfaces are clearly documented in ICD's, so the design details and envelopes are constrained. It is only in the case that an ICD simply cannot be followed that changes to the cell will be required.

(2) The main purpose of the "next phase" of work on the test rig is to provide equipment that can be used to test the Primary Control System. This application has been anticipated since the initial planning of the control system work. The work supporting the M1 support design is done.

(3) We agree that a summary performance vs requirements matrix should have been presented, as was done (in incomplete form) at the CDR. This will be updated and completed once the designs have been finalized.

(4) The design has evolved since the Systems Review, and the final design uses more metal tubing and fewer hoses. The specified hoses have good predicted lifetimes, but like any hoses will eventually have to be replaced. Spares will be provided, and at some point in the future, new hoses will probably have to be manufactured. All the drawings will be included in the design documentation. Standard materials are used. We will have the tools on sight to “manufacture” replacement hoses which consists of standard hose material (specified in drawings) and stock fittings which can be put on by observatory maintenance staff with tooling provided.

<table>
<tr><td colspan="2">Gemini System Review #3
Reviewer’s Comment #2</td></tr>
<tr><td>Topic: Ventilation of Primary Mirror Cell</td><td>Reviewer: Baldwin</td></tr>
<tr><td colspan="2">Issue/Concern:

A lingering doubt: It is not obvious that there will be good natural flushing of the primary mirror cell. We don’t really know how much it matters if pockets of warm or cold air are trapped in there, but they could eventually bubble out of the doors on the side.</td></tr>
<tr><td colspan="2">Recommended Action:

Check if forced ventilation would be a good idea.</td></tr>
<tr><td>Responsible Person: Stepp</td><td>Due Date:</td></tr>
</table>

Response #2:

We are trying to design the systems in the M1 Cell Assembly so that in total they do not dissipate or absorb heat. For example, we are adjusting the amount of insulation on node boxes and coolant lines so that the heat leaking out of the node boxes will be balanced by the “cold” leaking out of the coolant lines. To the extent we are unsuccessful in perfectly balancing the heat loads, the heat will be removed by either forced or natural ventilation. Air is already pulled out of the telescope center section by blowers in the equipment room, and a limited amount of air can be evacuated from the mirror cell by this means. We are already planning to use this approach to pull warm air out of the central hole of the mirror cell. However, water tunnel studies have shown that the natural ventilation of wind blowing through the enclosure can be much more efficient at removing warm or cold air from the vicinity of the telescope than forced ventilation. Therefore, we are reluctant to add further forced ventilation systems, which would introduce their own thermal and vibration problems, unless experience shows our current approach has somehow failed.

In addition, the large vents pulling air from the enclosure are located at the telescope base, close to the mirror cell assembly. Under low wind conditions, most heat generated near the base of the telescope would be pulled downward through these vents (and away from the telescope beam).

<table>
<tr><td colspan="2">Gemini System Review #3
Reviewer's Comment #3</td></tr>
<tr><td>Topic: Fault Diagnosis</td><td>Reviewer: K. Shortridge</td></tr>
<tr><td colspan="2">Issue/Concern:

If there is concern as to the functioning of an instrument, one good diagnostic is to repeat a standard observation, reduce the data for it and compare it to previous data held for just this purpose. The key here is to have a standard, "automatic" data reduction procedure that can be run as a diagnostic. It is my impression that Gemini does not see the provision of data reduction software for an instrument as an integral part of the construction of that instrument.</td></tr>
<tr><td colspan="2">Recommended Action:

Gemini should consider the minimum "diagnostic" data reduction software needed by each instrument and make sure it will be available.</td></tr>
<tr><td>Responsible Person:
McGonegal/Oschmann</td><td>Due Date: August '96 for response</td></tr>
<tr><td></td><td></td></tr>
</table>

Response #3:

This is a good idea and is consistant with our integration and commissiong plans for the telescope. In addition to an "automatic" diagnostic for a particular instrument, we intend to have standard "diagnostic" observations comparing telescope versus instrument performance (primarily with use of the A&G system and external monitoring) and comparisons with successive instruments with previous observations (with existing instruments). This idea was presented as part of the Integration, Test, and Commissioning plan.

