INFORMATION TO OFFERORS OR QUOTERS
SECTION A - COVER SHEET

1. SOLICITATION NUMBER	2. *(X one)*	
		a. SEALED BID
N00173-98-R-CB04	X	b. NEGOTIATED *(RFP)*
		c. NEGOTIATED *(RFQ)*

INSTRUCTIONS

NOTE THE AFFIRMATIVE ACTION REQUIREMENT OF THE EQUAL OPPORTUNITY CLAUSE WHICH MAY APPLY TO THE CONTRACT RESULTING FROM THIS SOLICITATION.

You are cautioned to note the "Certification of Non-Segregated Facilities" in the solicitation. Failure to agree to the certification will render your reply nonresponsive to the terms of solicitations involving awards of contracts exceeding $25,000 which are not exempt from the provisions of the Equal Opportunity clause.

"Fill-ins" are provided on the face and reverse of Standard Form 18 and Parts I and IV of Standard Form 33, or other solicitation documents and Sections of Table of Contents in this solicitation and should be examined for applicability.

See the provision of this solicitation entitled either "Late Bids, Modifications of Bids or Withdrawal of Bids" or "Late Proposals, Modifications of Proposals and Withdrawals of Proposals."

When submitting your reply, the envelope used must be plainly marked with the Solicitation Number, as shown above and the date and local time set forth for bid opening or receipt of proposals in the solicitation document.

If NO RESPONSE is to be submitted, detach this sheet from the solicitation, complete the information requested on reverse, fold, affix postage, and mail. NO ENVELOPE IS NECESSARY.

Replies must set forth full, accurate, and complete information as required by this solicitation *(including attachments)*. The penalty for making false statements is prescribed in 18 U.S.C. 1001.

3. ISSUING OFFICE *(Complete mailing address, including ZIP Code)*

CONTRACTING OFFICER
NAVAL RESEARCH LABORATORY
ATTN: CODE 3230.MM
WASHINGTON DC 20375-5326

4. ITEMS TO BE PURCHASED *(Brief description)*

ONE -METER, MOBILE, GIMBALLED TELESCOPE SYSTEM

5. PROCUREMENT INFORMATION *(X and complete as applicable)*

X	a. THIS PROCUREMENT IS UNRESTRICTED					
	b. THIS PROCUREMENT IS A _____ % SET-ASIDE FOR ONE OF THE FOLLOWING *(X one). (See Section I of the Table of Contents in this solicitation for details of the set-aside.)*					
		(1) Small Business		(2) Labor Surplus Area Concerns		(3) Combined Small Business/Labor Area Concerns

6. ADDITIONAL INFORMATION

The Naval Research Laboratory Contracting Division issues solicitations and amendments to solicitations electronically via the Internet at the following website: http://heron.nrl.navy.mil/contracts/home.htm.

Any amendments to this solicitation will be posted at that website. Amendments will not be distributed by any other means. It is the responsibility of potential offerors to periodically review the website for amendments to this solicitation.

7. POINT OF CONTACT FOR INFORMATION

a. NAME *(Last, First, Middle Initial)*	b. ADDRESS *(Include Zip Code)*
Thompson, Marita F.	Naval Research Laboratory
c. TELEPHONE NUMBER *(Include Area Code and Extension) (NO COLLECT CALLS)* (202) 767-0666	4555 Overlook Ave., SW Washington DC 20375-5326

DD FORM 1707, MAR 90 Previous editions are obsolete.

8. REASONS FOR NO RESPONSE *(X all that apply)*			
	a. CANNOT COMPLY WITH SPECIFICATIONS		b. CANNOT MEET DELIVERY REQUIREMENT
	c. UNABLE TO IDENTIFY THE ITEM(S)		d. DO NOT REGULARLY MANUFACTURE OR SELL THE TYPE OF ITEMS INVOLVED
	e. OTHER *(Specify)*		

9. MAILING LIST INFORMATION *(X one)*				
	YES		NO	WE DESIRE TO BE RETAINED ON THE MAILING LIST FOR FUTURE PROCUREMENT OF THE TYPE OF TIME(S) INVOLVED.

10. RESPONDING FIRM	
a. COMPANY NAME	b. ADDRESS *(Include Zip Code)*

c. ACTION OFFICER			
(1) Typed or Printed Name *(Last, First, Middle Initial)*	(2) Title	(3) Signature	(4) Date Signed *(YYMMDD)*

DD FORM 1707 REVERSE, MAR 90

FOLD FOLD

FOLD FOLD

FROM

AFFIX STAMP HERE

SOLICITATION NUMBER	
N00173-98-R-CB04	
DATE *(YYMMDD)*	LOCAL TIME
99 FEB 18	4:00 PM

TO

SOLICITATION, OFFER AND AWARD	1. THIS CONTRACT IS A RATED ORDER UNDER DPAS (15 CFR 350) ▶	RATING DO-C9	PAGE OF 1 | 31 PAGES

2. CONTRACT NO.	3. SOLICITATION NO.	4. TYPE OF SOLICITATION	5. DATE ISSUED	6. REQUISITION/PURCHASE NO.
	N00173-98-R-CB04	☐ SEALED BID (IFB) ☒ NEGOTIATED (RFP)	19 JAN 99	

7. ISSUED BY CODE	8. ADDRESS OFFER TO *(If other than Item 7)*
CONTRACTING OFFICER NAVAL RESEARCH LABORATORY ATTN: CODE 3230.MM WASHINGTON DC 20375-5326	

NOTE: In sealed bid solicitations "offer" and "offeror" mean "bid" and "bidder".

SOLICITATION

9. Sealed offers in original and 03 copies for furnishing the supplies or services in the Schedule will be received at the place specified in Item 8, or if handcarried, in the depository located in Bldg. 222, Room 115 @ NRL until 4:00 *(Hour)* local time 18 FEB 99 *(Date)*

CAUTION - LATE Submissions, Modifications, and Withdrawals: See Section L, Provision No. 52.214-7 or 52.215-10. All offers are subject to all terms and conditions contained in this solicitation.

10. FOR INFORMATION CALL: ▶	A. NAME	B. TELEPHONE NO. *(Include area code) (NO COLLECT CALLS)*
	Marita F. Thompson	(202) 767-0666

11. TABLE OF CONTENTS

(✓)	SEC.	DESCRIPTION	PAGE(S)	(✓)	SEC.	DESCRIPTION	PAGE(S)
		PART I - THE SCHEDULE				PART II - CONTRACT CLAUSES	
X	A	SOLICITATION/CONTRACT FORM	1	X	I	CONTRACT CLAUSES	13-17
X	B	SUPPLIES OR SERVICES AND PRICES/COSTS	2-4			PART III - LIST OF DOCUMENTS, EXHIBITS AND OTHER ATTACH.	
X	C	DESCRIPTION/SPECS./WORK STATEMENT	5	X	J	LIST OF ATTACHMENTS	18
X	D	PACKAGING AND MARKING	5			PART IV - REPRESENTATIONS AND INSTRUCTIONS	
X	E	INSPECTION AND ACCEPTANCE	5	X	K	REPRESENTATIONS, CERTIFICATIONS AND OTHER STATEMENTS OF OFFERORS	19
X	F	DELIVERIES OR PERFORMANCE	6-9				
X	G	CONTRACT ADMINISTRATION DATA	10-11	X	L	INSTRS., CONDS., AND NOTICES TO OFFERORS	20-27
X	H	SPECIAL CONTRACT REQUIREMENTS	12	X	M	EVALUATION FACTORS FOR AWARD	28-30

OFFER *(Must be fully completed by offeror)*

NOTE: Item 12 does not apply if the solicitation includes the provisions at 52.214-16, Minimum Bid Acceptance Period.

12. In compliance with the above, the undersigned agrees, if this offer is accepted within _____ calendar days *(60 calendar days unless a different period is inserted by the offeror)* from the date for receipt of offers specified above, to furnish any or all items upon which prices are offered at the price set opposite each item, delivered at the designated point(s), within the time specified in the schedule.

13. DISCOUNT FOR PROMPT PAYMENT *(See Section I, Clause No. 52-232-8)* ▶	10 CALENDAR DAYS %	20 CALENDAR DAYS %	30 CALENDAR DAYS %	CALENDAR DAYS %

14. ACKNOWLEDGMENT OF AMENDMENTS *(The offeror acknowledges receipt of amendments to the SOLICITATION for offerors and related documents numbered and dated:*	AMENDMENT NO.	DATE	AMENDMENT NO.	DATE

15A. NAME AND ADDRESS OF OFFEROR	CODE	FACILITY	16. NAME AND TITLE OF PERSON AUTHORIZED TO SIGN OFFER *(Type or print)*

15B. TELEPHONE NO. *(Include area code)*	15C. ☐ CHECK IF REMITTANCE ADDRESS IS DIFFERENT FROM ABOVE - ENTER SUCH ADDRESS IN SCHEDULE.	17. SIGNATURE	18. OFFER DATE

AWARD *(To be completed by Government)*

19. ACCEPTED AS TO ITEMS NUMBERED	20. AMOUNT	21. ACCOUNTING AND APPROPRIATION

22. AUTHORITY FOR USING OTHER THAN FULL AND OPEN COMPETITION:

☐ 10 U.S.C. 2304(c) ( ) ☐ 41 U.S.C. 253(c) ( )

23. SUBMIT INVOICES TO ADDRESS SHOWN IN ▶ *(4 copies unless otherwise specified)* ITEM

24. ADMINISTERED BY *(If other than Item 7)* CODE	25. PAYMENT WILL BE MADE BY CODE

26. NAME OF CONTRACTING OFFICER *(Type or print)*	27. UNITED STATES OF AMERICA *(Signature of Contracting Officer)*	28. AWARD DATE

IMPORTANT - Award will be made on this Form, or on Standard Form 26, or by other authorized official written notice.

PART I - THE SCHEDULE
SECTION B
SUPPLIES OR SERVICES AND PRICES/COSTS

B-1 SUPPLIES OR SERVICES AND PRICES/COSTS

ITEM NUMBER	SUPPLIES OR SERVICES	QTY	UNIT	UNIT PRICE	AMOUNT
0001	One-Meter, Mobile, Gimballed Telescope System in Accordance with Attachment No. 1. (For informational purposes only the total amount for CLIN 0001 includes $_____ for the data specified in CLIN 0002)	1	EA	$	$
0002	Data in Accordance with Exhibit A (DD 1423) and Attachment No. 1			*NSP	
Option 1					
0003	Spare parts in accordance with Section C.	1	LO	Pricing included as Attachment 2.	
Option 2					
0004	Storage of Telescope in accordance with Section C.				
0004AA	Storage of Telescope in accordance with Section C.	3	MOS	$	$
0004AB	Storage of Telescope in accordance with Section C.	3	MOS	$	$
0004AC	Storage of Telescope in accordance with Section C.	3	MOS	$	$
0004AD	Storage of Telescope in accordance with Section C.	3	MOS	$	$

Option 3					
0005	One (1) Year Extended Warranty in accordance with Section C.	1	EA	$	$
Option 4					
0006	ISO Container in accordance with Section C.	1	EA	$	$
Option 5					
0007	Uncoated Coude' mirrors in accordance with Section C.	1	LO	$	$
Option 6					
0008	Secondary Mirror and Field Flattener for the Nasmyth Configuration in accordance with Section C.	1	EA	$	$
Option 7					
0009	Specialized camera for the Nasmyth configuration in accordance with Section C.	1	EA	$	$
Option 8					
0010	Instrument Derotator for the Nasmyth Path Configuration in accordance with Section C.	1	EA	$	$
Option 9					
0011	Filter wheel in accordance with Section C.	1	EA	$	$
Option 10					
0012	Video Tracker in accordance with Section C.	1	EA	$	$

Option 11					
0013	Tilt Tip Secondary Mirror in accordance with Section C.	1	EA	$	$
Option 12					
0014	Assistance in moving the telescope in accordance with Section C.	1	LO	$	$
Option 13					
0015	Telescope Simulator which shall be a VME System in accordance with Section C.				
0015AA	Telescope Simulator SMI Interface in accordance with Section C.	1	EA	$	$
0015AB	Simulator Requirements in accordance with Section C.	1	LO	$	$
0015AC	Simulator Gimbal Control Data in accordance with Section C.	1	LO	$	$
0015AD	Simulator Focus Data in accordance with Section C.	1	LO	$	$
0015AE	Other Simulator Requirements	1	LO	$	$
Option 14					
0016	One (1) Year Maintenance Agreement in accordance with Section C.	1	EA	$	$

TOTAL DOLLAR AMOUNT FOR CLINs*: $

*CONTRACT LINE ITEM NUMBER

SECTION C
DESCRIPTION/SPECIFICATIONS/STATEMENT OF WORK

C-1 Items furnished under this contract shall comply with Attachment (1), Specifications with Exhibit A, DD Form 1423, Contracts Data Requirements List and all other Attachments cited in Section J, which are incorporated by reference into Section C.

SECTION D
PACKAGING AND MARKING

D-1 Preservation, packaging, packing and marking of all deliverable contract line items must conform to normal commercial packing standards to assure safe delivery at destination.

D-2 The Contractor shall mark all shipments under this contract in accordance with the edition of ASTM-D-3951-90 “Standard Practice for Commercial Packaging” in effect on the date of the contract.

D-1 The Contractor shall comply with FED STD 313 (Symbols for Packages and Containers for Hazardous Industrial Chemical and Materials) to the extent applicable.

SECTION E
INSPECTION AND ACCEPTANCE

E-1 INSPECTION AND ACCEPTANCE CLAUSES BY REFERENCE:

FAR CLAUSE		TITLE
52.246-2	-	Inspection Of Supplies - Fixed -Price (AUG 1996)
52.246-16	-	Responsibility For Supplies (APR 1984)

DFARS CLAUSE		TITLE
252.246-7000	-	Material Inspection And Receiving Report (DEC 1991)

E-2 INSPECTION AND ACCEPTANCE

Inspection and acceptance of the final delivery will be accomplished by the Technical Manager (TM) or Contracting Officer Representative (COR) designated in Section G of this contract within seven (7) days after delivery. Inspection and acceptance will be performed at the Naval Research Laboratory, Washington DC 20375-5320.

SECTION F
DELIVERIES OR PERFORMANCE

F-1 DELIVERIES OR PERFORMANCE CLAUSES BY REFERENCE:

FAR CLAUSE		TITLE
52.211-16	-	Variation In Quantity (APR 1984) - The permissible variation shall be limited to: Percent increase/decrease (fill in __-0-__)
52.211-17	-	Delivery Of Excess Quantities (SEP 1989)
52.242-15	-	Stop-Work Order (AUG 1989)
52.242-17	-	Government Delay Of Work (APR 1984)
52.247-34	-	F.O.B. Destination (NOV 1991)

F-2 52.211-9 – DESIRED AND REQUIRED TIME OF DELIVERY (JUN 1997)

(a) The Government desires delivery to be made according to the following schedule:

DESIRED DELIVERY SCHEDULE

Item No.	Quantity	Within Days After Date of Contract
0001	1 EA	450
0002	1 LO	See Exhibit A
0003	1 LO	30 Days after Exercise of Option
0006	1 EA	120 Days after Exercise of Option
0007	1 LO	90 Days after Exercise of Option
0008	1 EA	180 Days after Exercise of Option
0009	1 EA	110 Days after Exercise of Option
0010	1 EA	110 Days after Exercise of Option
0011	1 EA	110 Days after Exercise of Option
0012	1 EA	110 Days after Exercise of Option
0013	1 EA	180 Days after Exercise of Option
00014	1 EA	60 Days after Exercise of Option

0015	1 LO	90 Days after Exercise of Option

If the offeror is unable to meet the desired delivery schedule, it may, without prejudicing evaluation of its offer, propose a delivery schedule below. However, the offeror's proposed delivery schedule must not extend the delivery period beyond the time for delivery in the Government's required delivery schedule as follows:

REQUIRED DELIVERY SCHEDULE

Item No.	Quantity	Within Days After Date of Contract
0001	1 EA	545
0002	1 LO	See Exhibit A
0003	1 LO	120 Days after Exercise of Option
0006	1 EA	270 Days after Exercise of Option
0007	1 LO	180 Days after Exercise of Option
0008	1 EA	270 Days after Exercise of Option
0009	1 EA	180 Days after Exercise of Option
0010	1 EA	180 Days after Exercise of Option
0011	1 EA	180 Days after Exercise of Option
0012	1 EA	180 Days after Exercise of Option
0013	1 EA	270 Days after Exercise of Option
00014	1 LO	90 Days after Exercise of Option
0015	1 LO	110 Days after Exercise of Option

Offers that propose delivery of a quality under such terms or conditions that delivery will not clearly fall within the applicable required delivery period specified above, will be considered nonresponsive and rejected. If the offeror proposes no other delivery schedule, the desired delivery schedule above will apply.

OFFEROR'S PROPOSED DELIVERY SCHEDULE

Item No.	Quantity	Within Days After Date of Contract
0001	1 EA	
0002	1 LO	
0003	1 LO	
0006	1 EA	
0007	1 LO	
0008	1 EA	
0009	1 EA	
0010	1 EA	
0011	1 EA	
0012	1 EA	
0013	1 EA	
00014	1 LO	
0015	1 LO	

b) Attention is directed to the Contract Award provision of the solicitation that provides that a written award or acceptance of offer mailed or otherwise furnished to the successful offeror results in a binding contract. The Government will mail or otherwise furnish to the offeror an award or notice of award not later than the day the award is dated. Therefore, the offeror shall compute the time available for performance beginning with the actual date of award, rather than the date the written notice of award is received from the Contracting Officer through the ordinary mails. However, the Government will evaluate an offer that proposes delivery based on the Contractor's date of receipt of the contract or notice of award by adding (1) five calendar days for delivery of the award through the ordinary mails, or (2) one working day if the solicitation states the contract or notice of award will be transmitted electronically. (The term "working day" excludes weekends and U.S. Federal holidays.) If, as so computed , the offered delivery date is late than the required delivery date, the offer will be considered nonresponsive and rejected.

F-3 PERIOD FOR EXERCISE OF OPTION(S)

The Government may require delivery of the optional items under this contract by the Contracting Officer's giving written notice anytime from date of contract award through five (5) years thereafter.

F-4 PLACE OF DELIVERY - FOB DESTINATION

The contractor shall deliver supplies, all transportation charges paid, to destination in accordance with the clause in Section F of the Schedule titled FAR 52.247-34 FOB Destination (NOV 1991).

Receiving Officer
Naval Research Laboratory
Contract Number
ATTN: *
CODE: *
LOCATION: *
Bldg. 49
4555 Overlook Avenue, SW
Washington DC 20375-5320

(* To be filled in at time of award.)

SECTION G
CONTRACT ADMINISTRATION DATA

G-1 PROCURING OFFICE REPRESENTATIVE

In order to expedite administration of this contract, the Administrative Contracting Officer (ACO) will direct inquiries to the appropriate office listed below. Please do not direct routine inquiries to the person listed in Item 20A on Standard Form 26.

Contract Matters Marita F. Thompson, E-mail @contracts.nrl.navy.mil, Code 3230 , (202)767-0666, DSN 297-0666, or Telecopier (202)767-6197

Security Matters-Mr. Charles Rogers, Code 1221, (202) 767-2240, DSN 297-2240

Safety Matters- Mr. Kirk J. King, Code 1240, (202)767-2232, DSN 297-2232

Patent Matters- Mr. Thomas McDonnell, Code 3008.2, (202)767-3427, DSN 297-3427

Release of Data- Mr. Richard L. Thompson, Code 1230 (202) 767-2541, DSN 297-2541

The ACO will forward invention disclosures and reports directly to the Associate Counsel for Patents, Code 3008.2, Naval Research Laboratory, Washington DC 20375-5320. The Associate Counsel for Patents will return the reports along with a recommendation to the Administrative Contracting Officer. The Associate Counsel for Patents will represent the Contracting Officer with regard to invention reporting matters arising under this contract.

G-2 TECHNICAL MANAGER - FUNCTIONS AND LIMITATIONS

* is hereby designated the cognizant Technical Manager who will represent the Contracting Officer in the administration of technical details within the scope of this contract and inspection and acceptance. The Technical Manager is not otherwise authorized to make any representations or commitments of any kind on behalf of the Contracting Officer or the Government. The Technical Manager does not have the authority to alter the Contractor's obligations or change the specifications in the contract. If, as a result of technical discussions, it is desirable to alter contract obligations or statements of work, a modification must be issued in writing and signed by the Contracting Officer. The Technical Manager, after review and signature of the "Material Inspection and Receiving Report, DD Form 250, If applicable, will forward a copy to the Administrative Contracting Officer.

