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September 22, 1999
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NASA/MSFC
Marshall Space Flight Center, AL 38512

Attention: EB52/COTR/Ron Eng

Subject: Contract NAS8-98236

Mr. Eng:

In accordance with the requirements of the subject contract, enclosed herein is the Program Management Plan.

Should you have any questions of a technical nature, please contact Ms. Janet Zeidler at ext. 240. Cost or contractual matters should be addressed to the undersigned.

Sincerely,

P.H. Wilson
Contracts Administrator

cc: GP25B
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NASA Ctr. For Aero. Info.
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LIGHTNING MAPPER SENSOR
LENS ASSEMBLY
S.O. 5459

Project Management Plan

Submitted to:

National Aeronautics and Space Administration
Procurement Office Code GP25-B
George C. Marshall Space Flight Center
Marshall Space Flight Center, Alabama 35812

By:

Kaiser Electro-Optics, Inc.
2752 Loker Avenue West
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September 21, 1999

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1.0 General

Kaiser Electro-Optics, Inc. (KEO) has developed this Project Management Plan for the Lightning Mapper Sensor (LMS) program as required by the NASA Statement of Work and DRD 848MA-001. KEO has integrated a team of experts in a structured program management organization to meet the needs of the LMS program. The following plan discusses KEO's approach to critical program elements including Program Management, Quality Assurance, Configuration Management, and Schedule.

1.1 Understanding the Requirements

KEO fully understands and appreciates the challenges of designing and producing in quantity close tolerance, complex lenses such as the LMS Lens Assembly. We thoroughly understand the design parameters and analyses which are needed to ensure that "as built" lenses meet specified optical, mechanical, and environmental requirements.

KEO has a proven capability to provide space qualified, specification compliant optical lens assemblies similar to the LMS Lens Assembly with minimum size, weight, and power requirements. KEO contributed to the success of NASA's Lightning Imaging Sensor program in designing and building the Lens Assembly. KEO understands the specification of radiation resistant optical elements and precision mechanical components, and the quality control required to ensure that each item meets its own specifications and tolerances. Filter design and manufacture are critical to the success of the LMS program. KEO understands the filter requirements including thermal control.

This Project Management Plan covers the three phases of the LMS Lens Assembly program including:

- Phase I: Design (4 months)

  KEO is responsible for the design of the LMS Lens Assembly including optical, mechanical, filter, thermal, and tooling designs to achieve the NASA specified requirements. Data requirements including PDR and CDR are held, and preliminary engineering drawings are completed during Phase I.

- Phase II: 4 Flight Qualified Engineering Lenses (7 months)

  KEO will finalize the drawing package, fabricate required tooling, generate the optical and environmental Acceptance Test Procedure, manufacture, assemble, test, and deliver 4 Flight Qualified Engineering Lens Assemblies and associated Acceptance Data Packages.

- Phase III: 6 Flight Ready Lenses (7 months)

  KEO will manufacture, assemble, test, and deliver 6 Flight Ready Lens Assemblies and associated Acceptance Data Packages.

1.2 Method of Management

KEO's method of management is described in Section 2.0 Program Management Plan. This section presents KEO's approach to the principles and techniques to be used in managing the LMS program - the objectives, the organization, the performance management system and most importantly, the people. No management system can make a successful program without people and the experience they possess. What KEO offers is extensive hands-on experience coupled with the right management tools to ensure a successful LMS program for NASA.

The LMS program plan has been created from the conscious application of the following guidelines:

- Maximum use of previous NASA LIS optical, filter, mechanical and thermal design expertise - The KEO program team includes several key individuals familiar with the activities, designs and results which were achieved under the earlier LIS Lens Assembly development program.

- Lessons learned from numerous space qualified optical systems' developments – The LMS Lens Assembly will benefit from KEO's extensive experience in designing and building space-qualified systems. This experience will be utilized to provide a high performance lens of minimum size, weight, and power requirements.

- Mature assembly methods and test equipment – The LMS lens design can utilize KEO's standard precision lens assembly methods. The test plan is based on existing state of the art factory test equipment.

- Computer aided design engineering - Maximum use will be made of KEO's Code V® optical design facilities to reduce design cycle time and errors. KEO uses Pro/Engineer® for detail design.

- Analysis and testing program - The execution of comprehensive design analyses and qualification test program will provide the most reliable product possible.