This is a part of the ongoing dialogue with the Instrument Builders. We will add this to the list of work to be done during Instrument Integration phases. The final "diagnostic" will evolved during the commissioning phase of each particular instrument on the telescope.

<table>
<tr><td colspan="2" align="center">Gemini System Review #3
Reviewer’s Comment #4</td></tr>
<tr><td>Topic: Project Status</td><td>Reviewer: Johns</td></tr>
<tr><td colspan="2">Issue/Concern:

Work on two key systems, Hydrostatic Bearings and Encoders, seems to be late. Are these systems well enough understood that this is not a concern?</td></tr>
<tr><td colspan="2">Recommended Action:</td></tr>
<tr><td>Responsible Person: Raybould</td><td>Due Date: May, ‘96</td></tr>
</table>

Response #4: (Jim O.)

The Hydrostatic Bearing contract is in place and expected delivery is in time for first use in the telescope erection facility. The elevation bearings have been delivered to NFM for the factory tests.

The interface for the encoders was designed to allow for two different types being considered. Recent tests show that either type of encoder will work. Since then, we have gone out for procurement of the encoders, allowing bidders of either type. Proposals are due soon, but we do not believe that we will have a delivery problem. We will know more when we see the responses in the next few weeks.

Gemini System Review #3
Reviewer's Comment #5

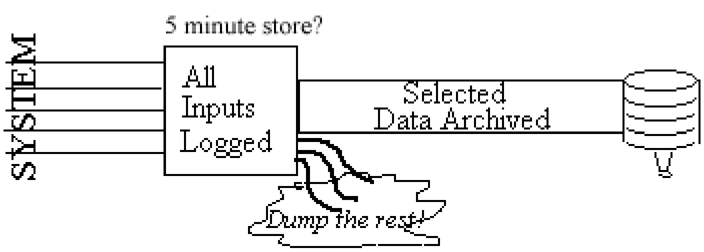
Topic: Diagnostics and Engineering Data Logging	**Reviewer:** Tim Hawarden

Issue/Concern:

It is clear that the control systems can log almost every action of interest. Those of us involved in operating telescopes repeatedly find that full logging of engineering info prior to a problem is highly desirable if fast diagnosis is to be the rule (or, sometimes, any diagnosis).

Recommended Action:

Actually build a detailed logging system - probably log everything at sensible intervals (keyboard when key pressed/mouse clicked, OIWFS@200Hz!) and keep a predetermined data string (eg. last 10^5 readings...) then dump all but a suitable synopsis. Then when there is a crisis you have ALL the last 5 minutes or so actual information at full detail. Maybe put this system on a separate platform perhaps with its own UPS, so a system crash does not lose the shorter-term bulk store.



Responsible Person: McGonegal	**Due Date: May '96**

Response #5:

The suggestion is a good one and easily implemented with our system. We have added a task called "Enginereing Logging System" and will deliver a prototype with the Functional Control System in September '97.

<table>
<tr><td colspan="2">Gemini System Review #3
Reviewer’s Comment #6</td></tr>
<tr><td>Topic: Operations Models</td><td>Reviewer: Tim Hawarden</td></tr>
<tr><td colspan="2">Issue/Concern:</td></tr>
<tr><td colspan="2">Recommended Action:

The A&G single-point failure review by Jim Oschmann looks immensely valuable and I suggest it be expanded and the implications of the various combinations followed. This will give a valuable picture of a variety of operating scenarios.</td></tr>
<tr><td>Responsible Person: Oschmann</td><td>Due Date: August, ‘96</td></tr>
</table>

Response #6:

Thanks for the comment! This type of philosophy is being followed in several other key areas such as the PCS. We are informally extending this as we get into more and more details. Systems Engneering attends almost all reviews, specifically looking for implications such as single point failures on the rest of the system. Failure modes are also covered in some of the operational scenarios that have been generated over the last few years.