(* To be filled in at time of award)

G-3 NAPS 5252.232-9000 - SUBMISSION OF INVOICES (FIXED PRICE) (JUL 1992)

(a) "Invoices" as used in this clause does not include contractor's requests for progress payments.

(b) The contractor shall submit original invoices with four (4) copies to the address identified in the solicitation/contract award form (SF 26-Block 10; SF 33-Block 23; SF 1447-Block 14), unless delivery orders are applicable, in which case invoices will be segregated by individual order and submitted to the address specified in the order (DD 1155-Block 13 or SF 26-Block 10).

(c) The use of copies of the Material Inspection and Receiving Report (MIRR), DD Form 250, as an invoice is encouraged. DFARS Appendix F-306 provides instructions for such use. Copies of the MIRR used as an invoice are in addition to the standard distribution stated in DFARS F-401.

(d) In addition to the requirements of the Prompt Payment clause of this contract, the contractor shall cite on each invoice the contract line item number (CLIN); the contract sub-line item number (SLIN), if applicable; the accounting classification reference number (ACRN) as identified on the financial accounting data sheets, and the payment terms.

(e) The contractor shall prepare:

__*__ a separate invoice for each activity designated to receive the supplies or services.

__X__ a consolidated invoice covering all shipments delivered under an individual order.

__*__ either of the above.

(f) If acceptance is at origin, the contractor shall submit the MIRR or other acceptance verification directly to the designated payment office. If acceptance is at destination, the consignee will forward acceptance verification to the designated payment office.

G-4 INVOICING ADDRESS

With reference to paragraph (b) of the above provision, "Submission of Invoices(Fixed Price)", the contractor shall submit invoices to the address in Block 12 of the contract award form (SF26)

G-5 ACCOUNTING AND APPROPRIATION DATA

(To be filled in at time of award)

SECTION H
SPECIAL CONTRACT REQUIREMENTS

H-1 TYPE OF CONTRACT

(To be filled in at time of award)

H-2 YEAR 2000 COMPLIANT INFORMATION TECHNOLOGY

This requirement applies to information technology (IT), as defined at FAR 2.101, that processes date-related information. All such IT delivered under this contract shall be Year 2000 compliant as defined at FAR 39.002.

H-3 REPRESENTATIONS AND CERTIFICATIONS

The Contractor's completed Representations, Certifications, and Other Statements of Offerors or Respondents is incorporated herein by reference in any resultant award.

PART II - CONTRACT CLAUSES
SECTION I
CONTRACT CLAUSES

I-1 52.252-2 - CLAUSES INCORPORATED BY REFERENCE (FEB 1998)

This contract incorporates one or more clauses by reference, with the same force and effect as if they were given in full text. Upon request, the Contracting Officer will make their full text available. Also, the full text of a clause may be accessed electronically at this/these address(es):

http://www.arnet.gov/far
http://heron.nrl.navy.mil/contracts/home.htm

a. FEDERAL ACQUISITION REGULATION CLAUSES

FAR CLAUSE		TITLE
52.202-1	-	Definitions (OCT 1995)
52.203-3	-	Gratuities (APR 1984)
52.203-5	-	Covenant Against Contingent Fees (APR 1984)
52.203-6	-	Restrictions On Subcontractor Sales To The Government (JUL 1995)
52.203-7	-	Anti-Kickback Procedures (JUL 1995)
52.203-8	-	Cancellation, Rescission, And Recovery Of Funds For Illegal Or Improper Activity (JAN 1997)
52.203-10	-	Price Or Fee Adjustment For Illegal Or Improper Activity (JAN 1997)
52.203-12	-	Limitation On Payments To Influence Certain Federal Transactions (JUN 1997)
52.204-4	-	Printing/Copying Double-Sided On Recycled Paper (JUN 1996)
52.209-6	-	Protecting The Government's Interest When Subcontracting With Contractors Debarred, Suspended, Or Proposed For Debarment (JUL 1995)
52.211-5	-	Material Requirements (OCT 1997)
52.211-15	-	Defense Priority and Allocation Requirements (SEP 1990)
52.215-2	-	Audit And Records-Negotiation (AUG 1996)
52.215-8	-	Order of Precedence - Uniform Contract Format (OCT 1997)
52.215-14	-	Integrity of Unit Prices (OCT 1997)
52.215-17	-	Waiver of Facilities Capital Cost of Money (OCT 1997) (*will be included if the successful offeror does not propose facilities capital cost of money)*
52.215-21	-	Requirements for Cost and Pricing Data or Information Other Than Cost or Pricing Data - Modifications (OCT 1997) - Alternate IV (OCT 1997) (a) Submission of cost or pricing date is not required. (b) Provide information described below: (SEE L-11 Part B)
52.217-8		Option To Extend Services (AUG 1989)
52.219-8	-	Utilization Of Small, Small Disadvantaged and Women-Owned Small Business Concerns (JUN 1997)
52.219-9	-	Small, Small Disadvantaged and Women-Owned Small Business Subcontracting Plan (AUG 1998)
52.219-16	-	Liquidated Damages - Subcontracting Plan (AUG 1998)
52.219-23	-	Notice of Price Evaluation Adjustment For Small Disadvantaged Business

Concerns (OCT 1998) Offers will be evaluated by adding a factor of 10 %
_____Offeror elects to waive the adjustment.

52.222-1 - Notice To The Government Of Labor Disputes (FEB 1997)
52.222-3 - Convict Labor (AUG 1996)
52.222-20 - Walsh-Healey Public Contracts Act (DEC 1996)
52.222-21 - Prohibition of Segregated Facilities (APR 1984) (DEVIATION)
52.222-26 - Equal Opportunity (APR 1984) (DEVIATION)
52.222-35 - Affirmative Action For Disabled Veterans And Veterans Of The Vietnam Era (APR 1998)
52.222-36 - Affirmative Action For Workers With Disabilities (JUN 1998)
52.222-37 - Employment Reports On Disabled Veterans And Veterans Of The Vietnam Era (APR 1998)
52.223-2 - Clean Air And Water (APR 1984)
52.223-5 - Pollution Prevention and Right-To-Know Information (APR 1998)
52.223-6 - Drug-Free Workplace (JAN 1997)
52.223-14 - Toxic Chemical Release Reporting (OCT 1996)
52.225-10 - Duty-Free Entry (APR 1984)
52.225-11 - Restrictions On Certain Foreign Purchases (AUG 1998)
52.226-1 - Utilization Of Indian Organizations And Indian-Owned Economic Enterprises (SEP 1996)
52.227-1 - Authorization And Consent (JUL 1995)
52.227-2 - Notice And Assistance Regarding Patent And Copyright Infringement (AUG 1996)
52.227-3 - Patent Indemnity (APR 1984)
52.227-10 - Filing Of Patent Applications - Classified Subject Matter (APR 1984)
52.228-5 - Insurance - Work on a Government Installation (JAN 1997)
52.229-3 - Federal, State, And Local Taxes (JAN 1991)
52.229-5 - Taxes - Contracts Performed In U.S. Possessions Or Puerto Rico (APR 1984)
52.230-2 - Cost Accounting Standards (APR 1998)
52.230-3 - Disclosure And Consistency Of Cost Accounting Practices (APR 1998)
52.230-6 - Administration Of Cost Accounting Standards (APR 1996)
52.232-1 - Payments (APR 1984)
52.232-8 - Discounts For Prompt Payment (MAY 1997)
52.232-9 - Limitation On Withholding Of Payments (APR 1984)
52.232-11 - Extras (APR 1984)
52.232-16 - Progress Payments (JUL 1991)
52.232-16 - Progress Payments (JUL 1991) Alternate I (AUG 1987)
52.232-17 - Interest (JUN 1996)
52.232-18 - Availability Of Funds (APR 1984)
52.232-23 - Assignment Of Claims (JAN 1986)
52.232-25 - Prompt Payment (JUN 1997)
52.233-1 - Disputes (OCT 1995)
52.233-3 - Protest After Award (AUG 1996)
52.237-2 - Protection Of Government Buildings, Equipment, And Vegetation (APR 1984)
52.239-1 - Privacy Or Security Safeguards (AUG 1996)
52.242-13 - Bankruptcy (JUL 1995)

52.243-1 - Changes - Fixed Price (AUG 1987)
52.243-6 - Change Order Accounting (APR 1984)
52.245-2 - Government Property (Fixed-Price Contracts) (DEC 1989)
52.245-9 - Use And Charges (APR 1984)(DEVIATION)
52.246-23 - Limitation Of Liability (FEB 1997)
52.246-24 - Limitation Of Liability - High-Value Items (FEB 1997)
52.247-63 - Preference For U.S.-Flag Air Carriers (JAN 1997)
52.248-1 - Value Engineering (MAR 1989)
52.249-2 - Termination For Convenience Of The Government (Fixed Price) (SEP 1996)
52.249-8 - Default (Fixed-Price Supply And Service) (APR 1984)
52.251-1 - Government Supply Sources (APR 1984)
52.252-6 - Authorized Deviations in Clauses (APR 1984) fill in Defense Federal Acquisition Regulation Supplement (48 CFR Chapter 2);
52.253-1 - Computer Generated Forms (JAN 1991)

DFARS CLAUSE TITLE

252.203-7001 - Special Prohibition On Employment (JUN 1997)
252.204-7000 - Disclosure Of Information (DEC 1991)
252.204-7003 - Control Of Government Personnel Work Product (APR 1992)
252.204-7004 - Required Central Contractor Registration (MAR 1998)
252.205-7000 - Provision Of Information To Cooperative Agreement Holders (DEC 1991)
252.209-7000 - Acquisition From Subcontractors Subject To On-Site Inspection Under The Intermediate-Range Nuclear Forces (INF) Treaty (NOV 1995)
252.209-7004 - Subcontracting With Firms That Are Owned Or Controlled By The Government Of A Terrorist Country (MAR 1998)
252.219-7003 - Small, Small Disadvantaged and Women-Owned Small Business Subcontracting Plan (DoD Contracts) (APR 1996)
252.219-7005 - Incentive For Subcontracting With Small Businesses, Small Disadvantaged Businesses, Historically Black Colleges And Universities, And Minority Institutions (OCT 1998) If the Contractor exceeds the small disadvantaged business, historically black college and university, minority institution goal of its subcontracting plan, at completion of contract performance, the Contractor will receive 1 percent of the excess.
252.225-7001 - Buy American Act And Balance Of Payments Program (MAR 1998)
252.225-7002 - Qualifying Country Sources As Subcontractors (DEC 1991)
252.225-7009 - Duty-Free Entry - Qualifying Country Supplies (End Products And Components) (MAR 1998)
252.225-7010 - Duty-Free Entry - Additional Provisions (MAR 1998)
252.225-7012 - Preference for Certain Domestic Commodities (SEP 1997)
252.225-7016 - Restriction On Acquisition Of Ball And Roller Bearings (AUG 1998)
252.225-7025 - Restriction On Acquisition Of Forgings (JUN 1997)
252.225-7031 - Secondary Arab Boycott Of Israel (JUN 1992)
252.227-7013 - Rights In Technical Data--Noncommercial Items (NOV 1995)
252.227-7014 - Rights In Noncommercial Computer Software And Noncommercial Computer Software Documentation (JUN 1995)

252.227-7016 - Rights In Bid or Proposal Information (JUN 1995)
252.227-7019 - Validation Of Asserted Restrictions--Computer Software (JUN 1995)
252.227-7030 - Technical Data--Withholding Of Payment (OCT 1988)
252.227-7036 - Certification Of Technical Data Conformity (JAN 1997)
252.227-7037 - Validation Of Restrictive Markings On Technical Data (NOV 1995)
252.231-7000 - Supplemental Cost Principles (DEC 1991)
252.232-7004 - DoD Progress Payment Rates (FEB 1996)
252.232-7009 - Payment By Electronic Funds Transfer (CCR) (JUN 1998)
252.233-7000 - Certification Of Claims And Requests For Adjustment Or Relief (MAY 1994)
252.242-7000 - Postaward Conference (DEC 1991)
252.243-7001 - Pricing Of Contract Modifications (DEC 1991)
252.243-7002 - Requests for Equitable Adjustment (MAR 1998)
252.245-7001 - Reports of Government Property (MAY 1994)
252.246-7001 - Warranty Of Data (DEC 1991)
252.247-7023 - Transportation Of Supplies By Sea (NOV 1995)
252.247-7024 - Notification Of Transportation Of Supplies By Sea (NOV 1995) *(will be included if the successful offeror made a negative response to the inquiry at DFARS 252.247-7022)*
252.248-7000 - Preparation of Value Engineering Change Proposals (MAY 1994)
252.251-7000 - Ordering From Government Supply Sources (MAY 1995)

I-2 FAR 52.223-11 - OZONE-DEPLETING SUBSTANCES (JUN 1996)

(a) Definitions.
“Ozone-depleting substance”, as used in this clause, means any substance designated as Class I by the Environmental Protection Agency (EPA) (40 CFR Part 82), including but not limited to chlorofluorocarbons, halons, carbon tetrachloride, and methyl chloroform; or any substance designated as Class II by EPA (40 CFR Part 82), including but not limited to hydrochlorofluorocarbons.

(b) The Contractor shall label products which contain or are manufactured with ozone-depleting substances in the manner and to the extent required by 42 U.S.C. 7671j (b), (c), and (d) and 40 CFR Part 82, Subpart E, as follows:
"WARNING: Contains (or manufactured with, if applicable)_____*_____, a substance(s) which harm(s) public health and environment by destroying ozone in the upper atmosphere."
* The Contractor shall insert the name of the substance(s).

I-3 DFARS 252.225-7008 - SUPPLIES TO BE ACCORDED DUTY- FREE ENTRY (MAR 1998)

In accordance with paragraph (b) of the Duty-Free Entry clause of this contract, in addition to duty-free entry for all qualifying country supplies (end products and components) and all eligible end products subject to applicable trade agreements (if this contract contains the Buy American Act - Trade Agreements - Balance of Payments Program clause or the Buy American Act - North American Free Trade Agreement Implementation Act - Balance of Payments Program clause), the following foreign end products that are neither qualifying country end products nor eligible end products under a trade agreement, and the following nonqualifying country components, are accorded duty free entry.

PART III - LIST OF DOCUMENTS, EXHIBITS, AND OTHER ATTACHMENTS
SECTION J
LIST OF ATTACHMENTS

J-1 Attachment (1) - Specifications - 60 Pages, with Exhibit A - DD Form 1423, Contract Data Requirements - Pages And Enclosure (1) - Instructions For Distribution - Pages

J-2 Attachment (2) – Figures for NRL One Meter, Mobile, Gimballed Telescope System – 4 Pages

J-3 Attachment (3) – Optional Spare Parts List , 1 Page

PART IV - REPRESENTATIONS AND INSTRUCTIONS
SECTION K
REPRESENTATIONS, CERTIFICATIONS AND OTHER STATEMENTS OF OFFERORS OR RESPONDENTS

K-1 Representations, Certifications, and Other Statements of Offerors or Respondents

Each Offeror must submit a completed Representations, Certifications, and Other Statements Of Offerors or Respondents with their proposal which is available electronically in full text at **http://heron.nrl.navy.mil/contracts/reps&certs.htm**

K-2 FILL IN FOR FAR 52.219-1 - SMALL BUSINESS PROGRAM REPRESENTATIONS (OCT 1998)

The fill in information is as follows:

The standard industrial classification (SIC) code for this acquisition is__3827_____.
The small business size standard is ___500_____.

K-3 COMMERCIAL AND GOVERNMENT ENTITY (CAGE) CODE REPORTING

The Offeror's CAGE Code is {fill-in}_____.
See DFARS 252.204-7001 in Section L for procedures on requesting a CAGE Code.

SECTION L
INSTRUCTIONS, CONDITIONS, AND NOTICES TO OFFERORS OR RESPONDENTS

L-1 52.252-1 SOLICITATION PROVISIONS INCORPORATED BY REFERENCE (FEB 1998)

This solicitation incorporates one or more solicitation provisions by reference, with the same force and effect as if they were given in full text. Upon request, the Contracting Officer will make their full text available. The offeror is cautioned that the listed provisions may include blocks that must be completed by the offeror and submitted with its quotation or offer. In lieu of submitting the full text of those provisions, the offeror may identify the provision by paragraph identifier and provide the appropriate information with its quotation or offer. Also, the full text of a solicitation provision may be accessed electronically at this/these address(es):

http://www.arnet.gov/far
http://heron.nrl.navy.mil/contracts/home.htm

FAR CLAUSE		TITLE
52.204-6	-	Data Universal Numbering System (DUNS) Number (APR 1998)
52.214-34	-	Submission Of Offers In The English Language (APR 1991)
52.214-35	-	Submission Of Offers In U.S. Currency (APR 1991)
52.215-1	-	Instructions to Offerors- Competitive Acquisition (OCT 1997)
52.215-16	-	Facilities Capital Cost Of Money (OCT 1997)
52.232-13	-	Notice Of Progress Payments (APR 1984)

L-2 FAR 52.211-14 - NOTICE OF PRIORITY RATING FOR NATIONAL DEFENSE USE (SEP 1990)

Any contract awarded as a result of this solicitation will be a ☐ DX rated order; ☒ DO rated order certified for national use under the Defense Priorities and Allocations system (DPAS) (15 CFR 700), and the Contractor will be required to follow all of the requirements of this regulation.

L-3 FAR 52.215-20 REQUIREMENTS FOR COST OR PRICING DATA OR INFORMATION OTHER THAN COST OR PRICING DATA (OCT 1997)ALTERNATE IV (OCT 1997)

(a) Submission of cost or pricing data is not required.
(c) Provide information described below:

The Contractor shall provide sufficient data/information to enable the Contracting Officer to determine the proposed price to be fair and reasonable. Such information may include the information called out in Section L-11 of the solicitation, access to records necessary to permit an adequate evaluation of the proposed price in accordance with FAR 15.403-3 and any other information that the Contractor may deem beneficial.

L-4 FAR 52.216-1 - TYPE OF CONTRACT (APR 1984)

The Government contemplates award of a Firm Fixed Price Supply Typecontract resulting from this solicitation.

L-5 FAR 52.233-2 - SERVICE OF PROTEST (AUG 1996)

(a) Protests, as defined in Section 33.101 of the Federal Acquisition Regulation, that are filed directly with an agency, and copies of any protests that are filed with the General Accounting Office (GAO) shall be served on the Contracting Officer (addressed as follows) by obtaining written and dated acknowledgment of receipt from the Control Desk, Code 3200, Bldg. 222, Rm. 115, Naval Research Laboratory, 4555 Overlook Ave., S.W., Washington DC 20375-5326.

(b) The copy of any protest shall be received in the office designated above within one day of filing a protest with the GAO.

L-6 DFARS 252.204-7001 - COMMERCIAL AND GOVERNMENT ENTITY (CAGE) CODE REPORTING (DEC 1991)

(a) The Offeror is requested to enter its CAGE code on its offer in the block with its name and address. The CAGE code entered must be for that name and address. Enter CAGE Before the number.

(b) If the Offeror does not have a CAGE code, it may ask the Contracting Officer to request one from the Defense Logistics Services Center (DLSC). The Contracting Officer will--
   (1) Ask the Contractor to complete section B of a DD Form 2051, Request for Assignment of the Commercial and Government Entity (CAGE) Code;
   (2) Complete section A and forward the form to DLSC; and
   (3) Notify the Contractor of its assigned CAGE code.

(c) Do not delay submission of the offer pending receipt of a CAGE code.

L-7 DFARS 252.227-7017 - IDENTIFICATION AND ASSERTION OF USE, RELEASE, OR DISCLOSURE RESTRICTIONS (JUN 1995)

(a) The terms used in this provision are defined in following clause or clauses contained in this solicitation--
   (1) If a successful offeror will be required to deliver technical data, the Rights in Technical Data--Noncommercial Items clause, or, if this solicitation contemplates a contract under the Small Business Innovative Research Program, the Rights in Noncommercial Technical Data and Computer Software--Small Business Innovative Research (SBIR) Program clause.
   (2) If a successful offeror will not be required to deliver technical data, the Rights in Noncommercial Computer Software and Noncommercial Computer Software Documentation clause, or, if this solicitation contemplates a contract under the Small Business Innovative Research Program, the Rights in Noncommercial Technical Data and Computer Software--Small Business Innovative Research (SBIR) Program clause.