- Schedule and budget tracking - During the course of the program, the schedule, budget, expenditures and technical performance are tracked and controlled through regular internal cost reporting, a hierarchy of established regular reviews, and periodic updating of budget and schedule plans. In addition, KEO management is always available to resolve any difficulties should any exceptional events occur which significantly affect the program team's ability to meet cost and/or schedule constraints or product specifications.

2.0 Program Management Plan

A detailed discussion of how KEO will manage the LMS program is included in this section. Developing and adhering to a Program Plan is an integral part of maintaining schedule and technical performance. A Program Plan has been developed which encompasses an Engineering Plan, a Manufacturing and Procurement Plan, and a Test Plan and is described in the following Section 2.1. The program organization is covered in Section 2.2. The Quality Assurance Plan, also an integral part of the LMS Program, has been provided to NASA with the KEO Proposal, and is summarized in Section 3.0. The Configuration Management Policy-Procedure is summarized in Section 4.0 and is provided in Appendix A.

2.1 Program Plan

This section outlines KEO's plan for meeting the requirements of the LMS program. The basic elements required for a successful program include strong program management and a well-conceived and thorough Program Plan. KEO's methods of managing performance including cost, schedule and technical are detailed in the Program Management section, below. Details of KEO's Program Plan including engineering, manufacturing, procurement, integration and test activities follow.

Program Management - KEO will apply a proven set of management tools to successfully execute the LMS program.

First, KEO uses a program management organizational structure to execute the program. This structure defines a single point of responsibility and authority to ensure that all schedule, budget, technical performance and contractual requirements are met. The Program Manager answers to the Product Manager under whose mission the program falls, and to KEO executive management. The Program Manager is responsible for direct interface with all other Company departments on whom the success of the program depends. All contractual matters are handled through KEO's Contracts Administrator.

KEO's approach to program management, which reflects an experienced response to the challenges of developing high performance optical systems, may be summarized as follows:

- Establish a strong Program Office and vest in its Program Manager the complete authority to implement the program plans.
- Provide the Program Manager total Company support through direct liaison at the Executive level thereby eliminating detrimental conflicts between programs and ensuring proper allocation of shared resources.
- Staff the program with technical and business professionals who possess the necessary experience and proven history of achievement to assist the Program Manager in successfully conducting the program.
- Support the Program Manager with a complete set of integrated cost and schedule management tools to ensure that cost and schedule commitments are achieved.

The Program Manager represents KEO in all matters related to the LMS program with NASA and is responsible for all KEO LMS activities. In this capacity, the Program Manager has full authority to direct all required supporting functions with regard to cost, schedule and technical performance and program priorities to achieve the overall LMS program objectives. Direct access to senior management is assured. The Program Manager is supported by subordinate team personnel who are responsible for executing the various elements of the LMS program.

KEO's Performance Management System is described below. Our Management System utilizes a Work Breakdown Structure and Master Program Schedule to ensure KEO performance to NASA requirements and schedule.

A Work Breakdown Structure (WBS) is used to establish all program tasks and provide traceability to LMS program requirements and help ensure that tasks are organized and performed in a manner consistent with control and tracking of expenditures.

At the outset of the program, after careful analysis of the LMS program requirements, the Program Manager prepares the WBS, which organizes every task and activity to be performed under the contract. The WBS provides KEO with the framework for subsequent detailed program planning. Using the WBS and the proposal estimates, budgets are allocated to the various activities and material expenditures. Major tasks are assigned WBS element numbers for proper traceability to program requirements.

To time phase the major task relationship and meet the required program dates, the proposed Master Program Schedule (MPS) is reviewed and, if necessary, the schedule is updated to reflect any changes which may have occurred between proposal and contract award. Purchased item lead times and resource utilization schedules are rechecked.

Finally, using the MPS as a guide, operating schedules are prepared for the individual technical disciplines. These schedules, along with the WBS task descriptions, provide the basis for budget and resource allocation. The WBS allocated Budgets and Schedules are reviewed with Company Management. At this point, the task assignments, schedule, budget allocations and resource allocation are refined into Work Authorization Packages (WAP's), which key charge numbers to WBS elements. The WAP's are released to establish and inform responsible individuals of the cost and schedule requirements at the task level for the program.

Program reviews are conducted at a number of levels during the course of the program. In addition to the daily interface between Program Manager and the task leaders, there are weekly reviews between the task leaders and the Program Manager. Formal monthly reviews are conducted with Executive Management.