We will do the best we can here! Please note that we are well into the manufacturing phase of most parts of the system. These analysis and scenarios will help use develop work around scenarios and better prepare for the true single point failures. This, balanced and coupled with the commission experience, will allow for a better planned maintenance program during operations.

Gemini System Review #3 Reviewer's Comment #7	
Topic: Mirror Supports	**Reviewer:** Abraham
Issue/Concern: Vendor Hardware - specialized hardware driving the performance of a system is cause for concern (hoses) but with proper documentation, alternate sources and adequate sparing in sealed storage packaging it could be done.	
Recommended Action: Each special hose should have a drawing and part number, general note calling out spec, and an "A" size drawing with vendor data describing the part.	
Responsible Person: Stepp	**Due Date: May '96**

Response #7:

The recommended actions for identification and specification of special hoses are sensible, and a system of this type will be implemented for these and other similar special parts having a limited lifetime.

Gemini System Review #3 **Reviewer's Comment #8**	
Topic: Mirror Coating	**Reviewer:** Abraham
Issue/Concern: Silver Overcoating: (1) Long term effects on surface. Some processes can produce pinholing which will allow moisture penetration and gradual deterioration of surface. (2) Difficulty in removing protective coating. Many processes can be extremely difficult to remove and require the use of hazardous materials.	
Recommended Action: - At a minimum some form of accelerated testing needs to be developed for any new process being considered. - Safety personnel need to keep in touch with the use of all materials being considered for stripping, cleaning, and coating mirrors, and their methods of disposal.	
Responsible Person: Raybould	**Due Date: May '96**

Response #8 (Jim O.)

(1) Standard coating tests were done on all coatings (old and new). These include tests that are well known and commonly used in the optics industry such as adhesion tests, and more. These are in effect, accelarated tests developed from years of coating development experience in the industry. We have data on this for anyone interested in the details.

(2) The coating development program included developing and testing the coating stripping and cleaning methods. The coatings chosen are removed with chemicals which are less hazardous than has been historically used to strip coatings. The details of these chemicals, including quantity, ware fed into the facility requirements to allow for holding tanks where chemicals can be collected and processed as required to make safe. The chemicals used, quantities and process is designed to comply with all OSHA and EPA guidlines.

Gemini System Review #3 **Reviewer's Comment #9**	
Topic: Mirror Cleaning	**Reviewer:** Abraham
Issue/Concern: Cleaning is a major issue and appears to be far from resolved. It looks more and more like CO_2 will be the final choice, at least initially. CO_2 is a marginal method of cleaning and is only capable of mechanically moving loose material off of the mirror surface.	
Recommended Action: Some kind of provisions should be designed into the telescope for doing the CO_2 cleaning and trapping the particles removed from the surface before it is too late. If CO_2 cleaning is selected other processes will have to be developed for removing oil, water, etc., spots from the mirror.	
Responsible Person: Raybould	**Due Date: May '96**

Response #9: (Jim O.)

We are implementing CO2 cleaning for use on the telescope (at first). Nozzles are being put into the mirror cover to allow easy "scanning" of the mirror with the system while the telescope is horizon pointing. This will allow for very frequent cleaning.

For tougher contamination, careful cleaning by more traditional methods will have to be used to clean small areas (alcohol, acetone swabbing of small areas for example). We have not ruled out laser cleaning for the future and are continuing to look into the issues. It still promises the possibility of removing these other types of contaminates.

Gemini System Review #3 **Reviewer's Comment #10**	
Topic: A&G Failure Modes	**Reviewer:** Abraham
Issue/Concern: - Major mechanical systems (bearings, drives, etc.) must be robust enough to allow for future growth and longevity. If any of these systems fail the cost will be high in labor, capital, and time. - Mirror drive mechanisms should have mechanical overrides whenever feasible. My experience is that most failures are normally due to software or electronic component failure. - In most cases the greatest down time is in determining what is wrong. Diagnostic tools are one of the major factors in reducing down time.	
Recommended Action:	
Responsible Person: Oschmann/McGonegal	**Due Date: May '96**

Response #10:

(1) This is addressed in the RFP (and now contract with Zeiss) for the A&G dealing with lifetime and the section on maintenance. We will keep a close eye on this as Zeiss finishes the design details and enters into manufactuing in the near future.