(b) The identification and assertion requirements in this provision apply only to technical data, including computer software documents, or computer software to be delivered with other than unlimited rights. For contracts to be awarded under the Small Business Innovative Research Program, the notification requirements do not apply to technical data or computer software that will be generated under the resulting contract. Notification and identification is not required for restrictions based solely on copyright.

(c) Offers submitted in response to this solicitation shall identify, to the extent known at the time an offer is submitted to the Government, the technical data or computer software that the Offeror, its subcontractors or suppliers, or potential subcontractors or suppliers, assert should be furnished to the Government with restrictions on use, release, or disclosure.

(d) The Offeror's assertions, including the assertions of its subcontractors or suppliers or potential subcontractors or suppliers shall be submitted as an attachment to its offer in the following format, dated and signed by an official authorized to contractually obligate the Offeror: Identification and Assertion of Restrictions on the Government's Use, Release, or Disclosure of Technical Data or Computer Software.

The Offeror asserts for itself, or the persons identified below, that the Government's rights to use, release, or disclose the following technical data or computer software should be restricted:

Technical Data or Computer Software to be Furnished With Restrictions*	Basis for Assertion**	Asserted Rights Category***	Name of Person Asserting Restrictions****
(LIST)*****.	(LIST)	(LIST)	(LIST)

* For technical data (other than computer software documentation) pertaining to items, components, or processes developed at private expense, identify both the deliverable technical data and each such items, component, or process. For computer software or computer software documentation identify the software or documentation.

** Generally, development at private expense, either exclusively or partially, is the only basis for asserting restrictions. For technical data, other than computer software documentation, development refers to development of the item, component, or process to which the data pertain. The Government's rights in computer software documentation generally may not be restricted. For computer software, development refers to the software. Indicate whether development was accomplished exclusively or partially at private expense. If development was not accomplished at private expense, or for computer software documentation, enter the specific basis for asserting restrictions.

*** Enter asserted rights category (e.g., government purpose license rights from a prior contract, rights in SBIR data generated under another contract, limited, restricted, or government purpose rights under this or a prior contract, or specially negotiated licenses).

**** Corporation, individual, or other person, as appropriate.

***** Enter "none" when all data or software will be submitted without restrictions.

Date _____

Printed Name and Title _____

_____

Signature _____

(End of identification and assertion)

(e) An offeror's failure to submit, complete, or sign the notification and identification required by paragraph (d) of this provision with its offer may render the offer ineligible for award.

(f) If the Offeror is awarded a contract, the assertions identified in paragraph (d) of this provision shall be listed in an attachment to that contract. Upon request by the Contracting Officer, the Offeror shall provide sufficient information to enable the Contracting Officer to evaluate any listed assertion.

L-8 DFARS 252.227-7028 - TECHNICAL DATA OR COMPUTER SOFTWARE PREVIOUSLY DELIVERED TO THE GOVERNMENT (JUN 1995)

The Offeror shall attach to its offer an identification of all documents or other media incorporating technical data or computer software it intends to deliver under this contract with other than unlimited rights that are identical or substantially similar to documents or other media that the Offeror has produced for, delivered to, or is obligated to deliver to the Government under any contract or subcontract. The attachment shall identify - -

(a) The contract number under which the data or software were produced;

(b) The contract number under which, and the name and address of the organization to whom, the data or software were most recently delivered or will be delivered; and

(c) Any limitations on the Government's rights to use or disclose the data or software, including, when applicable, identification of the earliest date the limitations expire.

L-9 GOVERNMENT-FURNISHED PROPERTY

No material, labor, or facilities will be furnished by the Government unless provided for in the solicitation.

L-10 INQUIRIES CONCERNING THE RFP

Any questions concerning the RFP must be submitted in writing to the Contracting Officer at the location noted in blocks 7 and 9 of the Standard Form 33, "Solicitation, Offer and Award," no less than fifteen (15) days before closing. The Government will not consider questions received after this date. Offerors are cautioned against directing any questions concerning this RFP to technical personnel at the Naval Research Laboratory.

L-11 INSTRUCTIONS FOR SUBMISSION AND INFORMATION REQUIRED TO EVALUATE PROPOSALS

PART A - TECHNICAL PROPOSAL

(1) Information for the technical proposal shall be placed in Volume I and be completely separate from the cost/price proposal (Volume II).

(2) Required Copies: Four (4)

(3) Proposal Identification/Mailing - The proposal should be packaged for delivery so as to permit safe and timely arrival at destination. The proposal package should be sent to the address shown in Block 7 of the RFP face page and marked:

RFP No. N00173-98-R-CB04
Closing Date:
(As specified in Block 9, RFP face page)
Attn: Code 3230.MM

(4) The following information is required for evaluation of your technical proposal. Any additional information may be provided.

(a) The technical proposal must demonstrate an understanding of all requirements covered in the RFP's terms and conditions. The proposal must be sufficiently detailed and complete to demonstrate an understanding of and an ability to comply with the requirements of the RFP's Statement of Work or Specifications. General statements that the offeror can or will comply with the requirements, that standard procedures will be used, that well known techniques will be used, or paraphrases of the RFP's Statement of Work or Specification in whole or in part will not constitute compliance with these requirements concerning the content of the technical proposal. Failure to conform to any of the requirements of the RFP may form the basis for rejection of the proposal.

(b) The following additional information is required:

1. A listing of recent Department of Defense or other Government or commercial contracts under which the offeror has furnished identical or similar products. Also, a statement of names and telephone numbers of customers and technical personnel involved in the contract.

2. A statement of the offeror's percentage of sales with the Government and its percentage of sales with the commercial sector last year.

3. Demonstrate that the supplies or services you propose to provide comply with the Specifications and discuss the reasons for any exceptions.

4. Telescope Pointing, Slewing, Control, and Remaining Subfactor: The proposer should demonstrated the ability to meet the requirements of the specifications, as shown by the manufacturing control of parts and processes, and demonstration of understanding of technical risk. In addition, the proposer should supply data from previous jobs on LOS

performance including jitter, and should describe testing procedures and tools used to verify that system works and demonstrate that tests translate into field performance. The proposer shall specifically detail how the servo system, gimbal, and telescope control systems shall be tested. The proposer shall describe the factory and acceptance tests required to show full compliance to the specification. The proposer should specifically detail the interfaces and block diagram and functions of all contractor supplied subsystems and boards and provide detailed interface and block diagrams of his proposed control system. The proposer should show how he intends to test the use of the SMI in the supplied TUI. The proposer should supply sample engineering drawings and parts lists, test data that demonstrate the proposer's capability to design, fabricate, and test a telescope of this class.

5. Past Performance Subfactor: (a) Offerors shall submit the following information as part of their proposal. (Offerors are encouraged to submit information prior to other parts of the proposal to assist the government in reducing the length of the evaluation period.) List the last five (5) contracts or subcontracts completed during the past five (5) years of services similar in nature to this requirement. Include, in the five (5), any current contracts or subcontracts for similar services that were awarded at least one (1) year prior to the date of this solicitation. Offerors that have no similar previous or current contracts should provide the requested information for proposed subcontractors that will perform major or critical aspects of the requirement or for the proposed project manager or key personnel responsible for major or critical aspects of the requirement.

1. Name of contracting organization.
2. Contract number
3. Contract type
4. Total contract value
5. Description of the contract effort
6. Contracting officer and telephone number
7. Contracting officer's representative, program manager, or similar official and telephone number.
8. Original completion date and current or actual completion date and reason for differences.

(b) Offerors shall contact the contracting organizations identified pursuant to paragraph (a) as soon as possible and request them to send past performance information on the identified contracts to the address in Block 7 of the face page of this solicitation. The past performance report which is available at http://heron.nrl.navy.mil/contracts/home.htm is to be provided to the contracting organization for this purpose. If the contracting organization has already collected past performance information on the contract pursuant to FAR Subpart 42.15, the format used to collect the information may be used instead of the past performance report.

(c) Offerors may include in their proposals specific information relating to problems encountered in performing the identified contracts and any corrective actions by the offeror. Offerors should not provide general information on their performance on the identified contracts as this will be obtained from the contracting organization.

6. Technical Reliability and Maintainability Subfactor: The proposer shall provide a narrative description of the following: (a) the telescope(s) that proposer has built and delivered, (b) the consumable replacement schedule, and (c) the company experience and ability to manufacture telescope systems of the type required in the Specification. This description must clearly describe the consumable replacement schedule, as the day-to-day and seasonal maintenance schedule, long lead-time maintenance items, and the board level maintenance procedures (procedure to use once fault is detected) and its use with TUI (or other) computer, including any test cables or other equipment necessary. The proposer shall indicate such matters as how long the mount model is anticipated to be applicable; how often star calibrations, alignment, safety checks, and rebooting will be necessary and the accuracy of alignment procedures and techniques. In addition, the proposal shall indicate availability and timeliness of delivery card replacement or updates, and describe the quality control in S/W delivery and software upgrades.

7. Telescope Optical System Subfactor: (a) The proposer shall provide a narrative description of how the mirrors will be fabricated and tested during the fabrication and factory acceptance process and describe how factory testing will carry over to field performance. This description must clearly describe the fabrication and testing tools and the mounting and assemble of the optical components. The proposal must describe alignment procedures for the proposed design and describe how the end user will know when the fielded system needs alignment. The proposer shall describe in detail the tradeoffs of various optical coatings with attention given to polarization effects.

(b) The Government is concerned that no unforeseen additional cost be accrued because a coating selection or testing, in particular the citing selection requiring to minimize polarization effects.

8. Offeror Capabilities, Experience, and Management Subfactor: (a) Proposals should provide a narrative description of company experience of projects with technical risks similar to those required in the specification. The description should clearly show the relationship between the contractor's experience and the tasks required in the specification. The offeror should provide a management volume in his proposal which describes the management aspects of his offer. This volume should include a schedule of events in design, development, testing, and delivery of the telescope. This plan should include the quality control and reconciliation procedures.

(b) The offeror shall include in the management proposal a program management plan which describes the management system and procedures used to plan, control, and track program/schedule performance and related information. The Contractor shall be required to maintain appropriate documentation to support the performance of the telescope. This documentation shall include the acceptance testing of the telescope. The offeror should list key personnel who will be involved with the management, design, fabrication and testing of the telescope. The offeror should describe the tools and equipment, tools, & facilities he intends to use on this contract. The offeror should list any subcontractors who will be involved with the work and describe the contribution of each.

PART B - COST/PRICE PROPOSAL

(1) The cost/price proposal shall be in Volume II and be completely separate from the technical and management proposal (Volume I).

(2) Required Copies: Three (3)

(3) The proposer shall provide information to support all proposed prices. This may include published price lists, including current discount policies, recent sales, or engineering estimates of the materials and labor required to fabricate items.

SECTION M
EVALUATION FACTORS FOR AWARD

M-1 EVALUATION

Award will be made to that offeror whose proposal is determined to be the best value to the Government, proposed cost and other factors considered. The Government reserves the right to make award to other than the low offeror. Although technical considerations are more important than cost, the closer the technical scores of the various proposals are to one another, the more important cost considerations become.

M-2 EVALUATION FACTORS FOR AWARD

Proposals will be evaluated in accordance with the following criteria. The technical factor is more important than price and price is more important than the other business factor. The technical subfactors are listed below in descending order of importance.

M-2-1. TECHNICAL/MANAGEMENT

(1) TELESCOPE POINING, SLEWING, CONTROL, AND REMAINING FACTORS

The proposal will be evaluated on: the technical approach; mechanical, electrical and control system proposed; the overall telescope design; LOS (gimbal) performance; design for transportability; day light performance; adherence to performance specifications; and all other factors not listed elsewhere.

(2) PAST PERFORMANCE

The proposal will be evaluated on the basis of the quality of the work performed, timeliness of performance, cost control, and business relations. The evaluation will be based on the information provided pursuant to Section L and other sources if available. Offerors that have no relevant performance history or for which past performance information is not available will not be evaluated favorably or unfavorably on past performance. The government may begin proposal evaluation prior to receipt of past performance information. If, after completion of proposal evaluation except evaluation of past performance, the contracting officer determines that evaluation of past performance will not affect the outcome of competitive selection, the contracting officer may waive its evaluation in accordance with FAR 15.304(c)(3)(iii).

(3) TELESCOPE RELIABILITY AND MAINTAINABILITY

The proposal will be evaluated on the offeror's demonstrated ability to provide materials and processes defined in the enclosed specification and the ability to meet all requirements and provisions of the specification.

(4) TELESCOPE OPTICAL SYSTEM

The proposal will be evaluated on the offeror's technical approach and demonstrated ability to meet the requirements of the specification, as shown by (1) the telescopes over all optical quality, (2) the offeror's ability to fabricate mirrors, mirror mounts, total optical systems, and on the quality and performance of the optical system proposed to meet all the requirements of the specification, (3) the performance of the proposed optical system under the stress of motion of the telescope, and expansion and contraction of the telescope due to temperature changes, should be addressed, (4) the ability of the optical system to maintain alignment under thermal cycling, and (5) the ability of the telescope to operated in daylight compared to night time operation.

(5) CAPABILITIES, EXPERIENCE, & MANAGEMENT

The proposer will be eveluated on the offeror's demonstrated: (1) company experience in successfully manufacturing and assembling sificicated electo mechnical systems, and (2) ability to produce the unit for this procurement, as surmised by the information provided on (a) past performance units, (b) manufacturing facilities and test equipment available, (c) major suppliers developed, and (d) personnel qualified.

M-2-2. PRICE

Overall Price To The Government

M-2-3 OTHER BUSINESS FACTOR

(a) Commitment to Small Business, Small Disadvantaged Business, Historically Black College and University and/or Minority Institution participation in performance of the contract. Evaluation will be based on the extent to which such firms are specifically identified in proposals, the extent of their participation in terms of the value of the total acquisition, and the complexity and variety of the work such firms are to perform. Small business concerns that are not required by FAR 52.219-9 to submit a subcontracting plan should indicate the extent to which proposed subcontracts are with large businesses, small disadvantaged businesses or historically black colleges and universities/minority institutions.

M-3 AWARD BY FULL QUANTITY

An offeror must propose on all items in this solicitation to be eligible for award.

M-4 FAR 52.217-5 - EVALUATION OF OPTIONS (JUL 1990)

Except when it is determined in accordance with FAR 17.206(b) not to be in the Government's best interests, the Government will evaluate offers for award purposes by adding the total price for all options to the total price for the basic requirement. Evaluation of options will not obligate the Government to exercise the option(s).

ENCLOSURE (1) TO DD FORM 1423
INSTRUCTIONS FOR DISTRIBUTION

DISTRIBUTION OF TECHNICAL REPORTS

The minimum distribution of technical reports and the final report submitted in connection with this contract is as follows:

ADDRESSEE	DODAAD CODE	NUMBER OF COPIES UNCLASSIFIED/ UNLIMITED	NUMBER OF COPIES UNCLASSIFIED/LIMITED AND CLASSIFIED
COR/TM Naval Research Laboratory Code: 4555 Overlook Ave., S.W. Washington, DC 20375-5320	N00173	1	1
Administrative Contracting Officer		1	1
Director Naval Research Laboratory ATTN: Code: 5227 4555 Overlook Ave., S.W. Washington, DC 20375-5320	N00173	1	1
Defense Technical Information Center (DTIC) 8725 John J. Kingman Rd. Suite #0944 Fort Belvoir, VA 22060-6218	S47031	4	2

DISTRIBUTION OF NON-TECHNICAL REPORTS

The minimum distribution of non-technical reports submitted in connection with this contract is as follows:

ADDRESSEE	DODAAD CODE	NUMBER OF COPIES UNCLASSIFIED/ UNLIMITED	NUMBER OF COPIES UNCLASSIFIED/LIMITED AND CLASSIFIED
COR/TM	N00173	1	1
Administrative Contracting Officer (DCMAO)		1	1

SOLICITATION N00173-98-R-CB04

MINIMAL ACCEPTABLE SPECIFICATIONS CHARACTERISTICS, and STATEMENT of WORK

for NRL ONE METER, MOBILE, GIMBALLED TELESCOPE SYSTEM

15 JANUARY 1999

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LIST OF TABLES AND FIGURES

1.0 SCOPE & BACKGROUND

The Naval Research Laboratory (NRL) seeks to purchase a mobile telescope with a meter clear aperture with coudé and Nasmyth optical paths. The telescope will be used to support laser ranging and laser radar, LIDAR, optical communications, astronomical imaging, and precision acquisition and tracking of satellites at various altitudes over wide elevation angles. The telescope is to operate for different configurations from visible wavelengths thru infrared (400 nanometers thru 15 microns), with the capability to extend to other wave lengths by replacing all optics but the primary with specially coated optics. The Government will furnish a standard grade Zerodur mirror blank suitable for making a 1 meter mirror to be fabricated into the primary mirror for this telescope.

The scope of this effort includes the design, fabrication, testing, delivery, installation, training, and documentation of a 1-meter, mobile, gimballed, telescope system within 18 months or less (the lower the bettor for credible offers) after contract award.

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The basic contract covers items 0001 thru 0002, which includes the fabrication and delivery of the one-meter telescope (item 0001) and technical assistance for integrating and training on the telescope (item 0002). The 14 options are items 0003 thru 0016.

Options that the offeror should offer upon and that the Government may exercise as additional item to procure are listed and described later in this SOW.

The magnitude of the specifications listed in this document are the minimal acceptable specifications. The Contractor may exceed performance on any or all of the listed specifications in this effort. Wherever there is the perception of inconsistent specifications the Contractor shall meet the more stringent value. Any reference in this specification to any interfaces between the telescope Contractor and other contractors associated with the project shall be governed by an appropriate Interface Control Document (ICD) generated by the Contractor and approved by the Government.

The telescope is to be designed with consideration given to mobility and easy setup since it may be moved to a fixed site or installed on a mobile platform and be moved to different locations. In light of this requirement, it is imperative that the Contractor incorporate additional safeguards within the design that allow for easy transportation without damage to the hardware, especially the optics, bearings, cables, sensors and control electronics. Also, it is necessary that the telescope be able to operate in adverse environments with only a marginal reduction in performance. The telescope shall be designed for static operation on an enclosed, ground pedestal. The telescope will be used at various sites. A high altitude site may be used in addition to a site near Washington, DC.

The Government also intends to streamline integration and simultaneously reduce costs. To this purpose, the supplying vendor shall be asked to design with specific proven hardware and software. The Contractor shall provide a free standing operation with a digital control system and interface to an external computer, the specific determination to be made at Critical Design Review.

Figure 3.0-2 presents the complete system in functional block form. The Contractor shall supply all parts of this system except the Hazard reduction radar, the Master Clock and systems connected to the Experimental Control System (ECS). The system shall be tested for performance with the Telescope Users Interface (TUI). The TUI shall be used for the acceptance testing of the delivered telescope and for operation of the telescope. The TUI with all hardware and software used for this project shall be delivered to NRL.

The Government intends to develop its own Experimental Control System (ECS) which will perform the functions of the TUI as well as experiments using the telescope. The performance of the contractor's system shall not be dependent upon any Government supplied hardware or software. To speed the development of the ECS the Government may exercise Option 15 to have the Contractor deliver a Telescope Simulator.

Initially, the telescope will be sited on a prepared pad. It is to be constructed such that it can be removed and shipped with minimum disassembly (the extent to which will be finalized at the Critical Design Review (CDR)). The system will be year 2000 compliant.

The integration shall be performed at the contractor's facility. Once the systems have been successfully integrated, it shall be moved without disassembly of the telescope and gimbal structure down thru the support for the last coudé mirror (M7) to be described later) to the first testing site to be determined near Washington, DC. The shipping container shall be reusable. The Contractor shall be required to deliver all hardware and software they have assembled for operation of the telescope to this site. It shall also be required to install the telescope onto the pedestal, assemble their portion of the hardware and assist NRL with the integration of the complete system.

1.1 Deliverables

The deliverables for the basic contract and options are as follows:

Item 0001. Fabrication and delivery of the one-meter telescope including all hardware and software (including source code).

Item 0002 Training at the Contractor Site and the Washington, DC area site and technical assistance in integrating the telescope.

Items 0003 thru 0015 are option items described in Section 4.

In addition to the primary deliverables, there are many deliverables of documentation described in this Statement of Work. Software rights to the Government shall be provided and include "limited rights" to software control, as defined in DFARS 252.227-7013, for real-time and non-real time control to the system. Version upgrades for ten years are to be included.