Engineering Plan - KEO has assembled a team of experts, experienced in achieving high performance lens requirements such as the LMS Lens Assembly. The team is described in detail in Section 2.2, Organization. In order to meet NASA requirements on schedule, this team will kick off design activities immediately upon contract award. Design and analysis activities will proceed from the excellent start point achieved during the proposal. Design improvements to increase performance and maximize manufacturability will be addressed during the design phase.

Communications with the filter vendor, Barr Associates, will be initiated at contract award and maintained throughout the design phase.

The engineering plan incorporates interactive communications between KEO and NASA. At the KEO recommended kickoff meeting, the NASA/KEO team will agree upon communication channels, means of communication and the expected timing for the exchange of design information. The interchange of optical, mechanical, filter, and thermal design information is critical to ensure a smooth assembly, alignment, and integration effort and to maximize system performance.

The optical design and filter design will commence immediately upon contract award. The duration of the optical design effort is six weeks. A preliminary optical design will be available within 2 weeks ARO and a final optical design will be available within 4 weeks. Mechanical design activities will begin with the preliminary optical design, within two weeks of contract award. Thermal analysis activities will begin as soon as a mechanical layout is available, 5 weeks ARO. The engineering plan also includes design of the element coatings, tooling design and test plan development.

Throughout the program, including during the design phase, a multi-discipline team approach will be used. Regular internal reviews will include assigned representatives from all departments: engineering, quality assurance, manufacturing, material control and purchasing. This overlapping, interdepartmental team will insure review of and adherence to NASA requirements. As soon as detailed information is available, KEO will initiate a dialogue with our suppliers. The dialogue will serve as input into the design process to ensure manufacturability as well as provide current manufacturing lead-time information.

Manufacturing and Procurement Plan - The first element of the manufacturing plan is to involve manufacturing and quality assurance personnel in the design phase as described above. The team will address manufacturability and tooling issues, guide the design and keep schedule risk minimized by early identification of optimum approaches.

Procurement of glass blanks, filter material, and glass fab tooling will commence at the beginning of Phase II. Blanks will be procured to released, detail drawings in cut disk form. The supplier and lead times are well understood.

Procurement of the narrow band filter will also commence at the start of Phase II. The detail drawing generated during the design phase will control filter procurement.

Finished glass fabrication activities will begin upon receipt of the glass blanks, 8 weeks from the start of Phase II. KEO will employ traditional proven glass fabrication techniques, as modified through internal proprietary processes, in the manufacture of the lens elements for the LMS Lens Assembly. Process steps will include rough generation, grinding and polishing to the prescribed tolerances. Spherical elements are then edged to obtain toleranced centration and wedge. KEO checks element dimensions at several steps in the set of operations using special tools such as spherometers, test plates and interferometers. Precision indicators check center thickness during grinding and polishing, and diameters during edging. During the optical component

manufacturing, fabrication progress will be monitored on a weekly basis. This will allow any possible issues that will affect delivery to be addressed quickly and corrected.

Following glass fabrication, KEO will coat the elements in a DynaVac 54-inch box coater. Witness pieces, which are coated along with the parts, are used for spectral performance and durability testing.

At the completion of coating, the lens elements are 100% inspected for quality. Accepted elements are placed in stores, segregated from other program components.

Procurement of machined and electrical components begins within 2 weeks of the start of Phase II. Machined parts will be procured from an outside machine shop to detail drawings, which include all tolerance, stress relieving and finish callouts. KEO has developed excellent relationships with our sources of precision-machined parts. An extremely high acceptance rate on incoming inspection has been achieved.

Tooling detail and fabrication will be initiated at the start of Phase II.

Assembly of the lenses begins upon receipt of finished materials, 20 weeks into Phase II. In general, lens elements are placed into the housings and the airspaces between the elements are checked with precision indicators. The mechanical spacers are re-machined and/or lapped to provide the correct airspace values. Once the correct airspacings have been achieved, the elements are installed into the housings. At this point, the alignment of each element is checked with high precision electronic indicators to insure the decentration and tilt of the elements is within the prescribed tolerances. After an element has been correctly aligned and secured with a retainer, it is potted into place with a specified type and thickness of RTV and allowed to cure.