(2) In the A&G system it is not possible to have mechanical overides due to implementation and the number of instruments required to support (hence surrounding the system). We will handle software problems via regression testing and burn in and component failure through adequate spares and diagnostics. Most failures (as shown in the failure analysis) will leave the overall telescope in an operable configuration. Replacing of failed electronics is easy in that all critical electronics are mounted in a thermal enclosure which is accessable (outside of the ISS).

(3) The software design and alarm system will pin point failed subsystems quickly. We would need to develop trouble shooting flow chats to rapidly isolate and cure problems. Given the small amount of FMEA scenarios which result in lost observing time, it may not prove cost effective to do so. We will certainly develop a beginning set during the commissioning phase.

Gemini System Review #3 **Reviewer's Comment #11**	
Topic: Mechanical and Optical Alignment	**Reviewer:** Abraham
Issue/Concern: Alignment remains to be a major issue and should be clearly defined at the earliest date possible, especially since fabrication and construction work is well underway in many areas where alignment tooling aids could easily be installed, fabricated, measured, etc. One example is using the Cass rotator as a major reference starting point. Reproducing this axis can be quite difficult in the future unless the proper tooling, references, and procedures are put into place. Bearings wear, things get removed and replaced within the machine allowances of the mating parts, different or worn alignment scopes are used, removal and reinstallation in fixtures causes changes, etc.	
Recommended Action:	
Responsible Person: Oschmann	**Due Date: May '96**

Reponse #11:

We agree that early attention to alignment plans will pay off later. The outline of the plan presented is the product of the experience of various people on the project, discussions with other projects with similar problems (ESO VLT, Subaru, WIYN). We have received copies of the VLT and WIYN alignment plans. I have also witnessed some parts of the WIYN alignment after the primary mirror was recently re-coated. The specific recommendation from WIYN was to document, in simple outline form, the procedure without going into too much detail. It must be something that will be used in practice by qualified personnel.

That said, our plans will evolve right through the initial integration efforts.

On the point of using the CR axis and how this might change with time, this is something that must be paid attention to. The procedure of using an alignment camera on the ISS uplooking port allows a very simple way of re-verifying the rotation axis. Once the telescope is integrated, this can be implemented with the A&G acquisition camera. It should be noted that having the reference axis on the rotating part of the axis make this test easy without any special tooling. This is similar to VLT plans and what is used to find the tertiary mirror rotation axis during the WIYN alignment (and works as advertised).

<table>
<tr><td colspan="2">Gemini System Review #3
Reviewer's Comment #12</td></tr>
<tr><td>Topic: CTIO Coatings</td><td>Reviewer: Abraham</td></tr>
<tr><td colspan="2">Issue/Concern:

The secondary optics are to be coated in the smaller coating chambers on Tololo. I question whether or not those chambers are capable of meeting the Gemini uniformity requirement.</td></tr>
<tr><td colspan="2">Recommended Action:

Test existing chambers and upgrade as necessary. The KPNO 4m chamber has been upgraded to provide a uniformity of ±10%.</td></tr>
<tr><td>Responsible Person:
Raybould/Oschmann</td><td>Due Date: May '96</td></tr>
</table>

Response #12

Couple of points:

The uniformity requirement is based upon what was recommended as reasonable. That does not mean that we should ignore the capabilities of these existing facilities, but if the uniformity is twice as bad as our specification (as an example), the effect is first in the noise in terms of delivered image performance and secondly, the non-uniformity's over large scales is removed by an very small part of our active optics capability (and hence removed automatically).

That said, we still want a nice uniform coating. We have since included mounting provisions for our secondary mirrors in our coating chamber and will be able to coat them to the required uniformity.