2.0 APPLICABLE DEFINITIONS AND ABBREVIATIONS

Angular Position, Measured
The angular position measured by an angular position sensor.

Angular Position, True
The angles descriptive of the direction that a light beam actually exits the telescope

Angular Position Sensor
An angular position sensor, or just encoder or position sensor is used in this document to define a device which measures the angle between an arbitrary, fixed, radial reference on the stationary portion of the azimuth (elevation) bearing and an arbitrary, fixed radial reference on the adjustable portion of the azimuth (elevation) bearing. This angular measurement is to be in a format that can be easily read by the controlling computer for feedback or display.

Angular Rate, True
The rate of change of the True Angular Position.

Commercial Off-the-Shelf (COTS)

Contract Data Requirements List (CDRL)

Control Law
The approach chosen to make a control system perform in a desired fashion within prescribed error tolerances. This definition encompasses the forward loop compensator, feedback filtering, and prefiltering of control inputs.

Coudé Optical Path
A coudé (coudé is a French word for elbow) optical path (as shown in Figure 3.0-1) is an optical path which allows the position of the light from the telescope to come to a stationary location while the telescope itself points to different directions.

Critical Design Review (CDR)

Encoder
A mechanism for determining the angle in which a gimbal is positioned. In our case this mechanism will presumably be an inductive or optical type encoder. This mechanism yields a much more accurate position of the gimbal than the resolver.

Encoder Line-of-sight (Encoder LOS)
Encoder line-of-sight (which ignores mount modeling issues) is the direction of the optical line-of-sight of the telescope as determined by the angles reported by the azimuth and elevation angular position sensors assuming the telescope

structure and optical elements are a rigid body and optical elements are perfectly aligned.

Experiment Control System (ECS)
The Government user control system which performs the function of the Contractor User Interface, but also controls the experiments being performed with the use of the telescope.

Factory Acceptance Test (FAT)

Field of View (FOV)

Frame Rate
The loop cycle rate (at least 1,000 Hz) in the Real Time TCS that defines adjacent ** to full loop cycle in the Real TCS (this also determines the time interval of logging states of the system).

Graphical User's Interface (GUI)

Interface Control Document (ICD)

Inter-Range Instrumentation Group (IRIG)

Jitter
Jitter is defined as the variability of a signal about the mean value. It is characterized in terms of the root mean square (RMS) of the signal. The RMS can be measured directly with a time sequence or by the square root of the integral of the power spectral density of the signal. The encoder line of sight is used to define line of sight jitter. (This assumes that no practical system level optical tests can achieve the high sensitivity and low noise necessary to characterize the jitter.)

Line of Sight (LOS)

M1, Primary Mirror

M2, Secondary Mirror

M3, Tertiary Mirror

M4-M7 Coudé Path Mirrors

Manual Control Unit (MCU)

Mobile
It is not intended that the telescope be mounted on a motorized platform at this time. Rather it is required that the telescope be transportable on flatbed

truck using a crane. No disassembly of the trunnion from the base shall be required and mirrors M1 thru M7 shall not need to be removed for shipping (the less disassembly and reassembly required the better). Once the telescope is in a new location it shall require no more than three days to become operational thru the performance of global star calibration.

Nasmyth Optical Path

A optical path which yields an image plane approximately one meter from the M3 mirror.

Optical Line-of-sight (Optical LOS)

The optical line of sight , also called the true optical line-of-sight, is the direction taken by the ray of light from the center of the focal plane and along the optical path established by the telescope optics. This path will include optical misalignments and structural bending. The term LOS by itself means optical LOS.

Optical Line-of-sight Error

The optical line-of-sight error (LOS Error), or just, line-of-sight error, is the difference between the expected LOS, calculated from commanded position with the assumption of a rigid, perfectly aligned telescope, and the true optical line-of-sight. For a time varying commanded input this error will include servo error, servo lag, optical misalignment and structural bending. For a constant commanded input, servo lag is not a part of this error.

Personal Computer (PC)

Position Error

The difference between commanded angular position and measured angular position.

Preliminary Design Review (PDR)

Procurement Contract Officer (PCO)

Rate Error

The difference between commanded rate and true rate.

Shared Memory Interface (SMI)

One of the two interfaces between the Real Time TCS Computer and a User Interface. This uses a pair of COTS (Commercial Off The Shelf) based cards with a fiber optical interconnection to accomplish synchronized shared memory.

Remote Procedure-call Ethernet Interface (REI)

One of the two interfaces between the Real Time TCS Computer and a User Interface. This uses a standard TCP/IP remote procedure call thru sockets.

Resolver

The mechanical method for LOS position. The resolver determination of LOS is considerably less accurate than the encoder method. This is used primarily for the independent safely subsystem.

Root Mean Square (RMS)

Satellite Laser Ranging (SLR)

Software (S/W)

State of Controller Process

The state of the controller includes the dynamic filter coefficients including commanded position, velocity, acceleration and observed position, velocity, acceleration and such variables as the states of the mirror cover (open or closed), brakes, safety mushroom switches, etc.

System Requirements and Design Review (SRDR)

Real Time Telescope Control System (TCS)

Perhaps more properly called the Real Time Telescope Control System (TCS). This is the control system which includes the power and other electronics and real time TCS computer which directly controls the telescope. This system interfaces to the user thru the Real Time TCS computer thru a Shared Memory Interface (SMI) and/or a Remote Procedure-call Ethernet Interface (REI) Interface.

Satellite Laser Ranging (SLR)

Transmission Control Protocol/ Internet Protocol (TCP/IP)

A standard computer to computer communication protocol.

Telescope User Interface (TUI)

The Contractor supplied Interface for the user to control the telescope. The TUI connects to the Real-Time Telescope Control Computer thru one of two interfaces.

Time Optimal

The movement of an object at rest, from position A to rest at position B, in the least amount of time that is consistent with the velocity and acceleration constraints imposed by the drive system. This control is called a "time optimal" control law.

Transistor-Transistor Logic (TTL)

Trunnion Box

The trunnion box is mounted on the gimbal structure yoke and contains the primary and tertiary mirrors and supports the trusses for mounting the head ring which supports the secondary mirror.

Versa Modular Eurocard (VME)

3.0 REQUIREMENTS

The Contractor shall design, fabricate, assemble, test, deliver, and train in the use of a 1 meter aperture mobile, gimbaled, telescope system. The specifications given in this Section 3 describe the minimal acceptable characteristics. Elements of the telescope mount and optical path system are illustrated in Figure 3.0-1 which is for illustrative purposes only.

3.0.1 Functionality of Telescope

Functionally, the system shall perform the following functions: collect and concentrate light from objects; track and image object at sidereal rate; track, image, and propagate laser light to and collection laser light from satellites; perform high level testing from the TUI; perform star calibration, mount modeling, Az/El pointing; and shall contain a FK5 star atlas and planetary data.

3.0.2 General Description of Telescope

The general system may be described as follows:

1. The Telescope mount and optical path consists of the following subsystems:

a. The telescope structure including the trunnion box, metering structure, head ring, mounts for the mirrors (M1 thru M7), primary mirror cover, baffles, focus drive for the secondary, and a mount location for an acquisition camera. The trunnion box is also called the centerpiece. The coudé and Nasmyth optical paths travels thru the pillow block bearings which supports the trunnion box.

b. All optical components for the system including the primary, secondary, and tertiary mirrors, the coudé optics M4 thru M7, narrow field-of-view (FOV) Nasmyth optics, and any alignment components required such as support flats and reticles. The telescope shall provide lambda over ten (L/10) system performance in the field over the FOV of the optics.

c. An elevation over azimuth gimbal structure including the yoke, the azimuth and elevation bearings, drive motors, and encoders, the mounts for the coudé mirrors, passive and active beam path conditioning, and cabling service lines and the base. The base for the gimbal system is a stationary platform which supports the yoke on the azimuth bearing. The coudé and optional Nasmyth optical paths and all of the cable lines will pass thru or be connected to this part of the gimbal. The base is a stationary platform mounted to a pier which holds the azimuth drive motor. The rotational portion of the azimuthal axis supports the yoke.

d. The capability for widening the FOV of the Nasmyth image plane at one pillow block location by replacing the secondary mirror with one designed for Nasmyth imaging, and enhancing the Nasmyth image capability by adding instruments.

2. The Real Time Telescope Electronics shown schematically in the functional block diagram in Figure 3.0-2 contains the motor drive power

amplifiers, electrical and power interfaces to position sensors and safety switches, and any power conditioning electronics. As can be seen from the figure, the telescope is controlled by the Real Time Telescope Control System (TCS). The Real Time TCS is accessed by and communicates with the Government Experiment Control System (ECS), as well as to the Manual Control Unit (MCU) and to the TUI.

3. The Digital Control Electronics, shown in Figure 3.0-2 shall among other functions:

a. include the chassis containing the Real Time TCS;

b. generate time stamped mount position and velocity data;

c. accept IRIG-A or B input for external timing control (that is master clock);

e. include the MCU, a hand-held unit for remote control of the azimuth, elevation axes and the secondary functions. The MCU shall connect allow an experimenter the ability to make adjustments to the telescope line of sight and focus while observing changes on the optics bench in the coudé room or at an eyepiece or instrument at the telescope Nasmyth focus;

f. include the TUI. The TUI software shall run on a PC which shall be capable of controlling all functions provided with the delivered system. This PC shall have the ability to be backed up and restored.

g. all software to control the above functions.

During fabrication of the telescope, the Contractor shall be required to maintain and deliver appropriate documentation to demonstrate the performance of the optical and control subsystems. This documentation shall include the results of the acceptance testing of the assembled telescope. It is essential that NRL have sufficient documentation delivered with the hardware for establishing the baseline performance of the optical and control performance since the ability to evaluate total performance in the field is dependent upon this understanding. To accomplish this performance documentation, minimal acceptable Data Item Descriptions are identified in Appendix B and cross referenced to CDRLs at the end of those paragraphs which reference important subsystem performance.

3.0.3 Proposal Requirements

The bidders shall discuss the expected reliability and maintainability of the telescope, and supply any detailed reliability and maintainability analysis record of performance that has been done on similar telescope(s) with a well defined mission that the bidder has delivered in the past.

3.1 TELESCOPE STRUCTURE

The telescope structure shall be designed to support a classical Cassegrain system with an f/1.5 parabolic primary, secondary and tertiary optics. It shall be an open truss structure with baffling designed to permit the telescope to operate during daytime operation. The telescope structure shall be designed to be mobile, as described in the definitions section. Mechanical, as built drawings for

the telescope (hard and digital copy), handling and support equipment, and fixtures are deliverables. (A010).

3.1.1 Configuration

The telescope structure shall include a rigid open frame truss with a head ring/spider assembly to support the secondary mirror assembly at its open end. The other end of the truss shall be attached to the front of the trunnion box. The primary mirror (M1) subassembly shall attach to the trunnion box in such a manner that meets the center of gravity requirements and so that the primary mirror can be removed for recoating without disassembly of the truss and spider ring assembly. The truss shall correctly position and rigidly support the secondary mirror (M2), secondary mirror mount, and secondary focus mechanism.

The telescope structure, baffles, and primary cover shall be designed and fabricated in a way which properly takes into account the need to minimize thermomechanical effects and thermal stagnation in the optical path in front of the primary mirror. Additional mounts shall be provided on the telescope structure to attach acquisition sensors. These additional mounts shall be on the head ring and trunnion box and shall not interfere with the rotation of the elevation axis nor will the additional mounts restrict the clear aperture of the system in any way.

3.1.1.1 Switchable Instruments

In addition to the coudé optical path of the telescope which is expected to be the optical path used most often, there are three other paths employing M1, M2, and M3. One is the Nasmyth path and the other two will are for future instruments. Holes (with covers) in the trunnion box and mounting facilities are to be provided for these future instruments in the delivered telescope. Section 3.1.14 describes how these instruments are to be switched using M3. Sufficient clearance between the trunnion box and its support for the clearance of instruments should be provided.

3.1.1.2 Base Extension

An extension to the base of the telescope shall be provided by the Contractor which may be used to raise M7 several feet. The height of this extension shall be determined at CDR. This extension may be used to adjust the height of M7 to match the optical table without using additional mirrors. It is anticipated that this extension will be used in the initial telescope site, but may be removed if the telescope is mounted on a higher platform.

3.1.2 Optical Prescription

The base line optical prescription is given in Table 3.1.2. These are nominal values for the back focal length and effective focal length and will be adjusted when the coudé path distances and the distance to the coudé bench are known.

Table 3.1.2 Optical Prescription for the One Meter Telescope

CLASSICAL CASSEGRAIN/COUDÉ PATH	VALUES
Effective focal length	125 +/- 1 meters
Back Focal Length (from primary vertex)	16.2 +/- .05 meters
Primary Mirror Clear Aperture	1 meter
Primary Mirror Focal Length	1.5 meter nominal
Primary Conic Constant (parabola)	-1.00000
Secondary Mirror Clear Aperture	141 mm
Secondary Mirror focal length (convex)	-212.43 mm nominal
Secondary Mirror Conic Constant	-1.051 nominal
Mirror Separation	1290.119 mm nominal
Angular Magnification	7.07 nominal

3.1.3 Clear Aperture

The clear aperture of the telescope primary shall be no less than one meter. The clear aperture of the optical elements and all of the telescope system structure shall support the full primary mirror aperture over the unvignetted field of view as defined in section 3.1.4.

3.1.4 Field of View

The unvignetted FOV of the telescope shall be circular with an angular radius of at least 500 microradians (1.0 millirad full field angle) at the coudé Cassegrain focus. All of the optical elements and all of the structure of the system shall support this unvignetted FOV for all focus positions from targets located from 1.0 km to infinity.

An analysis of the telescope field of view at the coudé and Nasmyth focus is a deliverable. This may be simply a copy of the ray tracing program file/results and verbiage to explain this file/results. (A005)

3.1.5 Optical Line-of-sight Repeatability

It is essential that the optical LOS be smooth, repeatable and modelable as related to encoder LOS. Modelable in this context means predictable for future times; this functionality can be bounded by laboratory testing. This future time would be defined as the time up to the point that additional information for the next modelable calculation has been input to the model. This time period will vary from hours to days. However, the mechanical and optical structures shall, during any one hour period, be thermally and mechanically stable such that the optical line-of-sight shall be repeatable with respect to the gimbal readouts to better than ±4.85 microradian (plus or minus 1 arcsecond) peak with the system in a stable environment. The optical LOS shall meet performance requirements for the step response tests for the azimuth and elevation axes listed in Section 3.3.6. Analysis, test plans, and test reports of optical line-of-sight performance are deliverables. (A003, A004, A005)

3.1.6 Absolute Pointing Accuracy

The telescope shall have an absolute pointing accuracy within 4.85 microradian (1 arcsec) RMS under normal day and night time conditions. If there is to be difficulty meeting this specification in day operations because of solar heating and deformation of the telescope, the Contractor shall provide a method or procedure of shielding the telescope from the sun. The Contractor shall provide an analysis of the absolute pointing accuracy over the specified environmental range.

These accuracy and precision for operating the telescope within the specified global pointing accuracy requirement must be met without the utilization of star alignment following power down and reboot of the control system. The manual movement of the gimbals while powered down shall not affect the accuracy of the encoder LOS when the system is rebooted.

3.1.7 Primary Mirror Mount

The Contractor shall design a primary mirror mount that shall maintain the mirror (fabricated from the Government supplied blank) figure in all positions of the telescope and during all prescribed velocity and acceleration conditions excluding hard stop decelerations.

The trunnion box and primary mirror support structure shall be designed to enable the mirror to be unfastened and removed from the trunnion box (still being contained in its cell and support) without disassembly of the truss tubes or trunnion box. This should allow easy removal, transportation, and replacement into operating position of the primary mirror if it needs to be replaced, repaired, or recoated.

The Contractor shall design the primary mirror support so that outside air may be circulated over the mirror face. This mirror face purge should allow for more rapid thermal equalization and reduction of thermal air flows which disrupt seeing.

An analysis of the primary mount and its performance are deliverables. (A005)

3.1.8 Secondary Mirror Mount

The secondary mirror mount shall be mechanically and thermally stable within the operational range and thermal environment system performance specification of section 3.1.10 while meeting the overall wavefront error budget described in section 3.2 and other specifications.

The secondary support shall allow for manual centration and tilt adjustment of the secondary with respect to the primary mirror.

The telescope shall be designed for the potential later addition of a tilt tip secondary mirror. This shall include the determination of whether or not a counter balance would be needed for such an addition.

The secondary mount shall provide the capability to exchange the secondary mirror for the coudé or Nasmyth configurations or for replacement of optics for efficient response at different wavelengths. Method should enable exchange in 15 to 30 minutes by one or two trained professionals using standard hand tools and standard tooling such that realignment of the secondary with respect to the primary will not be necessary.

The secondary mirror may have a center hole which may be used for a retroreflector or an alignment laser. The secondary mirror mount should be able to accommodate this.

Analysis of secondary mirror mount is a deliverable. (A005)

3.1.9 Secondary Mirror Focus Mechanism

The secondary mirror mount shall contain a mechanism to provide real time focus adjustment for the secondary mirror that is controlled and monitored at the operator's console. In its fastest mode of travel it shall require less than 5 seconds to cover the range of focus from infinity to 1.0 kilometer. Sufficient overage of motion shall be provided to allow correction of the primary/secondary inter-mirror distance for thermal expansion of the truss and trunnion box over the environmental conditions discussed in section 3.1.10 and the focus subsystem shall be capable of automatically maintaining focus over these conditions. Any optical LOS change due to tilt or decentration of M2 over the focus range shall be with in the overall system specification during operation. Any change in optical performance because of change in focus during automatic focus maintenance shall be within system optical specification.

It is possible that an improved model of M2 position setting required to maintain focus over temperature range may be obtained by recording temperature, and M2 position setting, and M1 - M2 distance. The Contractor shall provide the means of examining and changing the focus model over temperature change as experience is acquired with the telescope.

Analysis of mirror focus mechanism performance is a deliverable. (A005)

3.1.10 Environmental Conditions Around Pedestal

The telescope structure and gimbal systems shall conform to all parts of this specification under the environmental conditions outlined in Table 3.1.10. The temperature and humidity are specified for inside the dome. The electronics and other components in the coudé room are to have environmental control and are exempt from this table. Analysis of telescope performance for environmental conditions on the pedestal and R&D Equipment List, ICDs are deliverables. (A005, A009)

Table 3.1.10 Operational and Survival Conditions for the Telescope System

	Operational Conditions	Survival: Dome Open	Survival: Dome Closed
Temperature Inside dome	-20 to 50 deg C	-20 to 50 deg C	-40 to 50 deg C
Temperature Change Inside dome	2 deg C /hour	5 deg C /hour	5 deg C /hour
Wind outside dome	0-30 mph gusts	0-60 mph gusts	Not Applicable (Dome separate)

Humidity Inside dome	5 to 95%	5 to 99%	5 to 99 %
Sunlight (see Section 3.1.10.1)	full sun throughout day	full sun throughout day	full sun throughout day

3.1.10.1 Operation in Sunlight

The telescope and gimbal systems shall be operated in direct sunlight for a portion of the time. Performance achieved in sunlight is expected to meet the objectives of this specification including the dynamic pointing and encircled energy specifications. Bidders should describe in their proposals how they will meet the specifications of day light operations. Analysis of telescope operations in sunlight is a deliverable. (A005)

3.1.11 Telescope Baffling

The telescope shall include a design baffling for the Cassegrain system that minimizes scattered light on the focal plane over the full FOV during daylight imaging. There will be no direct illumination of the coudé or Nasmyth focal plane (no ray gets past M2 without first hitting M1) and no first bounce illumination of the coudé focal plane.

The Contractor shall suggest additional mounting locations for the telescope system baffling. Analysis of telescope baffling design is a deliverable. (A005)

3.1.12 Primary Mirror Protective Cover

A retractable cover shall be provided to protect the primary mirror from dust and small falling objects when the telescope is not in use. Small falling objects are defined as any standard off-the-shelf hand tools (such as a screw driver) required to work on the telescope. The cover can be operated locally thru the MCU at the telescope and remotely from the operator's console. The cover shall have an indicating element on the control console to inform the telescope operator when the cover is fully opened or fully closed.