Test Plan - KEO will develop Test Plans as required by the NASA Specification and SOW. This includes an Environmental Test Procedure, an Acceptance Test Procedure and Acceptance Test Reports. The procedures will have detailed sections as follows: 1.0, Scope, 2.0, Applicable Documents, 3.0, Test Equipment List, 4.0, Test Requirements, and 5.0, Test Procedures, including stated requirement to be met. Test setup diagrams are included to further define procedures, as needed. Test Procedure Data Sheets have the following information: procedure name, number, revision; unit under test part number and serial number; parameter tested; result; space for QA identification and stamp, date. Data sheets are submitted to NASA as required by the Data Requirements. NASA is requiring that each lens be subjected to environmental and acceptance tests.

2.2 Organization

In this section, both the Company and the Program organizations are provided. All Program personnel are identified. KEO contains the necessary resources to develop, manufacture, test and support the LMS Lens Assembly. The Company structure supports efficient use of its resources with direct access to executive management and close working relationships between departments. The KEO Company Organization Chart is shown in Figure 2.2-1.

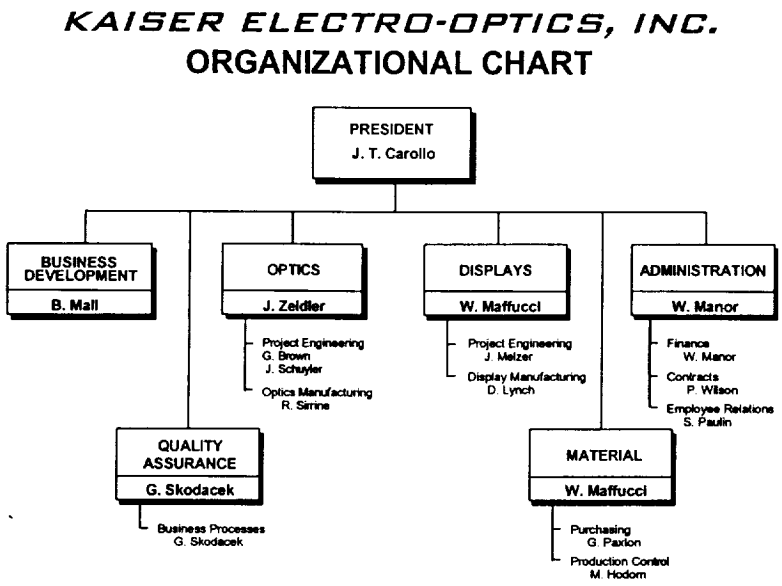


Figure 2.2-1 Kaiser Electro-Optics Company Organization

Product development is undertaken in both the Optics Product Group and the Display Product Group. The Optics Product Group, led by Janet Zeidler, will be responsible for the LMS Lens Assembly as will be discussed below. Functional departments, including Contracts, Finance, Quality Assurance, Purchasing and Material Control provide required support throughout all phases of the program.

The LMS Lens Assembly Program Organization is shown in Figure 2.2-2. By reporting directly to Executive Management and by including representatives of all Company functional departments, this organization will ensure that the LMS Program receives continuous high level management visibility for the timely achievement of all program goals. All Program personnel defined on the Organizational Chart are full time employees of KEO with the exception of Optical Research Associates (ORA), Steve Sagan, and the Structural/Thermal Analyst firm of SNA Engineering. KEO is subcontracting the optical design and analysis to Optical Research Associates, the world renowned optical design firm, to ensure the optimum design solution. KEO subcontracted with ORA for the previous NASA LIS optical design. ORA's Steve Sagan performed the LIS optical design and will be doing the LMS design as well. Additionally, KEO has subcontracted with SNA Engineering on previous successful programs requiring structural and thermal analyses. SNA's expertise is modeling and analyzing lens assemblies for specified space and airborne environments.