3.1.13 Acquisition Camera and Mounts for Auxiliary Instruments

The Contractor shall provide a mounting fixture for a course acquisition telescope and camera on the head ring with power and with cabling to coudé room. Appropriate counter balancing of this station will be provided with adjustable counter weights. The Contractor may be required to use his own camera for delivery testing of the telescope.

A mounting surface shall be provided on the yoke tine for an alignment laser between M4 and M5.

In addition, two general purpose mounting surfaces will be provided on the trunnion box to support other instruments, alignment tooling, or survey jigs. Weight capacity of these stations will be 30 lb on the head ring and 100 lb on the trunnion box. Other mounting locations may be proposed at the System Design Requirements Design Review (SRDR). Refer to section 3.3.7 for balance requirements.

Analysis of mounts for auxiliary instrumentation which shall include counter balance functionality is a deliverable. (A005).

3.1.14 Tertiary Mirror Mount

The tertiary mirror mount shall be rotatable to four positions zero degree, 90 degrees, 180 degrees, and 270 degrees for switching from a coudé to a Nasmyth configuration and to other instrument locations. The tertiary mirror mount rotation positions shall be repeatable to within an arcsec (plus or minus one half arcsec) in object space. M3 shall be mechanically interchangeable to, for example, replace the optics with optics for efficient response at different wavelengths.

3.1.15 Coudé Mirrors and Mounts

The coudé mirrors shall be easy to remove from their mounts for replacement with out disturbing alignment. The adjustment points shall be easily accessible for adjustment.

Documentation of the procedure for alignment and removal and replacement of the mirrors shall be included. (A005)

3.2 CASSEGRAIN, COUDÉ, NASMYTH, AND ALIGNMENT OPTICS

The Contractor shall design, fabricate, assemble, test and deliver an optical system to the minimal acceptable specifications given in this section. The telescope shall be mobile as defined in the definitions section. References to an optical wavelength shall refer to 632.8 nm unless otherwise specified.

3.2.1 Configuration

The telescope shall be configured with an f/1.5 primary mirror (M1), a secondary mirror (M2), a tertiary mirror (M3) and coudé optics (M4-M7). The mounts and support structure shall have a compact beam path, with a coudé aperture not less than 15 cm for an object at infinity within the specified FOV. Preference should be given in the optomechanical design to minimizing effects from sky light and scattered light into the optical path.

In addition to the coudé optical path the telescope shall have a Nasmyth optical path and image plane at one pillow block. This rudimentary Nasmyth optical path shall be implemented by the rotatable tertiary mirror and by an focal length reduction lens and an eyepiece. This Nasmyth configuration may be considerably expanded by the exercise of the Nasmyth options.

Cables for power, control, and video output to/from the Nasmyth focus position should be supplied in the basic configuration.

Analysis of the telescope configuration including optical data sheets and ZEMAX data file are a deliverable. Materials, coatings, spacing, diagrams, stability over temperature should be included. (A005)

3.2.2 System Optical Quality

The telescope shall provide lambda over ten (lambda/10) system performance in the field over the field-of-view (FOV) of the optics. This performance shall be ensured in part by the primary mirror such that wave front

quality shall be at least lambda/20 RMS (surface) over the entire clear aperture. At least 80 % of the light shall be encircled within 0.5 arcsecond by the primary mirror. The telescope is to provide diffraction limited performance over the full range of motion of the telescope. The telescope shall be designed for an interchangeable secondary such that one secondary supports a classical cassegrain system with a f/1.5 parabolic primary, secondary, and tertiary optics, and the other secondary shall support an optional Nasmyth imaging system which will include rotation of the tertiary mirror.

The telescope must support efficient transmit and collection functions from 0.5 micrometer thru 1.06 micrometer.

The field mounted optical system shall have a single pass transmitted wavefront error of less than 1/13 wave RMS at a wavelength of 632.8 nm over the full aperture and over the full range of motion. Verification of this system wavefront shall be done by testing of the assembled system in both horizontal and vertical orientations. Testing at azimuthal angles in the horizontal position may be required to demonstrate minimal polarization effects. The offeror shall indicate in his proposal his position on this matter.

The optical quality of the fielded system shall be such that the final on-axis image shall have 80% of the theoretical, diffraction limited, energy in a 0.50 arcsec diameter circle. Both raw interferometric data and reduced data are to be documented. The maximum peak-to-valley (p-v) mirror wavefront deviation shall not exceed 1 wave p-v at 0.633 micrometer wavelength within the specified effective clear aperture.

A verifiable error budget shall be created to show that the system wavefront is maintained during operational conditions.

The small scale optical surface roughness shall result in a loss of light in the image due to wide angle scatter from the complete optical system not to exceed 0.5% at a wavelength of 632.8 nm. The Contractor shall verify that the scatter requirements are met by using either Bidirectional Reflection Distribution Function or Total Integrated Scatter measurement techniques. (A004, A005)

3.2.3 System Obscuration

Aside from the support vanes, the secondary mirror mount shall cause no more obscuration that the secondary mirror itself. The maximum vane width shall be no more that 0.2 inches. The linear obscuration of M3 and its mount shall be no more that 110 % of the clear aperture of M3.

An analysis of the system obscuration is a deliverable. (A005)

3.2.4 Primary and Secondary Mirror Optical Quality

The final polished quality of the f/1.5 primary mirror shall be less than or equal to 0.10 wave RMS wavefront at 632.8 nm with the maximum diameter of the 80% of the theoretical, encircled energy in 0.4 diameter arcsec circle. For spatial frequencies larger than 0.10 aperture, the RMS band limited wavefront error shall be less than 0.02 waves RMS. The primary and secondary mirrors shall have a surface quality of 80/50 or better over 99.9% of the clear aperture (MIL-O-13830).

Both the primary and secondary mirrors shall have an uncoated surface roughness of 15Å RMS or better.

Calculations of mirror deflection and wavefront error resulting from operation in other mirror/cell orientations shall also be accomplished and shall meet the system and primary mirror specifications given in this paragraph.

These test and inspection reports are deliverables. (A004)

3.2.5 Substrates

The Government will furnish a mirror blank to be fabricated into the primary mirror for this telescope. This blank shall be a cylinder blank of standard grade Zerodur suitable for making a 1 meter mirror. The dimensions will be 41.5 inches in diameter and 6.81 inches thick. The finished thickness will then be about 6.69 inches at the edge and sag 1.8 inches relative to the edge in the center. The larger than 1 meter diameter of the finished mirror will leave room for a chamfer around the edge to prevent a very sharp edge and still have a 1 meter clear aperture.

Mirrors M2 thru M7 shall be fabricated from the same low coefficient thermal expansion material (ULE or Zerodur).

3.2.6 Coatings

the Offeror shall recommend coatings in his proposal. The coatings desired shall have the maximum optical thru put at all valid loss LOSs with minimum polarization angle dependent effects. As a base line for the present all mirrors are coated and specified to operate over a wavelength range from 0.5 to 3.0 microns. Durability of the coating samples shall be tested using as a guide the minimum requirements found in MIL-C-48497A or MIL-M 13508B.

The primary mirror shall be vacuum coated with Enhanced Al or equivalent or superior coating. The primary mirror coating shall be optimized for an angle of incidence around 5 degrees (from zero to 10 degrees). A minimum of 10 witness samples on slides shall be coated at the same time the primary mirror is coated.

The M2 mirror coating shall be optimized for an angle of incidence around 5 degrees (from zero to 10 degrees). M3 thru M7 shall be coated for an angle of incidence of 45 degrees.

Laser damage threshold of the mirrors shall be verified experimentally by the Government. The laser characteristics are: 1) at 532 nm: 300 mJ energy for a 200 ps length Gaussian over full aperture pulse. 2) at 1.06 nm: 600 mJ energy for a 200 ps length Gaussian over full aperture pulse. A report on expected damage threshold is a deliverable. A set of 20 extra tiles for NRL testing is a deliverable: 10 for the M2 of the same material as the M2 and coated at the same time as M2, and 10 for the coudé mirrors make of the same material as the coudé mirrors and coated at the same time as the coudé mirrors.

The coatings selected for the mirrors shall be reviewed at PDR and finalized at CDR.

At the present time, the exact specifications of the coating for mirrors M2 thru M7 have not been determined. These coatings will be determined at CDR depending on coatings available, whether an extra set of coudé mirrors are purchased and other considerations. However, an Enhanced Al or equivalent is

likely, and the vendor may propose a comparable or superior coating. Mirrors M2 thru M7 shall have an average reflectivity of 98% or greater at all wavelengths between 0.5 and 15 microns. The reflectivity shall be measured on a minimum of 3, 1.5 inch diameter samples coated in the same coating run.

A test report on the mirror coatings (including expected damage threshold) is a deliverable. (A004)

3.2.7 Coudé Path

The Contractor shall deliver mirrors which when mounted in the same gravitational orientation as in the telescope looking at zenith shall meet the overall error budget specifications outlined in section 3.2.2 and the specifications given below. A test report and analysis on the telescope's coudé path including configuration and optical performance are deliverables. (A004, A005)

3.2.7.1 Coudé Configuration

The Coudé path consists of mirrors M4, M5, M6. and M7. The Coudé path shall be reflected horizontally by M7 thru an exit port on the side of the base mount. The size of the Coudé path will depend on the beam footprint on the secondary mirror, and the required field of view for the unvignetted clear aperture of the telescope. In the case of a collimated optical system M4 thru M7 should have adequate size to accommodate the 45 degree incidence of a 15 cm diameter beam.

The mirrors shall be mounted on stable, high quality adjustable mounts which can be locked into position after adjustment. The mounts shall provide all adjustments needed to align the coudé path so that the optical axis of the telescope can be brought smoothly and incrementally into coincidence with the gimbal axes in a way which also meets the vignetting and field of view requirements of this specification and reduces the combined coning error of the elevation and azimuth axes to less than 20 microradian RMS. The housings shall provide for alignment and easy and replacement of the mirrors with removable sealing covers at each mirror. A test inspection report and analysis of the telescope's coudé configuration are deliverables (A004, A005).

3.2.7.2 Coudé Mirror Finish

All optical surfaces shall be polished with surface quality of 40-20. The coudé mirrors M3 thru M7 shall have uncoated surface roughness of 10 Å RMS or less. The RMS wavefront of the coudé optics shall be sufficiently low to meet the overall wavefront budget for the system given in Section 3.2.2. Analysis of coudé mirror substrates and finish is a deliverable. (A005)

3.3 GIMBAL AND POINTING AND JITTER SPECIFICATIONS

The Contractor shall design, fabricate, assemble, test, and deliver a gimbal structure to the minimal acceptable specifications given in this document.

3.3.0.1 Mechanical Description

The gimbal system shall be an elevation over azimuth arrangement. The gimbal system's function is to support and position the telescope structure in response to commands of the gimbal system electronics. Motors shall drive the gimbal axes. Shaft angle encoders shall report shaft angles with sufficient accuracy and read-out bandwidth to the following minimal acceptable specifications.

The yoke tines shall contain the elevation drive and encoders. The center of mass of the balanced inner gimbal must lie on the primary-secondary optical axis and the elevation axis. Ideally the mechanical elevation axis and the M3 - M4 optical axis shall coincide and is called the elevation axis. The M1 - M2 - M3 optical axis shall intersect the elevation axis. Ideally the mechanical azimuthal and M6 - M7 optical axis shall coincide and be called the azimuthal axis. The M1 - M2 - M3 optical axis shall be coplanar with the M6 - M7 optical axis for all LOS positions. The skew distance between two axes is the distance between these two axis at the closest point. The azimuthal/elevation axis skew distance shall be less than 0.25 millimeter.

The mechanical mount shall have a yoke which supports the telescope structure, and a base which shall provide for azimuthal rotation. The drive system shall be a direct-drive system. The trunnion box shall have sufficient torsional stiffness to transmit the torque loads of the elevation drive system to the telescope structure, and shall have sufficient bending stiffness to maintain the alignment of the elevation axis. The trunnion shaft may be constrained in both yoke tines to prevent motion along its axis.

Each end of the trunnion shaft shall have a minimum inner diameter suitable for the coudé or Nasmyth path described in a following section. The mechanical mount shall be as stiff as necessary to meet the Optical LOS jitter and repeatability specification.

A test report and analysis of the telescope's mechanical performance are deliverables. (A004, A005)

3.3.1 Wobble and Orthogonality

The Axis Wobble and Orthogonal Error shall be modelable to 4.85 microradian such that the performance specification in Section 3.1.6 is achievable and this model shall be included in the mount model provided with the telescope by the contractor.

Wobble and orthogonality are specified in Table 3.3.1.

Table 3.3.1 Axes Coverage, Wobble, and Orthogonality

Azimuth Angular Coverage	±335 deg. (+335 in one direction and -335 in the opposite direction)
Elevation Angular Coverage	-5 to +185 deg: measured from the horizon (Note: Performance specification applies only to +5 to +175 degrees. Outside this range the given performance specifications are goals).
Azimuth Axis Wobble	75 microradian, peak
Elevation Axis Wobble	50 microradian, peak

Orthogonal Error	less than 50 microradian
Az/El axis skew distance	less than 0.25 mm for all LOS positions

3.3.2 Angular Velocity and Acceleration Profiles

The gimbal system shall be capable of controlling the telescope along the trajectory of a satellite in a 200 km circular orbit when the trajectory passes 5 degrees of zenith. The command to track shall begin at the instant the satellite can be theoretically seen thru the telescope.

The velocity and acceleration requirements are defined in Table 3.3.2. The Contractor shall be required to show that the system can achieve performance requirements during acceptance testing in his facility with Contractor defined tests.

A test plan, test report and analysis of the telescope's angular velocity and acceleration are deliverables. (A003, A004, A005)

Table 3.3.2: Minimal Acceptable Angular Velocity and Acceleration

	Azimuth Axis	**Elevation Axis**
Maximum Velocity (deg/s)	20.0	10.0
Maximum Acceleration (deg/s/s)	10.0	5.0

3.3.3 Encoding and sensing requirements

The minimum acceptable bit value of the shaft angle angular position sensors shall be at least 24 bits (no noise on the 24th bit) over 360 degrees for the azimuth axis, with unambiguous designation across the full azimuth axis coverage. The elevation axis shall have 24 bits of resolution over 360 degrees, bits (no noise on the 24th bit). Encoding and sensing requirements and the requirement for rate command accuracy are given in Table 3.3.3. The performance specifications in this table shall be met after all sources of angular position sensor/sensor error have been included. A test/inspection report and a technical report on encoding performance regarding meeting those specifications are deliverables. (A004, A005)

Table 3.3.3 Encoding and Sensing Requirements

All encoding and sensing requirements should be satisfied simultaneously.

Position Encoding (Calibrated)		
	Az & El Resolution	0.3745 microradian/bit
	Absolute Accuracy	±2 microradian, peak

	Repeatability	±1/2 bit, peak
	Azimuth Range	unambiguous full gimbal range +/- 335 deg
	Elevation Range	-4.99998 degrees to +184.99998 degrees
	Focus Position Resolution	lambda/4 or better and as required to meet the overall optical specifications
Rate Command Accuracy (Calibrated)	Azimuth Velocity	±2 microrad/s (at 20 deg/s), peak
	Elevation Velocity	±2 microrad/s (at 10 deg/s/s), peak
	Azimuth Acceleration	±3 microrad/s/s (at 10 deg/s/s), peak
	Elevation Acceleration	±1.5 microrad/s/s (at 5 deg/s/s), peak

3.3.4 Angular Position Sensor Jitter

The gimbal system shall be designed to minimize the angular position sensor jitter. The peak error in following the commanded angular position shall never deviate more than 5 microradian for any point along the satellite's trajectory. The RMS position error for an entire trajectory shall not be greater than 1 microradian for the integrated bandwidth 0.1 Hz to 500 Hz. Furthermore, the gimbal system shall be capable of directing the LOS along the path of a star that passes within 1 degree of zenith with a LOS error that never exceeds 5 microradian, peak tracking at sidereal rate, at any point along the path. The analysis, test report, and test plan from the angular position sensor jitter work are all deliverables. (A003, A004, A005)

3.3.5 Optical LOS Jitter

The gimbal system shall be designed to minimize the optical LOS jitter due to drive commands, imperfections in the bearings that support the azimuth and elevation axes, and any structural resonances in the mounts that support the coudé optics, primary, secondary and tertiary. Telescope bearing and optical mounts' choices will be determined by the vendor based upon the requirements of this specification. The bearing systems for each of the gimbal axes shall be designed and fabricated to minimize optical LOS jitter and vibration into the structure. The entire telescope system under closed loop control shall not exceed the LOS jitter outlined in Table 3.3.5 for operational conditions.

Any other specifications in this telescope gimbal specification document that require tighter specifications than those listed in Table 3.3.4 shall take precedence. The analysis, test report, and test plans from the optical LOS jitter work are all deliverables. (A003, A004, A005)

Table 3.3.5 gives values are the minimal acceptable thresholds allowable RMS jitter values for LOS jitter for the frequency bands listed.

Table 3.3.5 Minimal acceptable RMS Angular LOS Jitter

LOS velocity in deg/sec	0.1-10 Hz	10-20 Hz	20-100 Hz	100-1000 Hz
0.0 (stationary) for any valid position	0.75 microrad	200 nrad	100 nrad	50 nrad
0.001 (approx. sidereal rate)	2.0 microrad	200 nrad	100 nrad	50 nrad
1.0 (typical satellite)	10.0 microrad	400 nrad	200 nrad	100 nrad

3.3.6 Optical Line-of-sight Step Response

The gimbal system shall be designed to perform a 400 microradian step with only 18% overshoot and with a settling time of 0.2 seconds to an error less than 1% of input. The intent of this test is to ensure that the telescope LOS does not contain significant resonances and that the bandwidth is high enough to accomplish the tracking.

The LOS jitter and accuracy shall be measured during step commands of 17 and 400 microradian with telescope LOS changing at a sidereal rate (both gimbals moving). Additionally LOS jitter and accuracy shall be measured during step commands of 2 milliradian with telescope LOS changing at an azimuth rate of approximately 0.25 degree per second (both gimbals moving) with steps in both axis separately and simultaneously. The logged position shall be recorded and over shoot of the step response shall be included in the analysis.

The test plans, test report, and analysis of the optical LOS step response are deliverables. (A003, A004, A005)

3.3.6.1 Time Optimal Moves

The gimbal system shall be designed to perform a time optimal move for large moves. A large move shall be considered any move when the commanded position is at least 5 degrees away from the current position.

3.3.7 Balance and Ancillary Load Capability

The elevation assembly shall be balanced about its axis to minimize the torque required to hold the telescope in a stationary elevation position. The system shall have the capability to counterbalance the sensor weight loads as shown in Table 3.3.7, which might be added or removed at the locations shown. The counterweights in increments necessary to achieve balance up to maximum weight shall be supplied by the Contractor. The final weight, balance, and mounting locations shall be identified in an ICD six months after contract award and subsequently redefined as necessary. The additional counterweights shall not degrade the telescope system performance. The maximum weight the

telescope must support is 120 lbs, excluding counterweights, but no more than 30 lbs shall be mounted near the head ring, at the top of the telescope. Analysis and interface control documents on the balance and ancillary load capability are deliverables. (A005, A009)

Table 3.3.7 Weight Load of Course Acquisition Camera and Telescope

Component	Weight	LxWxH (in)	Location
Coarse Acquisition Camera and Telescope	30 lbs	14x8x8	Head Ring
Coarse Acquisition Camera and Telescope, alternate location	60 lbs	14x8x8	Trunnion

3.3.8 Cables

The Contractor shall provide cables, fluid lines, and air lines which are for use by the Government. These cables shall be routed from the base thru the rotational axes to the telescope and terminate at the telescope trunnion box or telescope gimbal yoke as appropriate. Final determination of the cables will be made at CDR. The tables give the likely cables to be routed to each location. A connector panel with bulkhead connectors shall be provided on the yoke within 1 meter of the Nasmyth focus. A connector panel with bulkhead connectors shall be provided on the trunnion box near the mounting locations for the guide telescope, and convenient to run line to the headring.

The Contractor shall prepare interface control drawings for the cables which show cable characteristics, connector types, pin assignment, and fluid line sizes and pressures. These interface control drawings shall be subject to Government at CDR. As appropriate, the mate to each connector, at both ends of the cable, shall also be provided. An ICD on the cabling & routing on the telescope is a deliverable. (A009)

Table 3.3.8.1 Cables to be Routed to Yoke

CABLE TYPE	NUMBER	CONNECTOR
110 volt AC Power	4 lines, 30 Amp total, switchable at TUI	
Shielded twisted pair	8 lines	In one connector
coaxial cables	5 type TBD at CDR	BNC
Fluid lines	1 supply 1 return 1 gpm @ 15 psi delta Pressure between ports measured at the base	
Air Line		

RS-232c	2	

Table 3.3.8.2 Cables to be Routed to Trunnion Box.

CABLE TYPE	NUMBER	CONNECTOR
110 volt AC Power	4 lines, 30 Amp total, switchable at TUI	
Shielded twisted pair	8 lines	In one connector
Coaxial cables	5 type TBD at CDR	BNC
RS-232C	2	defined in ICD
Fiber optics cable	2 TBD at CDR	

3.3.8.1 On-Gimbal AC Power

In addition to the cables routed thru the gimbals described above, the Contractor shall provide 6 115 V grounded AC outlets each with a total of 30 amp power. These will be placed on the telescope structure for operation of the on-gimbal sensors and equipment. The outlets shall be conveniently located for easy use and not cause any mechanical interference with gimbal motion when in use.

3.3.9 Beam Path Conditioning

Provision shall be made to enclose the coudé path and to flow conditioned air thru the coudé path to adjust and maintain the temperature differences to within 1 degree Celsius of the ambient temperature. Temperature sensors shall be placed on the telescope and in the coudé path to monitor temperature gradients to 0.1 degree C. The number of sensors required, their response and sampling time, their locations, the type and location of a sensor interface box to be placed on gimbal will be defined in an ICD. A test report on the beam path conditioning is also a deliverable. (A004, A009)

3.3.10 Mechanical Safety

This section refers to the safety of the structure. Reference section 7.7 as well as 3.3.10 for system safety specifications.

3.3.10.1 Stops

The gimbal system shall have physical stops to restrict motion of the gimbal. The stops shall be located approximately 5 degrees past the active range, for each axis, as specified in Table 3.3.1. Additionally, the Contractor shall provide an electrical stop for use at the option of the user at the 105 degrees location on the elevation axis. An interlock shall alert the user by means of an indication on the control console, and on a status buffer accessible to the REI and SMI to the state of this electrical stop. Application of the stops shall not over stress any element of the telescope and gimbal system and shall deactivate servo drives. A test analysis of the gimbal system's stopping performance is a deliverable. (A005)

3.3.10.2 Brakes

The gimbal system shall contain an active braking system that slows and stops both gimbal axes in emergency situations. It is not adequate just to remove power from the gimbal drives and let the gimbal coast. Furthermore this braking system shall be designed so that the brakes are activated (applied) when power is removed (except that it shall be possible to disable this feature for testing purposes only). Furthermore, a shorting plug shall be provided that permits external user installed safety interlock switches to be daisy chained throughout the facility. If the safety interlock circuit is opened at any point, the gimbal drives are automatically disabled and the brakes applied. The brakes, when applied, shall deactivate the servo drive and shall stop the axis motion in less than 10 degrees of rotation without destructively over stressing any portion of the system.

At a minimum a safety interlock switch shall be installed on each yoke tine, at four positions on the pedestal base and at the electronic console and any other locations deemed appropriate (to be determined at CDR). A relay closure from the output of the Emergency Stop circuit shall be provided for shutting down such functions as the dome, the search radar, and laser.

A test report on the gimbal system braking is a deliverable. (A004)

3.3.10.3 Protection

The control system shall contain appropriate sensors and automatic controls to prevent the telescope and gimbal system from being damaged by erroneous or invalid commands. That is, the protection system shall override manual and automatic controls in time to slow the gimbal system down adequately before it hits a stop hard enough to cause damage or misalignment of the optics. The protection system shall include limit switches to properly report the status of the gimbals. The system shall also protect the gimbal from an overspeed condition. For the safety of personnel and to limit potential damage to the mount, the torque available to drive the mounts two axes shall be limited in a user adjustable manner. Analysis of the telescope protection system is a deliverable. (A005)

3.3.10.4 Safety Interlock

There shall be placed on or near the vicinity of the telescope base a safety shutoff that can be operated and locked to ensure that the telescope cannot be operated during the maintenance of the telescope.

3.3.10.5 Laser Control

A means to install and remotely control a laser cavity interrupt at the Telescope User Interface (TUI) and The ECS thru the Real-Time TCS shall be provided. Documentation shall be a deliverable.

3.3.11 Activity Periods

At a minimum the telescope is required to meet the activity periods shown in Table 3.3.11.

Table 3.3.11 Minimal Acceptable Velocity Operational Activity Periods

% Max Velocity	Operational Activity
At 100% Max Velocity, both axes	three 15 s periods in 2 hr operation
At 90% Max Velocity, both axes	six 15 s periods/hr in 2 hr operation
At 50% Max Velocity, both axes	ten 30 s periods/hr in 2 hr operation
At 25% Max Velocity, both axes	ten 60 s periods/hr in 2 hr operation
At 10% Max Velocity, (for sidereal tracking operations and for all other less stressing tracking scenarios)	Remaining time in 2 hr operation

Note: All operational activity rates must be capable of continuous/sequential operations.

3.3.12 Satellite Laser Ranging (SLR) Mission Profile

For purposes of life cycle and maintenance analysis the following mission profile is assumed.

1. Cold Start: boot up, verify subsystem operations, and have telescope pointed at a star -- within five minutes.

At this point it should be known if there are any subsystem failures.

2. Perform small star field data collection for at less four (4) stars to verify accuracy -- no more than five minutes.

3. Turn on alignment HeNe and begin SLR/HeNe coalignment procedure -- no more than 20 minutes

This requires the telescope to point to various azimuths and elevations and remain accurately pointed at given LOS.

4. SLR calibration: Slew to approximately zero degree elevation pointed at terrestrial target -- approximately five minutes.

5. Operational Satellite Tracking: Ranging on mixture of SLR satellite targets at low and higher earth orbits for duration's from 15 minutes thru 24 hours per day. This operation may run on the average up to fourteen eight hours shifts per week for 52 weeks per year. The number of passes where the LOS change is greater than 1 degree per second shall be less than 6 on average in an eight hour shift.

6 Power Down sequence:

Calibration on terrestrial targets
Stew of mount to stow position
Application of brakes
Close primary mirror cover
Log duration of usage
Turn off.

The Contractor shall provide an availability analysis for this mission as a deliverable. (A005)

3.4 TELESCOPE ELECTRONICS

The Contractor shall design, fabricate, procure, assemble, test, and deliver, the Telescope Electronic System

A schematic of the telescope system is shown in Figure 3.0.3. The telescope electronics includes the telescope mount electronics (all electronics on in or around the telescope the cabling connected to the mount), the Real Time TCS and external control systems: the TUI or the ECS.

3.4.0.1 Real Time Telescope Control System (TCS)

The Real Time TCS shall be housed in a single electronics rack capable of being located a minimum of 100 ft from the telescope base. This rack shall contain a VME chassis housing the real time TCS Computer and power and other electronics. This rack shall be operated in a environmentally controlled environment. The Real-Time TCS Computer shall control the power and other electronics and connect externally to the operation and experiment console area via two fiber optic interconnections: an Ethernet interconnection and a Shared Memory Interconnection (SMI) each of at least 100 feet in length.

The source and executable code, User's Manual, and Software Programmer's Manuals for the Real Time TCS are all deliverables. (B001, B002, B003)

3.4.0.2 Time Reference

The Real Time TCS Computer shall contain the interface to the time reference IRIG-A or IRIG-B signals and this shall be delineated in the REAL TIME TCS Interface ICD. Any additional timing signals needed to meet the requirements shall be determined at CDR.

3.4.0.3 Minimization of Optical LOS Jitter

The REAL TIME TCS has a primary goal of minimization of optical line-of-sight jitter of the telescope due to drive commands, imperfections in the bearings that support the azimuth and elevation axes, jitter in the encoders, and any structural resonances in the mounts that support the coudé optics, or primary, secondary, and tertiary mirrors. The primary goal shall be performed while attempting to keep the LOS at the commanded position determined thru an external interface (or MCU). This process has access to all timing signals and it is envisioned that it operate as dynamic filter to provide smooth LOS performance. This software process shall have available all state and condition information of the subsystems, and this software will imposed safety limits and

correct for known systematic behavior of the resolvers and encoders which is inherent in these devices.

3.4.0.4 Provision for Later Addition of a Video Tracker

The Contractor shall make provision for the possible later addition of a video tracker to the telescope system. In particular space should be available in the VME chassis for the later addition of a card for a video tracker. Provision should also be make for the possible integration of this video tracker into the Real Time TCS.

3.4.1 The Real Time TCS Computer

The Real-Time TCS shall operate on a card in a VME chassis. This master real-time computer process of the TCS shall read the angular position sensor signals from each axis, process the acquired data, process commands from the external interface or MCU, and send control signals to the power amplifiers that drive the gimbal motors. In addition this process shall perform a first line of safety in software, monitor key parameters for status, and update the status and state buffers for the REI and SMI. The status buffer shall keep track of safety switches and other signals needed to evaluate the condition of all systems. The complete definition of the status variables and data variables shall be decided jointly within the Real Time TCS Interface ICD. These variables include those in the SMI memory allocations described elsewhere in this document.

The VME interface ICD is a deliverable (A009).

3.4.1.1 Self-Booting on Power Up

The Real-Time Telescope Control System (TCS) computer shall be self-booting on power up and operational via the MCU. (Operations may be performed via the MCU without requiring the TUI or the ECS.)

3.4.1.2 External Interface between the Real Time TCS and the Telescope User Interface

All communications between the VME chassis of the Real Time TCS and the monitoring/controlling computers shall be performed thru either of the two external interface within the VME chassis to the TUI or ECS. These external interfaces shall control the pointing and other functions of the telescope.

The non-hard real-time commands will be over the remote procedure-call Ethernet interface (REI) on dedicated Ethernet ports. This is a bi-directional ASCII command sequence of data between the TCS and one of the controlling computers (TUI or the ECS). The Contractor shall provide the necessary cables and hubs/router between the Real time TCS and the TUI with spare ports for the ECS. The length of these cables shall be at least 100 feet. The details of the port and hub arrangements shall be specified at CDR.

The hard real-time commands will be over a shared memory interface (shared memory). This is a pair of cards connected to each other over a fiber optical interconnection. The TCS shall examine the commanding area of the SMI on every frame cycle, and update the controlling filter upon receipt of new commanded position and/or rates. All boards and optical interconnection fibers

shall be provided. Common practice for environmental protection of these fibers and cables should be used. The use of COTS cables, interconnectors, and shared memory cards is required.

3.4.1.3 Functional Level Gimbal Dynamics Analysis

The Real Time TCS Computer shall include a real-time testing feature for analyzing and updating the telescope control models. This control testing system shall be integrated into the Real Time TCS Computer. This feature shall provide the ability to test the telescope control response by inputting test signals into the inner loops of the gimballed axes. This test shall be implemented in digital form. The testing shall provide the ability to measure the actual response of subsystems, identify the control parameters, and to provide a periodic health check. The testing shall provide the ability to convert the data into a mathematical model of the corresponding subsystem and to save this model for future comparison with other tests.

The models generated by the testing shall be easily incorporated into the Telescope Simulator by the user. The testing system shall support at least the generation of Bode plots and parameter identification. The Real Time TCS Computer shall input the test signals and record in real time the subsystems data. This data shall then be made available to the TUI or ECS for processing. It is not the intent of this requirement that the Real Time TCS Computer perform any data reduction, or that it generate the test signal. It is acceptable that the test signal be generated by the TUI, ECS, or be stored on disk and down loaded to the Real Time TCS Computer. The data measured by the Real Time TCS Computer shall be saved into memory, and shall be available to the TUI or ECS via the REI.

The Contractor shall provide the ability to process the real-time test data on the TUI. This control testing system shall be integrated into the TUI. Several good commercial software packages exist which support control systems analysis (e.g. Matlab/Simulink). Any commercial package supplied by the Contractor must be purchased from the vendor. Any lease arrangement that the Government would be required to maintain after delivery in order to continue operation of the system is not acceptable. The source and executable code, User's Manual, and Software Programmer's Manuals for the Functional Level Gimbal Dynamics Analysis are all deliverables. (B001, B002, B003)

3.4.1.4 Status Information

The status upon power up, including health and checkout functions as well as response to sudden shocks or force or load changes shall be detected. This status shall be available over the both external interfaces. The TUI shall have the ability to perform advanced diagnostics of subsystems.

3.4.1.5 Logged History of State Information

A logged history of state information shall be maintained using a circular buffer of size to support at least 30 seconds of commands at the frame rate of 1,000 Hz. This should include the commands from the external interface (shared memory or Ethernet) and the state parameters of the filter and gimbal encoder

values and time stamps. The exact logged parameters shall be selectable thru the REI Ethernet interface and will be specified in the REI interface ICD.

Real-time access to the full history set from other process is not required, but should be obtainable via the external interface with the gimbals stopped. There shall be provisions for other slower logging rates as will be determined at CDR, and commanded and received thru the (non-deterministic and slower) Ethernet REI

3.4.1.6 Frame Rate

The TCS software process responsible for gathering all requested commands, processing the current state and generation of the desired future gimbal position, velocity and acceleration profiles will operate in the TCS at a frame rate of a minimum of 1,000 Hz. This interface process shall look at the SMI and the REI (remote procedure call Ethernet Interface connected to a dedicated Ethernet port) on every frame cycle. This process shall respond to commands from both the SMI and Ethernet REI interfaces during normal operations. An ASCII command language will be used to provide and obtain and command state information from this process over the REI. There shall be a memory map and protocol developed for the SMI. The SMI shall be utilized for all time critical commanding and logging applications.

3.4.1.7 Time Response to Commands

The TCS shall respond to commands over these interfaces with a total latency of less than 4 milliseconds. The response to a command is defined to be the necessary change in motor torque of the affected gimbal. Processing of commands from the TUI or ECS shall be initiated by the lowest level controlling subsystem not more than 1 inter loop cycle time after a valid command has been received at the Real Time TCS Computer (1 millisecond for a 1 kHz inner loop cycle time) or no more than 2 cycles of processing of the inner loop of the Real Time TCS Computer, if the inner loop digital controller of the Real Time TCS cycles faster 1,000 Hz. (A004)

3.4.2 Telescope Electronics General Considerations

3.4.2.1 Mount Electronics

The mount electronics shall include as a minimum the gimbal motors, and encoders, resolvers, focus motors and encoders, primary mirror covers, breaks, interlocks, mushroom buttons, cables , and various temperature sensors. These should all be connected to subsystem controlling boards in the Real Time TCS.

Electrical input power to the telescope mount (not counting the auxiliary instrument power that NRL may mount on the telescope) and systems shall be supplied thru the Rack containing the VME chassis. All electronics shall be powered from 120 or 240 V AC, 60 Hz, single phase and/or 120 to 208 V AC, 60 Hz, three phase, electrical service. At a minimum, there should be power available at M2, the headring periphery, both yoke tines, and the base of the

telescope. Exact locations and require service will be determined in an ICD. All gimbal electronic drawings are deliverables. (A010)

3.4.2.2 Commercial Off-the-Shelf (COTS)

The Contractor is strongly urged to use COTS hardware wherever possible. All chassis boards not COTS shall be fully documented with theory of operation, circuit schematics, component layout, test points, typical values, and maintenance and check out procedures. The diagnosis and repair procedures should be specified in the manuals including the necessary schematics. (A004, A010)

3.4.2.3 Cables

The use of similar cables is encouraged to support the determination of potential cable failure (when practical cable should be run in pairs so that swapping them can be used to determine a fault). The performance of the assembled gimbaled telescope is to be determined in acceptance testing solely with the contractors systems.

3.4.2.4 Heat Sources

All major sources of heat and noise (electronic and mechanical) shall be located away from the telescope. Sources of heat near the telescope must be minimized to ensure maximum optical performance.

If the Contractor determines that electrical noise considerations outweigh heat considerations, then exceptions to the remote mounting of heat generating, electronics should be made. Under this exception, the Contractor is strongly urged to use on-gimbal digitization of the axes' position sensors. However, every consideration to reducing the heating effects of telescope electronics should be made (e.g. remote power supplies, low-power electronics, heat shielding, etc.).

3.4.2.5 Rack Cooling, Filtered Air and Ruggedness

The Rack housing the Real Time TCS shall be designed to provide sufficient cooling with filtered air for the power dissipated. Each chassis shall be rugged and capable of withstanding the harsh, dusty environments of field operations. Standard practices in meeting these requirements are acceptable.

3.4.2.6 Electronic Boards

All boards shall be capable of being recessed so that connecting cables (at least five (5) inches clearance may be required) do not interfere with front or rear panel covers. Additionally, the rack and stack should be performed with the connections available to facilitate the ability to disassemble, ship and re integrate this telescope system without the damage to cables and connectors.

3.4.3 Gimbals and Focus

3.4.3.1 Gimbal Angle Encoders and Resolvers

There shall be two subsystems which determine the angular position of the azimuth and elevation gimbals. The low precision LOS shall be determined thru resolvers, and the high precision and accuracy LOS thru encoders.

A buffered set azimuth and elevation resolver bits in Transistor-Transistor Logic (TTL) binary form shall be made available, along with the strobe signal that latched the resolver values for use with other slaved safety equipment such as a radar. Another of these buffered signals shall be provided so that the dome can be slaved to the telescope azimuth. The intent for these buffered signals is to provide a hardware derived position indication of the gimbal line of sight over the full range of travel on both axis. The accuracy of these angles shall be better then 0.040 degree in the least significant bit with no jitter. The latched values shall be included as status information and shall be available to the external interface of the TCS to monitor the agreement between these and the more accurate encoder determined LOS positions. If these disagree at a determined rate, a safety related condition shall be sent to the controlling (TUI or ECS). The sensors shall be deterministic in the event of rebooting or power cycling, including the moving of the gimbal during power outages.

The encoder sensors utilized shall result in an absolute and deterministic angular position of the gimbal LOS over the full range of motion. Any corrections necessary to remove the non linearity of the encoder hardware required to achieve the LOS sensing accuracy of 4.85 microrad RMS pointing and sidereal rate tracking jitter of less than 0.25 microrad shall be applied prior to utilization by the TCS control filter, the logged positions, or the SMI.

3.4.3.2 Report of Modeling of Encoder Output

A report describing the modeling of the output of the encoders as a function of angular rate is a deliverable and should include the modeling necessary to correct for known systematic behavior of the resolvers and encoders which is inherent in these devices. Procedures for replacement, alignment, and verification of encoders, of the same model and part number, should be included in the manuals.

3.4.3.3 Accuracy of Time Stamp of Encoder Output

The accuracy of the time stamp for the azimuth, elevation and focus encoders with respect to the supplied IRIG-B and the master clock 1 Hz, shall be better than 20 microseconds. An analysis of the relationship of the time tag accuracy for each encoder within an individual frame is a deliverable. (A005)

3.4.3.4 Azimuth and Elevation Gimbals Controls and Amplifiers and Feedback loops

The TCS interface between the controlling circuitry and the power amplifiers controlling the torque commands to the gimbal motors and other boards determining the angular position shall have a command frame rate controlling these devices of at least 1,000 Hz. The feedback from the encoder circuitry and any feedback from the amplifier circuits shall be included in the filter state information which shall be loggable.

3.4.3.5 Focus Motion Controls and Encoders

The TCS interface between the focus position controls and the encoder position of M2 shall be at the frame rate of the TCS. Any coupling of the system focus and elevation shall be modeled with coefficients and algorithms described in the manuals. The coefficients shall be stored files similar to the mount model. The application of the temperature focus correction may be disabled for various reasons including modeling of the focus motion as a function of temperature control.

3.4.4 Manual Control Unit (MCU)

The MCU, a hand-held unit for remote control of the azimuth, elevation axes and the secondary functions. The MCU shall connect to the TCS and allow an experimenter the ability to make adjustments to the telescope LOS and focus at various locations near the telescope.

3.4.4.1 Manual Control Unit (MCU) Functions

The manual control functions shall permit the user to independently move the azimuth and elevation axes, stop all movement of telescope adjustments, focus the telescope, open and close the primary mirror cover, set and goto the home settings, trigger shutdown and perform an emergency stop. This interface is not expectable to be used while there is a computer controlling the telescope over the external interface. The MCU shall have an interface response that allows the user to make the smallest step possible with a single input or a graduation of speeds up to half the maximum speed, for the axis or component being controlled, with a sustained input.