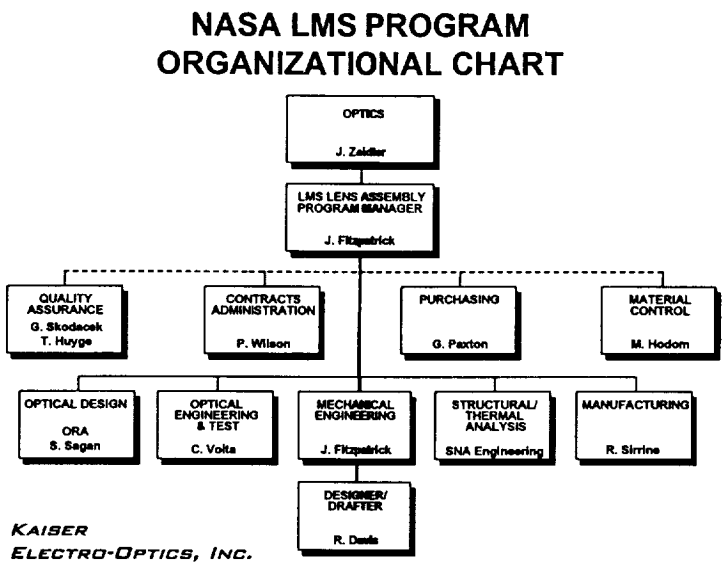


Figure 2.2-2 LMS Lens Assembly Program Organization

Responsibility for the LMS program resides in the Optics Product Group under the direction of Janet Zeidler. The LMS Program Manager reports directly to Ms. Zeidler. His specific responsibilities include providing overall direction of the program, meeting program technical, cost and schedule requirements, and acting as the single-point contact for KEO with NASA on all technical matters.

To meet the management needs of the program and to ensure top priority is given to it, KEO has selected an experienced Program Manager, Mr. John Fitzpatrick. Mr. Fitzpatrick is supported with an organizational structure which optimizes the Program Manager's control by delegating authority and responsibility to strong technical leaders covering the key technical disciplines needed on the LMS Program and by providing him with dedicated managers for Contract Administration, Material Control, Purchasing and Quality Assurance functions on the program. Ms. Fitzpatrick has many years of experience successfully managing several similar programs at KEO, meeting cost, schedule and technical requirements on these programs.

As mentioned above, the optical design and analysis will be subcontracted to ORA in order to ensure that the LMS optical design receives the most expert and experienced attention. KEO has a long and successful history of working with ORA. The subcontract will be based on a formal Statement of Work detailing specific tasks and a schedule consistent with the LMS Program requirements. ORA's Mr. Sagan has specific expertise in performing complex visible design and analysis on Code V®, and significant experience in designing for manufacturability and cost sensitivity. KEO has included ORA and in particular, Mr. Sagan, as a team member many times in the past on design efforts of this nature. We have found that the combination of his expertise in performing the automated design and analysis tasks coupled with KEO's expertise in manufacture and assembly of high tolerance lens assemblies, results in highly producible, affordable and superior performance designs in the minimum amount of time. Regular internal review of Mr. Sagan's work by the Program Team will take place.

Optical engineering for the LMS Lens assembly, alignment, and test will be the responsibility of Mr. Chris Voita, Senior Optical Engineer. Mr. Voita's extensive experience with optical alignment methods and equipment, and with test methods and equipment will promote a smooth manufacturing effort. Mr. Voita will also have the primary responsibility for the development of KEO test procedures.

In addition to Program Management, Mechanical Engineering will also be the responsibility of Mr. John Fitzpatrick. Mr. Fitzpatrick has functioned as Senior Mechanical Engineer on some of the most demanding mechanical design tasks KEO has had in recent years. On complex lens assembly programs, Mr. Fitzpatrick developed innovative and robust design solutions which led to product qualification successes. Mr. Fitzpatrick will be responsible for the LMS opto-mechanical and tooling design and analysis. He was also a key team member on the NASA LIS Lens Assembly program.

As Quality Engineer, Mr. Thom Huyge will provide input to the design for producibility, ensuring that the design is consistent with methods of manufacture. He will also be involved in reviewing assembly and test tooling. Mr. Huyge will be responsible for writing work orders and process instructions for glass fabrication and optical assembly. As part of the concurrent engineering team, some of the items he will address include materials selection, tolerances, detail specifications and fabrication processes. Improved manufacturability will result.

The manufacturing organization including glass fabrication and optical assembly is headed by Mr. Robert Sirrine. Mr. Sirrine has extensive experience in the manufacture of precision lens assemblies. He will provide direction and support of all fabrication and assembly processes.

The Structural and Thermal analyses will be subcontracted to SNA Engineering, a consulting firm specializing in structural/thermal design and analysis of airborne and space systems. Mr. Frank Reganato, a principle of SNA Engineering, has a long history of successfully meeting stringent structural and thermal requirements on space qualified optical assemblies. His tasks will be detailed in a Statement of Work and reviewed at all internal and customer reviews.

3.0 Quality Assurance Plan

The quality of the LMS will be assured through the implementation of KEO's proven Quality Assurance capability.

In May of 1997 KEO was approved and received ISO 9001 registration by Perry Johnson Registrars, Inc. A copy of KEO's Quality Assurance Manual is included in Appendix A. Appendix B contains KEO's Quality Policy; Appendix C contains KEO's Quality System. KEO's Configuration Control Policy-Procedure is included in Appendix D.

Specific methods utilized to ensure the compliance of the LMS will include the following:

- All critical component subcontractors will be evaluated for capability and quality performance. All LMS SOW requirements will be flowed down to subcontractor level.
- Procurement activities are controlled by requiring deliverable certifications and data reporting via Quality Codes which define levels of documentation and responsibility.
- All lens element fabrication and optical assembly will be performed to established procedures. Records of all work and inspections performed will be maintained on file.
- All optical components will be subjected to 100% first article inspection. The configuration of all components in the first deliverable system will be verified.
- A data package of Environmental Test data and ATP measurements will be supplied with each assembly.

4.0 Configuration Management

KEO maintains a Configuration Management system that is compliant with the NASA Statement of Work. A copy of KEO Configuration Management Policy-Procedure PR 190 was submitted to NASA with KEO's Proposal.

The Configuration Management Policy-Procedure controls the numbering system for KEO generated documents including engineering drawings, procedures and processes, specifications, statements of work, materials, and technical manuals. The Policy-Procedure controls the document release process by defining the Engineering Order, and the signature cycle for each type of document including Customer Documents. It also defines the recording procedure for the release of documents and the storage and distribution of documents. The Policy-Procedure identifies the parties responsible for defining program configuration control requirements and ensuring adherence to requirements.

5.0 Schedule

A detailed discussion of how KEO proposes to meet the schedule requirements of the LMS program is included in this section. KEO is presenting a schedule which is compliant with program requirements and is realistic and achievable. It will provide hardware on the dates specified. Several schedule contributors have been addressed to ensure the schedule integrity and to minimize the development time and costs. The key contributors include:

- Assignment and utilization of a highly experienced team of engineers already thoroughly familiar with the design of producible high performance lens assemblies.
- Utilization of existing suppliers to the maximum extent possible. This ensures a good understanding of the vendor's capabilities and limitations to accurately predict delivery performance.
- Utilization of personnel and vendors with knowledge and experience on KEO's previous contract for the NASA LIS Lens Assembly.

The program schedules for the design, development, fabrication, integration, test, and delivery of 4 Flight Qualified and 6 Flight Ready Lens Assemblies are given in Figures 5.0-1 through 5.0-3. This schedule plan has been constructed by considering many factors including the current state of the engineering development and the availability of personnel, facilities and equipment resources needed to complete the design and manufacturing effort.

The Phase I schedule, Figure 5.0-1, shows the agreed upon schedule as of May 26, 1999. During Phase I, KEO will accomplish all the required design activities, detail drawings, and develop a test plan. A PDR and CDR will be held at KEO. In addition, KEO recommends a Kickoff meeting to be held at KEO within 1 week ARO.

The Phase II schedule, shown in Figure 5.0-2, delineates the 7 month schedule for the manufacture of 4 Flight Qualified Lenses, producing 4 Lenses 11 months ARO as required by NASA. Glass fab tooling and glass blank procurement will be initiated at the start of Phase II. Glass fabrication will begin upon receipt of tooling and blanks. Element coating will follow, producing finished glass 20 weeks into Phase II.

Filter procurement will also begin at the inception of Phase II. The filter lead-time allowance fits well within the schedule.

Mechanical and electrical component procurements will be initiated within 2 weeks of Phase II start. The longest lead item – the housing – has an allowed lead-time of 12 weeks. This allows adequate time for incoming inspection and parts kitting for movement into assembly.