3.4.5 Safety Mushrooms, Axis breaks, Limit and Rate sensors for Gimbals

There shall be sufficient circuitry to protect the telescope and the environment of the operators. These include strategically placed “mushroom” buttons connected in series to stop all gimbal motion and remove the high voltage power. Additionally gimbal axis breaks shall be applied. These must slow and stop the gimbal with out violation of the maximum deceleration rate to be determined by the Contractor such that no realignment of the optics are required and no damage is done to the telescope in the event of an emergency stop.

The protocol for safety related reasons for feedback to higher level shall be determined at CDR. These safety violations should be logged to the local disk of the TCS for to support diagnosis. The movement of the gimbals following a preliminary and final limit violation will be permitted following a valid reset / status handshake thru the external interface. This may require manually moving the gimbal out of restricted travel regions.

The control functions shall be designed such that no command, defined or undefined, shall be allowed to cause damage to the telescope or cause the usable range of the telescope to be exceeded. It is not acceptable for the control functions to depend on the automatic braking system to achieve this objective.

3.4.6 Temperature and Air Circulation in Coudé Path Monitoring

The temperature of various areas of the gimbals and coudé path shall be monitored via the TCS. These will be required to determine temperature gradients of the telescope under various conditions but especially under day light conditions. The standard temperature sensors include: primary cell, secondary, ambient, and dome environments. The sensors values shall be made available over both the SMI and the Ethernet REI external interfaces. The specific type and number of sensors shall be determined at CDR, but should likely include 2 on each truss tube (assuming 4 truss tubes), 4 on the head ring, 4 on the trunnion box, and 4 on the primary mirror. An attempt may be made by the Government after the telescope is operational to devise a method to adjust focus based on knowledge of temperature at various points on the telescope.

There should also be provisions for coudé path conditioning and air flow rate sensing in addition to the standard sensors.

All these data shall be available thru the external interfaces.

3.4.7 External Time and Frequency Interpolation

A means to slave telescope control to a Government provided master clock or timing and frequency reference shall be provided by the Contractor. All reported position and temperature data shall be time stamped referenced to externally supplied timing signals. A Government provided master clock or timing and frequency reference shall be provided to the TCS rack at a timing interface. Timed tagged elevation and azimuth positions and temperature shall be available to the ECS and TUI over both the standard SMI and Ethernet REI digital interfaces. All position data shall be acquired nearly simultaneously within a frame and shall be time tagged in a deterministic manner within 20.0 microsecond (or more accurately) with respect to the supplied clock signals. The temperature data may be sampled at a lower rate of 10 times per second. There will be at a minimum IRIG-B time code and 1 Hz, and 1,000 Hz signals all synchronized from the same master clock system. Any additional signals required to meet the required accuracy shall be requested before CDR.

3.4.7.1 Timing Deliverables

Analysis of the timing relationship between the provided timing signals interface and the epoch of the reported values and time tags is a deliverable. The algorithm for determining all position values when not instantaneously determined should be included in this analysis.

3.4.8 Mirror Cover Controls

The Primary mirror covers shall be capable of being opened and closed remotely. This shall be performed via the MCU, the external interface or manually. The purpose of the covers is to prevent sun loading, and particulate matter from contacting the primary mirror.

3.4.9 Power Up Diagnostics

There shall be self checks of all the subsystems of the telescope during the power on sequence. The report of success/failure to requested commands thru the Ethernet REI interface shall be available.

The safety interlock sensors should report to the appropriate levels upon power up and respond to a reset command to verify connectivity and proper functionality. Power up, power down, and normal operations should not require the use of the (TUI) Contractor user interface.

The power switch and the subsystem status should be available over the Ethernet REI, as the ECS will be used for normal operations.

The source code, User's Manual, and Software Programmer's Manuals for the TCS Power Up Diagnostics are all deliverables. (B001 ,B002, B003)

3.5 EXTERNAL INTERFACE AND USER CONTROL SYSTEMS

Figure 3.0-2 is a block level description of the hierarchy of processes required for this Telescope and the expected experimental environment. The Telescope is but one of several instruments to be controlled by the ECS (Experiment Control System) developed by the Government. The nominal expected command stream for applications will communicate with the Real-Time TCS telescope controller chassis over both the non-real-time (Ethernet REI) and real-time SMI. This facilitates maximum flexibility in controlling the telescope.

Stand alone operations and health checkout of the telescope shall be performed on a Contractor provided TUI machine (an IBM or clone personal computer (PC)) running the TUI software. This software shall control the telescope over the Ethernet REI or SMI interfaces. Only one of the TUI or ECS will be permitted to operate at any time.

The TCS shall begin responding to these commands, once they have been verified valid, so that the total latency of LOS response is less than 4 frames. The Contractor shall deliver a PC to run the TUI, the real-time TCS running in a VME chassis, and the cards and connection fiber optic cable for the SMI.

The source and executable code, User's Manual, and Software Programmer's Manuals for the TUI computer software are all deliverables. (B001 ,B002, B003)

3.5.1 Remote Procedure Call Ethernet Interface (REI)

The external interface shall respond to a standard dedicated Ethernet interface of at least 100 megabits per second (Mbps) transfer rate. The command sequence should be a bidirection sequence of ASCII state commands and status. The TCS should respond to this interface in an identical manner as that of the SMI The REI may be used for non-real time commands, including the initial health and status. Any nonstandard filter state information being logged shall be transferred over this interface.

3.5.2 Shared Memory Interface (SMI)

The external interface utilized for real-time data exchange between the ECS and the TCS process shall be a shared memory, also referred to as a SMI. A dedicated card in each chassis shall be connected with a fiber optic link. The VME interface ICD describing the dedicated memory regions shall be jointly

decided at CDR. The same ASCII state commands and status information to the TCS real-time filter shall be passed thru this interface as that of the Ethernet interface. Additionally the standard filter state information, which is being logged to circular buffers, should be made available on a frame by frame basis.

The Contractor shall be directed to check the shared memory during each cycle of calculation which shall be at least at a 1 kHz rate. The contractor's design shall update a designated status buffer each cycle of calculation. It should be clear from this description that the Contractor must be aware of the SMI memory map of the ECS. Also, the details of the communication protocol will be defined jointly in the VME interface ICD. The Contractor shall supply the fiber optic shared memory connector and boards and the fiber optic Ethernet connectors and boards to the ECS.

3.5.3 Telescope User Interface (TUI) Software and Computer

The Contractor shall design, fabricate, assemble, test , and deliver a TUI. This shall be hosted on a IBM PC/Clone type computer and self-boot on power up. The TUI shall be able to control all functions of the Telescope/Gimbals and display all status. The TUI shall use the Ethernet REI interface to perform every delivery tests of the telescope. Additional diagnostics, power on/off status and mount models will be performed on this computer thru this interface. All source code and the executables shall be delivered. Additionally, any mount model coefficients developed should be exportable and usable by other applications which use this telescope. It is expected, for example, that different mount models may be used for the Nasmyth and the coudé focus. They should be switchable. The TUI shall comply with the Real Time TCS Computer Interface ICD jointly generated by the Contractor and NRL for the communications protocol and state and status buffers resident on the Real Time TCS Computer.

3.5.3.1 TUI Graphical User interface

The TUI shall have the ability to graphically display the status of the TCS and subsystems, point the LOS to both Az/El and RA/DEC positions, and perform emergency stops. The user shall be able to command tracking at sidereal rates stars, moon and planets, comets, etc. The user shall be able to track earth orbiting satellites from two line elements or state variables. This program shall obtain barometric pressure from the user and timing from the TCS as needed.

The data base in the TUI shall contain:

1. Stars atlas (FK5)
2. Planets ephemerides
3. Comet ephemerides
4. Satellite orbital parameters

The TUI shall include the following capabilities (but are not limited to):

1. Az/El pointing capability
2. RA & DEC pointing capability
3. Health and Status Indications
4. Mount Status Indications

5. Track offset Capabilities
6. Telescope Controls including
   - Focus control: temperature and gravity sag compensation
   - Automatic focus control
   - Dome Controls
7. LOS error estimation and modeling.

3.5.4 Acceptance Tests

The Ethernet REI interface and the TUI shall be used for the acceptance test at field delivery. The Global LOS pointing tests to stars shall meet the accuracy (approximately 2 arcsec RMS in factory environment). If the Contractor desires to meet this requirement via a mount model (including coefficients for encoder zero point, axis non orthogonality, miss alignment of vertical, optical/mechanical alignment, wobble in each axis, and mechanical drop), there must be a software module(s) which estimates and uses these coefficients delivered for used by other software commands to the TCS. This external utilization source and executable software is a deliverable. The coefficients necessary for modeling the gimbal and focus encoders non linearity shall be changeable should the physical encoders change. The source software for this, if considered proprietary need not be delivered, but procedures for developing parameters and making the changes in the parameters for the executable shall be included in the maintenance manuals.

3.5.5 Low Level Board Diagnostics

The TUI should be usable to perform diagnostics at the board level, with function level diagnostics procedures for board isolation for fault isolation. This processes shall be provided over the Ethernet REI external interface. This should exercise the lower level functions and provided diagnostics to support possible hardware and software problems. Use of these process shall be limited to stand alone operations and may be used to demonstrate the CDRL deliverables. The user interface of these shall be a user friendly Graphical User Interface (GUI) that runs of the TUI PC.

If subsystem cards in the VME chassis have diagnostic procedure that can be performed stand alone then a serial interface to the software and executable shall be provided to run on the TUI PC. Any special cable and manuals and procedures shall be provided.

The source and executable code, User's Manual, and Software Programmer's Manuals for the low level board diagnostics are all deliverables. (B001 ,B002, B003)

3.5.6 Experimental Control System (ECS)- Government Processor

The Government intends to have an ECS which will control experiments using the telescope in addition to the telescope. This ECS will be PC based and may incorporate the TUI software. In any event the same external interfaces (SMI and REI) that are used by the TUI for the control of the telescope position and performance shall be used by the ECS. The performance of the Telescope shall be demonstrated thru these interfaces, and shall not depend on the performance of the government control processor.

The simulator (described elsewhere) which mimics the response of the telescope will be used for the purpose of development and testing of the ECS.

3.5.7 Command and Status State information

The TUI (and the ECS) shall contain tracking and applications algorithms that will send commands to the TCS. This process will allow operators to induce biases in the pointing and ephemerides sources. These biases will be induced upon the nominal gimbal rate profile of the satellite or star at rate up to 1,000 Hz for the SMI External interface. The Real Time TCS will also have knowledge of safety limits and exclusion zones, and should be able to initiate a safety stop condition which turns off the gimbal amplifiers and apply the breaks so as to slow the gimbal without exceeding deceleration limits. This same safety stop response can be initiated thru the mushroom buttons.

A test report describing the control functions is a deliverable. (B001, B002, B003, A004).

3.5.8 Set of Commands for Control and Status

A set of commands for control and status of the gimbal and telescope control subsystems via the interface between the TUI or the ECS and the real time TCS shall be implemented. The control functions shall be designed such that no command, defined or undefined, shall be allowed to cause damage to the telescope or cause the usable range of the telescope to be exceeded. It is not acceptable for the control functions to depend on the automatic braking system to achieve this objective.

The following is a partial list of commands to be supported over the external interface:

3.5.8.1 Configuration Capabilities

1. Set Home Positions (both axes). The ECS / TUI shall be able to designate any allowable azimuth and elevation position as the home position.

2. Shutdown. The Contractor shall propose a shutdown command that configures the system for a controlled shutdown, including the home command to return the gimbal to the stow position and apply the brakes.

3. Reset. Perform a stop of all gimbal velocity and perform a warm reboot, and status checkout as in a power up condition.

4. Standby. Apply brakes and set commanding to subsystem at a level to conserve power. This command will be used to maintain pointing accuracy, and increase the life span of the components and allow the computer performing ECS/TUI to be rebooted.

5. Open/Close Primary Mirror Cover

3.5.8.2 Command Capabilities

At a minimum, the following commands shall be implemented with the precision and repeatability outlined in this document.

1. Go to Home Position (for each axis: Azimuth, Elevation, and Focus)
2. Emergency Stop
3. Set Focus position to value passed
4. Move an axis to a defined position, a, with defined velocity, b, and with defined acceleration, c, all referenced to time, t_ref. Desired position is calculated as, position
= a + b*(t_current- t_ref)+c*(t_current-t_ref)*(t_current-t_ref)
5. Position hold (Freeze any or all movements)
6. Unfreeze Position hold (Continue with last a, b, c coefficients sent and update t_ref to current time)

3.5.8.3 Commands for Saving Data

The TCS shall provide for the capability to save into memory the state of the system on each calculation cycle. All state information should be made available over the SMI on each frame when commanded via the REI. Arbitrary frame state history shall be logged in a circular buffer in the Real Time TCS. This buffer state information shall be transferred over the REI upon stopping of logging and gimbal motion. The size of this buffer shall support the full frame rate for at least 30 seconds (or at an arbitrary lower rate selectable by the REI interface). The recomended state information to be logged shall be presented at CDR. The minimum logged information shall include state of each subsystem, time, gimbal and focus position, velocity, acceleration, and commanded positions, and temperature sensor read outs.

The status of system shall be saved with individual bits used for defined binary conditions, i.e. open = 1, closed = 0, in-limit =1, out of limit = 0, and so on. The definition of what data (state) and status to save shall be decided jointly in the Real Time TCS Interface ICD. The Contractor shall provide a recommendation of what to save for both status and state within the proposal.

The Contractor shall also provide for at least a large enough ram so that a full status and state buffer can be stored to make room for a second full buffer save. The Contractor shall provide commands to decimate the data saved such that a decimation of 2 would allow 2 data saves into the ram , a decimation of 3 would allow for 3 separate and distinct data saves into the ram disk, and so on.

The following commands for data saving shall be implemented:

1. Stop circular buffer data save, do not reset pointer;
2. Start circular buffer data save, do not reset to top of buffer;
3. Enable single pass data save. Set pointer for data save to top of buffer, wait for start signal from TUI or ECS. This data save stops automatically at end of buffer;
4. Start single pass data save on user input from TUI or ECS.
5. Write saved data to ram disk.
6. Set decimation factor for data saves.

7. Write stored data in ram disk to permanent storage. Write Command requests comments (max 1024 bytes) from user which are added to file. File names include current IRIG time.

The file configuration shall be establish with the Real Time TCS Interface ICD. The Contractor shall provide a hard disk drive with a formatted storage capacity of at least 9 gigabytes.

3.5.8.4 Status and State Capabilities

The Contractor shall propose those variables not included in the following incomplete list that he believes are necessary to monitor for complete definition of the system's state and status. At a minimum the following status information shall be provided on each cycle:

1. Actual Position. Actual positions shall be available for both gimbal axes and the secondary mirror. Position data shall be available both absolute and relative to the home position.
2. Actual Rate (both gimbals and focus)
3. Line of sight Position Error, (filter following error).
4. Line of sight Rate Error, (both gimbal axes only)
5. Systems Status. For example, Safety Interlocks, position of mirror cover, Location of most frequent emergency stop initiation, proximity to rate or position limit, exceeded rate or position limit, hydraulic fluid level (if used), power supply OK, Each card in the Chassis status, etc.
6. Temperature sensor amplitudes for necessary monitoring points.
7. Set mode of modeling and performance logging. This mode makes it possible to have all the state information retained in a circular buffer saved to disk for diagnostics. The buffers shall be large enough to perform (30 seconds) of commands and have all the state information to be transferred over the Ethernet REI interface. The gimbals may be stopped to perform this transfer for all rates higher than sidereal
8. Difference between safety resolver LOS and encoder LOS.

3.5.9 Diagnostics and Power Up

There shall be a sequence during power up for handshaking between the External interface processes and the TCS. The TCS shall be capable of determine the heath and operability of the telescope subsystem and convey this status to the controlling process. This includes the MCU. In the event of non-nominal conditions, the subsystem failing the healthy status should be identified over the Ethernet REI.

3.5.10 Fetch and Logged Filter State Information

The logged TCS filter states shall be made available over the external interface. The information content shall be documented in the delivered manuals and contain both the time stamped encoders, the filter parameters, and the desired commands. This feature will be utilized to analyze the dynamic performance of the LOS in both dynamic and thermal gradient conditions.

3.7 MANUALS, SOFTWARE, AND SOFTWARE DOCUMENTATION

3.7.1 Operator's Manual

The Contractor shall develop and furnish operating procedures for the telescope system in the form of an Operator's Manual. At a minimum, the manual shall contain: hardware descriptions with view of displays and a full explanation of all user functions, Pre-Test Checklist; Run Procedures (both standard and nonstandard cases); Emergency Procedures with emphasis on immediate actions to control damage; and Shutdown Procedures. The manual should stress user compatibility. Contractor format is acceptable. Initial submission of the manual shall be at CDR. Four copies of the final procedures shall be submitted at the start of factory acceptance testing. (A009)

The manual(s) shall include but not be limited to following material:

1. M1/M2 alignment procedures (swapping M2's or recoating M1)
2. M1 removal and reinstallation procedures
3. Full coudé alignment procedure
4. Users guide, programmers guide for Ethernet and SMI external interfaces
5. All existing applicable documentation.

All manuals should also be delivered in digital format on CD and installed on the delivered PC with all pdf formatted manuals cross indexed for searching a when this does not violate a third party license.

3.7.2 Software

All software written by the Contractor (developed under this contract) shall be delivered in executable form, along with source code. The developmental system shall be described and maintained at the Contractor's facility for a minimum of 10 years. All control software modules shall be written in a computer language which complies with Governments requirements. Acceptable languages are C and C++, (and visual basic for the TUI). Where assembler code is required to meet performance specifications such code shall be well-documented, and isolated from other source code. All assembler code shall be written in discrete modules used to perform a single function. All uses of assembler code must be approved by the Government.

Final versions of all software shall be delivered when the TUI/Real Time TCS Computer is delivered and is subject to a acceptance testing and quality assurance inspection before acceptance. The inspections shall be performed by a government representative to ensure compliance with the software documentation requirements listed below.

3.7.3 Software Documentation Requirements

Documentation for the software shall include a software development plan and design document (called the Software Development Document), a Software Programmer's Manual, a Software User's Manual, and Software Test Reports. All computer machine specific code shall be specified in separate modules. All software written by the vendor (or its subcontractors) for use in the 1.0 m

telescope or any associated computer/control system, including custom, semi-custom device drivers, and programmable read-only memories (proms) shall be documented in the Software Design Document. The Software Design Document shall meet the standards in 3.7.3.1 and 3.7.3.2.

Initial and interim versions of delivered software shall be accompanied by preliminary and updated versions of the Software Programmers Manual and Software Users Manual. (B001, B002, B003, A004)

3.7.3.1 Data Variable Dictionary

The documentation for each control program shall include a data variable dictionary for all local and global variables. Each entry in the dictionary shall contain the following information:

1. Variable Name
2. Description
3. Range of Valid Values
4. List of All Modules Using this Variable
5. Specifications, (e.g. type, size, and any subparts)

3.7.3.2 Header Section

Each module within the control program shall include the following information in its header section:

1. Module Name
2. Description
3. List of All Other Modules called
4. List of All Modules Which Call this Module
5. List of All Arguments/Parameters including a description of each one

3.7.4 Telescope System Design Model

The Contractor shall furnish a control model of the telescope system implemented in MATLAB /Simulink. The model shall support the user's addition of supplementary equipment on the telescope and adjustment of all control parameters. The system model shall consist of the azimuth and elevation gimbal axes, the structural bending modes of the beam path as a function of Az and El angles. The model shall be accompanied by the computer files and written documentation necessary for use in the standard modeling package. The first version of the model shall be delivered at CDR. Updates to the model shall occur as needed, but no more frequent than every 2 months.

3.8 SYSTEM AVAILABILITY AND QUALITY

The Contractor shall provide analysis and documentation and provide an appropriate design to deliver a telescope system which meets the availability specification and which meets the quality requirements of the contract. The Contractor shall provide the availability analysis as a deliverable as specified below.