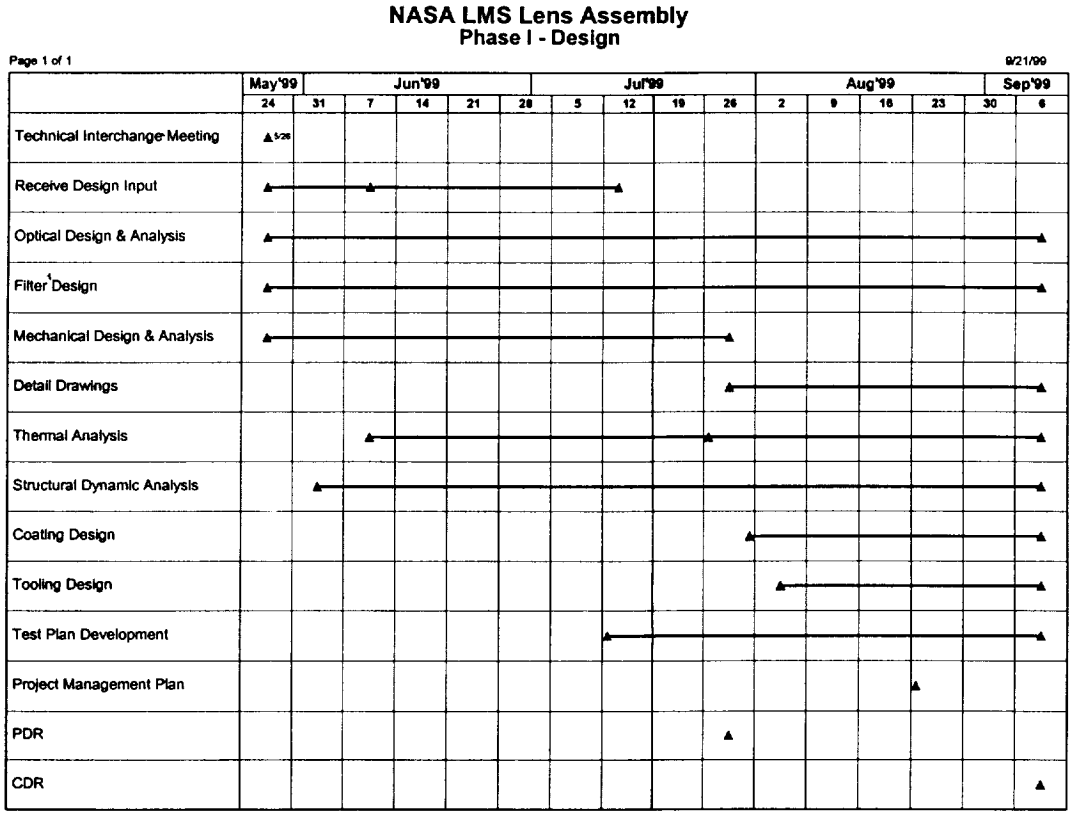
Tooling detailing will begin at the start of Phase II. Sufficient fabrication time is allowed in order to support assembly and test beginning 20 weeks into Phase II.

Two weeks of assembly is allowed for each unit. This duration allows adequate cure times for doublet cement prior to paint, primer and paint of elements and mechanical components, and

potting of elements into the housing. Each lens moves to test at the completion of assembly. Two weeks of testing is allowed to perform environmental and acceptance tests.

The Phase III schedule, shown in Figure 5.0-3, produces 2 each Flight Ready Lenses at 5, 6, and 7 months after the start of Phase III, which is 16, 17, and 18 months ARO, as required by the NASA RFP. Achieving this schedule requires procurements to begin immediately. Lenses will proceed to assembly and test beginning 18 weeks into Phase III.

Figure 5.0-1 NASA LMS Phase I Schedule



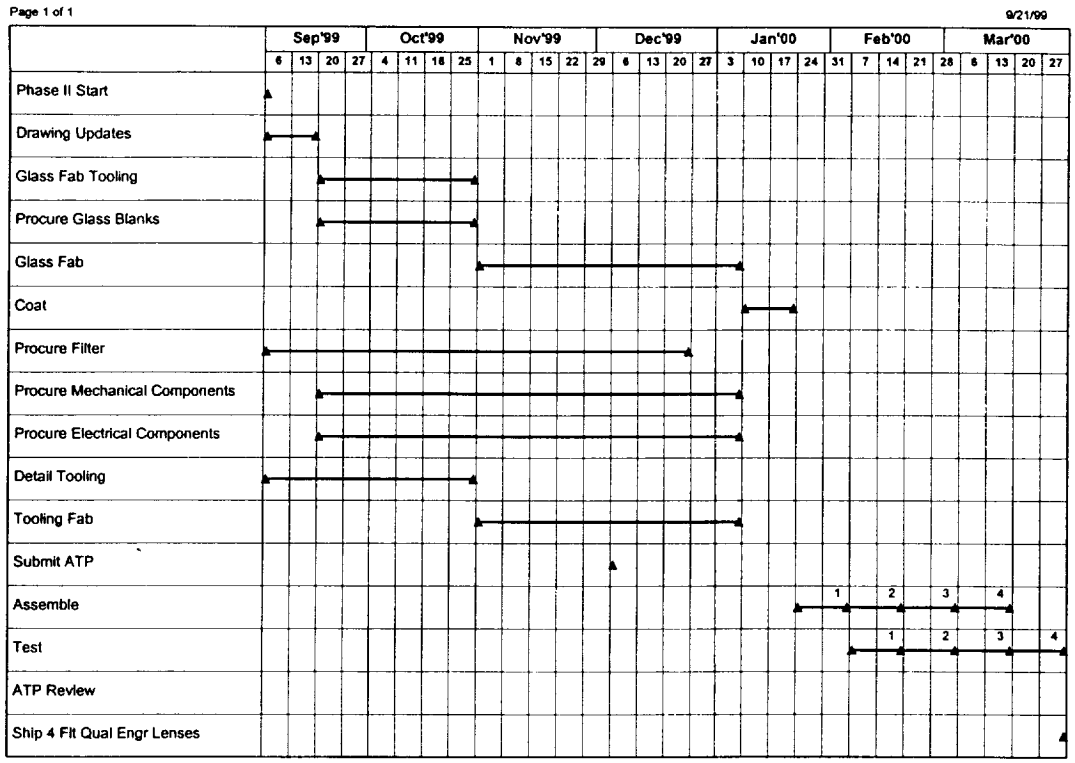


Figure 5.0-2 NASA LMS Phase II Schedule

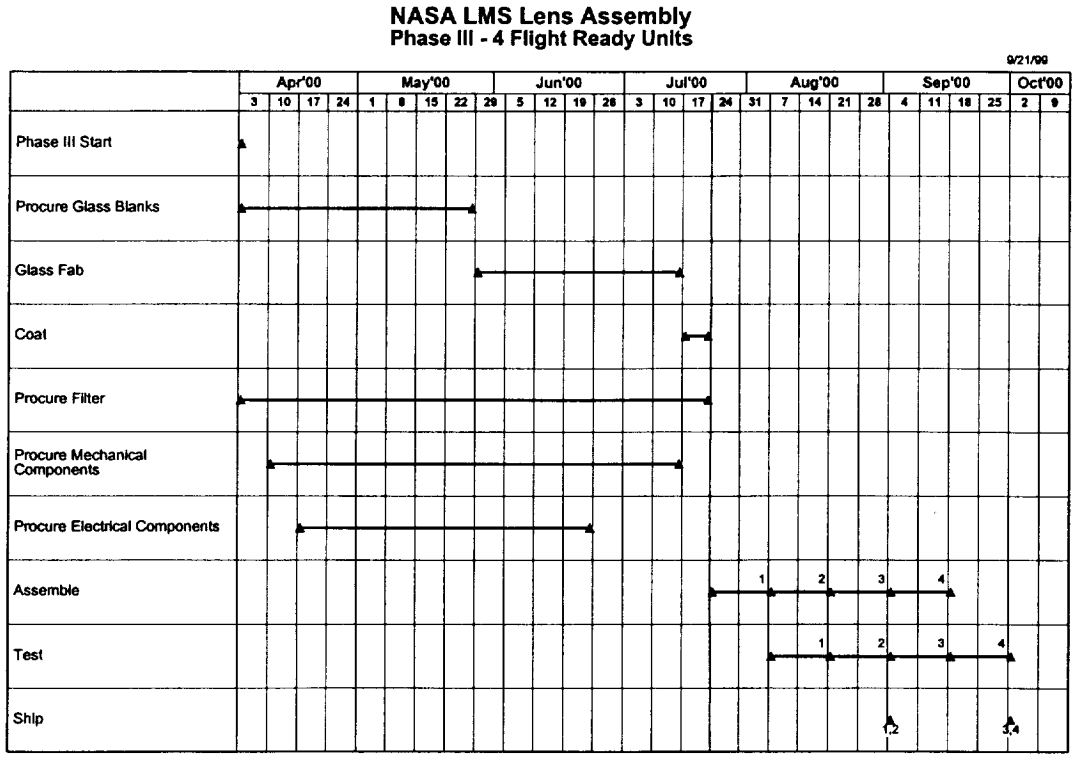


Figure 5.0-3 NASA LMS Phase III Schedule