3.8.1 Availability

The Contractor shall design and fabricate the telescope system to be available 95% of the time at a 90% confidence level for a standard telescope mission operational profile from Table 3.8.1, the activity periods given in section 3.3.11, and the SLR mission profile given in 3.3.12. Availability is defined as all telescope systems and subsystems operating as specified, at a primary or redundant level, continuously during the mission profile. The Contractor shall assume a 12 year useful lifetime for the telescope, its systems, subsystems, and components. The extent of the analysis shall be limited to the contractor's best judgment and past experience. (A005)

Table 3.8.1 Telescope Operational Mission Profile

Core Mission Duration (continuous operation)	3 hours
Warm-up, Calibration, and Diagnostics	1 hour
Shut-down and Post-Mission Diagnostics	1 hour
Total Mission Duration	5 hours
Assumed Mission Time at Maximum Operating Stress	30 minutes
Minimum interval between Missions	2 hours
Number of Missions per Year	100 Missions
Assumed Number of passes per Mission	10 Passes

3.8.1.1 Availability Reviews

The Contractor shall schedule availability program reviews at mutually agreed times. Two such reviews will be held in conjunction with the SRDR and the CDR. The Contractor shall include availability reviews in conjunction with the specified requirement and design reviews in section 7.5. A status report on the availability of the telescope shall be presented at SRDR and CDR. (A002)

3.8.2 Reliability

The Contractor shall implement a reliability program which shall support the specified availability requirement. The Contractor shall model the telescope system's optical, mechanical, electrical, pneumatic, hydraulic, control, environmental, shelter, and mobile carrier subsystems. Using common reliability terms, the model shall be used to evaluate the reliability characteristics of the telescope system, its component subsystems, and components for its 12 year life, under the assumptions in Table 3.8.1. The reliability model shall be used to perform design trade-off analyses. The Contractor shall make maximum use of any existing reliability programs, past data, structure, procedures, or formats. Analysis of the telescope's reliability is a deliverable. (A005)

3.8.3 Maintainability

The Contractor shall implement a maintainability program which shall support the specified availability requirement. The Maintainability Program shall be developed and shall address the tasks described in the following sections.

3.8.3.1 Maintenance Program

The Contractor shall analyze and predict the maintainability requirements of the telescope system, its subsystems, and components. The Contractor shall use common maintenance terms, such as mean-time-to-repair and mean-time-between-maintenance actions. The Contractor shall recommend, and the Government shall approve, the levels at which such predictions are to be performed. The Contractor shall list consumable and replaceable items; for example air filters and air for the air brakes. The Contractor shall deliver the maintainability analysis. (A005)

3.8.3.2 Maintenance Procedures

Using the analysis and data created in the maintenance program, in 3.8.3.1 above, the Contractor shall write detailed and complete maintenance procedures that shall be comprehensive and sufficient to perform all scheduled and unscheduled (preventive, diagnostic, and corrective) maintenance procedures necessary to maintain or return the telescope system to full operational capability. The maintenance procedures shall contain all safety procedures and precautions associated with each maintenance action. The Contractor shall propose, and the Government shall approve, a process whereby each maintenance procedure shall be validated and verified for scope, thoroughness, and accuracy. The maintenance procedures shall be documented and delivered as a Maintenance Procedures Document. (A009)

3.8.4 Recommended Spare Parts List

The Contractor shall develop and submit a recommended spare parts list with estimated costs. The list shall contain components, parts, assemblies, and end items essential for maintenance and replacement in the telescope system. The spare parts list will contain the following information: part name, the assembly or component to which the part belongs, the quantity of each part used in the telescope system, part number, part vendor or source (with address and telephone number), and part cost. The recommended spare parts list shall identify the priority of acquisition recommended by the Contractor. The recommended parts list shall estimate the number of each part necessary for 12 months of operation. Some items should perhaps be purchased in pairs because a supply can not be guaranteed in the future. Any such items should be identified by CDR so that they may be purchased at the same time. (A007)

3.8.5 Quality Assurance

The Contractor shall develop and implement or use an existing quality assurance program to ensure that the designed telescope system is the telescope system delivered to the Government. The Contractor shall make maximum use of any existing quality assurance structure, procedures, and formats. (A001)

3.8.6 Support Equipment

The Contractor shall collect and deliver a list of all items of equipment required to support, move, transport, package, store, operate, maintain, repair, diagnose, align, and calibrate the telescope system. (A007)

4.0 OPTIONS

Section numbers 4.1 and 4.2 are not used

4.3 Item 0003. Optional Spare Parts

The offeror shall provide spare parts as specified in paragraph 3.8.4 of Attachment 1, the Minimal Acceptable Specifications, Characteristics and Statement of Work. The government shall have the exclusive right to acquire any individual spare or group of spares for a period of five (5) years beginning the date of contract award. Purchase of these spares will be affective by issuance of a modification to the contract using the nomenclature and prices established during contract award. Delivery schedules for each item or group of items will be established in the applicable modification.

4.4 Item 0004. Optional Storage of Telescope at Contractor's facility

The anticipated delivery time frame might require the telescope Contractor to propose a plan for storage. If this option is exercised, the plan for storage shall take into consideration the completion of the telescope acceptance testing at the Contractor's facility. Once a plan is outlined for the storage of the telescope the Procurement Contract Officer (PCO) shall give written approval to the Contractor. (A001)

4.5 Item 0005. Optional Warranty Contract

On custom components designed and fabricated by the Contractor, the Contractor shall provide the Government with a warranty for one additional year after the expiration of the initial warranty has expired.

4.6 Item 0006. Optional ISO Container for Transporting the Telescope in a C130 Aircraft

The Contractor shall give a quote for an ISO container for transporting the telescope in a C130 Aircraft. This option may be exercised up to one year after delivery of the telescope at the NRL site.

4.7 Item 0007. Optional Extra Set of Coudé Mirrors

The Contractor shall give a quote for an extra set of uncoated coudé mirrors in mounts with ten (10) witness samples to be coated at the same time as the mirrors. The Government may exercise this option up to two (2) times up to three years after delivery of the telescope at the NRL site.

4.8 Item 0008. Optional Extra Secondary Mirror and Field Flattener for the Nasmyth Configuration

The telescope as delivered shall have a Nasmyth configuration with an eye piece. This option is for extending the capability of the Nasmyth configuration. The Contractor shall give a quote for supplying an extra secondary mirror to widen the field of the Nasmyth optical path. The new Nasmyth secondary mirror will be the same size as the existing secondary mirror and located at the same position (or as proposed by the Contractor and agreed to by the Government). This would keep the total obscuration the same as in the coudé mode.

The Contractor shall supply a refractive Field Flattener to correct field curvature and residual field coma. The field flattener shall be optimize over a band from 450 nanometers to 1,000 nanometers weighted by silicon detector response. All surfaces shall be anti reflective coated. It shall be possible to remove and replace the field flattener without significant disassembly of the telescope and with out requiring optical alignment.

Image Plane. The image plane will be located approximately 1.0 meter from the tertiary mirror aperture.

Nasmyth Secondary Mirror Material. The Nasmyth secondary mirror shall be fabricate from Zerodur or ULE material and be coated with a commercial broad band (450-1000 nanometer) protected aluminum coating to a specification subject to Government approval at CDR.

Exchange of Coudé and Nasmyth Secondary Mirrors. It shall be possible to exchange the coudé and Nasmyth secondary mirrors without realignment. Separate alignment features shall be provide for each secondary.

Focal Length: The composite focal length of the primary and secondary mirror and field flattener shall cause the image plane to be located 150 mm outside the instrument mounting surface or as recommend by the Contractor and agreed to by the Government.

Provision in this option would allow for the Government to supply and install its own camera in addition to or to replace the eye piece.

Field of View. The Nasmyth focus shall have an unvignetted field of view of at least 0.2 degrees (diameter).

Wave Front Error. The wave front error of the telescope in the Nasmyth configurations shall be less than 80 nanometers RMS over the field of view under the full range of operational conditions. The wave front error over the central 0.05 degree (diameter) field of view shall be less than 63 nanometers RMS for the same conditions.

The Government may exercise this option up to 2 years after delivery of the telescope at the NRL site.

4.9 Item 0009. Optional and specialized Nasmyth camera, for the Nasmyth configuration

The Contractor shall supply a specialized camera for the Nasmyth configuration of Option 4.6.

This option should include installation and testing on the system at the Contractor's site if this option is exercised within 6 month of contract signing or on site of the telescope installation if this option is exercised within 2 years after the telescope is delivered to the NRL site.

4.10 Item 0010. Optional Instrument Derotator for the Nasmyth path

The Contractor shall supply an instrument derotator for the Nasmyth configuration of Option 4.6. This derotator shall automatically rotate around the optical axis to match the image rotation caused by azimuth and elevation rotation.

Accuracy. The instrument derotator shall match the image rotation with an accuracy of 1 arcsecond RMS (object space) at the edge of a 0.2 degree diameter field of view over any 10 minute period of time.

Range of Motion. The instrument derotator shall have a motion range of at least ±30 degrees. It shall be possible to remotely propositioned the derotator to any point in its operational capability. The instrument derotator shall support instruments up to 50 by 50 by 50 cm and 50 kg mass.

This option should include installation and testing on the system at the Contractor's site if this option is exercised within 6 month of contract signing or on site of the telescope installation if this option is exercised within 2 years after the telescope is delivered to the NRL site.

4.11 Item 0011. Optional Filter Wheel

If this option is selected the Contractor shall supply a filter wheel which shall have at least 8 selectable positions. This filter wheel shall accept standard 2 by 2 inch filters up to 5 mm thick.

Open Position: One position shall have a BK-7 window 4 mm thick. The window shall be anti-reflective coated on both surfaces. The thickness of this window shall be accounted for in the design of the field flattener.

The filter wheel shall mount to the instrument mounting surface and occupy less that half of the optical path length form the mounting surface to the focal plane.

This option should include installation and testing on the system at the Contractor's site if this option is exercised within 6 month of contract signing or on site of the telescope installation if this option is exercised within 2 years after the telescope is delivered to the NRL site.

4.12 Item 0012. Optional Video Tracker

The Contractor is free to specify and bid on this tracker. The output of this tracker shall operate with the SMI interface.

This option should include installation and testing on the system at the Contractor's site if this option is exercised within 6 month of contract signing or on site of the telescope installation if this option is exercised within 2 years after the telescope is delivered to the NRL site.

4.13 Item 0013. Optional Tilt Tip M2 Mirror

The Contractor should propose a tilt tip secondary mirror to be installed in this telescope. This should include the actuators and the sensing and control features necessary to implement this mirror. This proposal shall be reviewed at the PDR (Preliminary Design Review). This option should include installation and testing on the system at the Contractor's site if this option is exercised within 6 month of PDR or on site of the telescope installation if this option is exercised within 2 years after the telescope is delivered to the NRL site.

4.14 Item 0014. Optional Assistance in Moving the Telescope

The Contractor shall make a bid on assistance in moving the telescope from the initial NRL site to another site. The option may be exercised up to 4 years after acceptance of the telescope at the NRL site.

4.15 Item 0015. Optional Telescope Simulator

Under this option the Contractor shall supply a Telescope Simulator which shall be a VME system which simulates the telescope and its electronics including the Real Time TCS in order to support the parallel development of the Government ECS. The Telescope Simulator will allow the Government to test the interface between the Government ECS and the Real Time TCS without the actual telescope. The telescope simulator shall support both REI and SMI interfaces and simulate all control and status features of the real-time system. The choice of cards and cables should be chosen to be spares of the Real Time VME TCS when practical.

If this option is exercised at the start of the contract, the simulator shall be delivered at CDR in a separate VME chassis together with all software (source and executable) and manuals. The simulator shall be acceptance tested at the Contractors Facility using the TUI. When the simulator is moved to the NRL site the functionality of the TUI shall be installed on the Government supplied ECS computer. The acceptance testing of the simulator shall include verification of the SMI and REI interfaces by running examples.

The Telescope Simulator is to provide a realistic interface for the development, verification, and operational checkout of software, hardware, and firmware. The Telescope Simulator shall be able to mimic all commands and return an example of all data to be passed between the actual Real Time TCS and the ECS. It is the intent that this simulator chassis be used to support development and also be used to help to isolate problems or faults in interfaces. The Telescope Simulator simulations shall be used to verify the response to all commands for form, response time, and memory locations.

The simulator software shall include a User's Manual and Programmer's Manual, both manuals which shall be delivered when the simulator is delivered. (B002, B003).

4.15.1 Telescope Simulator SMI Interface

The Contractor shall deliver the Telescope Simulator with the software (source and executable) for running the REI interface.

The Contractor shall deliver the Telescope Simulator with the following items for the SMI:

1. A SMI card in the telescope simulator
2. A SMI card for the ECS
3. A fiber optic cable for connection between these two cards
4. The software (source and executable) for running this interface.

These cards shall be the same make cards as used in the Real Time TCS-TUI interface. These may be used as functional spares for the SMI interface supplied with the telescope. The contractor shall deliver the source and

executable software necessary to verify and run this interface. This verification software should function both on the real TCS chassis and the simulator chassis.

4.15.2 Simulation Requirements

The Telescope Simulator simulations shall be used to verify the response to all commands for form, response time, and memory locations. The Telescope Simulator is not intended to provide the capability to perform control systems analysis. The Contractor shall define a minimum set of commands that will allow the Telescope Simulator models to be updated with new parameters to improve the system model as the actual hardware is tested.

4.15.3 Simulator Gimbal Control Data

The Telescope Simulator shall simulate the closed loops of the azimuth and elevation axes.

1. For the azimuth and elevation axes, a filter will be developed to emulate the response of the gimbal to commands. The output of this filter will be limited to position, velocity, and acceleration for each axis. This filter will be updated at 1,000 Hz or the actual rate of the position loops. The simulation will be tuned to emulate the real response of the axes and will include position, rate, and acceleration limits. The simulation shall accept all valid commands.
2. Encoder data shall be simulated in the same format as the telescope data, and be updated at the appropriate rate.
3. Other data which will be logged over the SMI may be generated as nominal values.

4.15.4 Simulator Focus Data

The operation of the secondary focus shall be included in the simulation. The simulation software will emulate the secondary mirror response to commands with a low pass filter tuned to represent the hardware response. The position of the axes will be updated at the appropriate rate.

The simulation software will also include all coupling effects.

4.15.5 Other Simulation Requirements

The Telescope Simulator shall have the ability to simulate the self-testing of the control loops.

Simulated failed condition responses should be set thru a simulator interface separate from that being tested. All diagnostic and safety protocols should included.

Both the SMI and Ethernet interfaces along with working examples with source code and executables shall be delivered. The development environment shall be a COTS product and specified in full so that this may procured by the Government if desired. The source code for the process interfacing with the TCS real-time filter and the two external interfaces shall be documented and delivered at this time. Example source and executables shall be provided which interface with the simulator chassis. The usage examples shall be working examples so that an experience programmer can begin development and testing of the external interface software and applications.

4.16 Item 0016. Optional Maintenance Agreement

For one year, the Contractor shall provide field response for telescope repair/maintenance in less than 36 hours from when the support is requested. The Offeror shall estimate the anticipated number of such request and quote rates and costs for spares.

This option may be exercised up to five (5) years after acceptance of the telescope at the NRL site.

5.0 ACCEPTANCE REQUIREMENTS

5.1 Acceptance Tests at Contractor's Facility and NRL's Site

Detailed preliminary acceptance testing shall be performed at the contractor's facility in accordance with the acceptance test plan developed by the Contractor and approved by the Government. Final acceptance will occur at the NRL site after installation based on the results of a series of tests developed by the Contractor and approved by the Government. These tests will be designed to demonstrate that the telescope/gimbal system performs in accordance with contract specifications. It is expected that at least half of the acceptance tests shall be performed on-site.

The acceptance test plan and test results shall be documented and delivered. (A001, A004)

5.2 Workmanship and Finish

The telescope/gimbal system shall be designed and fabricated making full use of the contractor's existing quality assurance and configuration control structure, procedures, and practices and shall exhibit the best level of workmanship normally associated with commercial instruments of this type. The Contractor shall utilize all appropriate IEEE, ASME, manufacturing, and ANSI standards as are applicable to the telescope/gimbal system. The contractor's quality assurance and configuration control procedures shall be available for Government evaluation of compliance. All exterior surfaces shall be ground to eliminate weld spatter, rough surface projections, and to blend corner and edge radii.

All external surfaces of the gimbal structure and of the telescope shall be protected from rust, corrosion, and excessive thermal loading with appropriate finishes. Exterior surfaces shall be smooth and finished. Interior surfaces shall be coated to minimize stray light with a stable low vapor pressure material suitable for use with low scatter optical surfaces. For thermal stability, the Contractor may propose and use (with written permission of NRL's Project Officer and the PCO) additional materials to cover a portion or all of the telescope structure.

The inspection report covering the telescope's workmanship is a deliverable. (A004)

5.3 Structure Interfaces

The Contractor shall determine and describe necessary structure interfaces between the telescope/gimbal system and the facility at the Washington, DC site. The Telescope/Site ICD shall include the mobile and stationary mounting schemes, the telescope pier design requirements, the maximum weight, the maximum total mount center of gravity offset, and the maximum dynamic reaction loads for the gimbal design. The Contractor is required to interface with the architectural and engineering and other appropriate design contractors to ensure all necessary facility interfaces are addressed.

6.0 SHIPMENT, INSTALLATION, TRAINING AND TECHNICAL ASSISTANCE

6.1 Shipping

The Government shall be notified 14 days in advance of the contractual shipment of any optical components and provided the opportunity for inspection. The Contractor shall design and fabricate the telescope/gimbal system while taking into account size and weight limitations associated with delivering the system and installing it. The Contractor shall develop shipping and installation plans, as an appendix to the Management Plan, as well as specifications for the heavy equipment that will be needed for the installation. The Contractor shall install and monitor maximum and recording "g" accelerometers during shipping. The shipping containers shall be reusable. The Contractor shall deliver the equipment directly to the NRL Washington, DC area site. The government will provide a crane and forklift, and personnel to off-load and handle the telescope at the delivery site. The supervision of the crane and forklift operations shall be provided by the Contractor until NRL accepts delivery. Other shipping requirements are described in the contract document. (A001)

6.2 Installation

The Contractor shall interface directly with the site contractor and the dome contractor to provide inputs for delivery schedules of the telescope gimbal. Once a plan, as an appendix to the Program Plan, is outlined for the installation of the telescope the PCO shall give written approval to the Contractor on the delivery schedules. (A001)

6.3 Training and Technical Assistance

The Contractor shall train up to three NRL personnel in the operation and maintenance of the system. This training may be performed during and after Government acceptance testing; it shall include hands-on operation of the system; and it shall result in certification by the Contractor that the trained personnel can satisfactorily operate and perform scheduled maintenance and probable unscheduled maintenance actions. The training must cover each of the telescope operations and maintenance procedures and shall evaluate each procedure for clarity, accuracy, safety provisions, thoroughness, sequence of actions, and tools and materials. Changes to the maintenance procedures may result from the training process. The Contractor shall provide a five day training class, 3 days at the Contractor facility and 2 days at the NRL site.

The training documentation shall be delivered. (A011)

The Contractor shall provide technical assistance to the Government for installation of the system following acceptance testing, and technical assistance for on-site diagnostics, troubleshooting, and technical support.

7.0 OTHER CONSIDERATIONS

7.1 Program Management

The Contractor shall manage all Specification tasks. The Contractor shall be responsible for preparing all management tools necessary to provide insight into system and subsystem activities and potential risk areas. The Contractor shall provide a program plan, and monthly written program progress reports to the Government. (A001, A002)

7.2 Travel

The Contractor shall plan to attend technical meetings at NRL in Washington, DC during the fabrication and testing of the system and during installation at the site near Washington, DC.

7.3 Configuration Management

The Contractor shall develop a configuration management program or use an existing configuration management program to identify and document the functional and physical characteristics of a configuration item, control changes to the characteristics, and record and report change processing and implementation. The Contractor shall establish and manage configuration baselines, perform systems engineering, and perform interface control. The configuration management program shall address, identify, and track both hardware and software configuration items. The configuration management program shall be used to allocate and track error budgets, manage trade-off decisions, and address areas such as reliability, maintainability, and safety. Contractor formats, documents, terminology, processes, and procedures may be used.

7.4 Software Maintenance and Testing

The Contractor shall create and implement a Software Development and Design Plan. The Software Development Plan shall address the contractor's software development process and the software configuration control process to include software configuration identification and control. The Plan shall address software engineering, to include software languages, design and functional requirements to the software design. The Plan shall also address software testing, to include test planning and traceability or requirements to test cases. The plan shall address the creation and detailed contents of a Software User's Manual and a Software Programmer's Manual. The plan shall also address a configuration audit that shall verify and validate the software requirements; the software test results; the Software User's and Programmer's Manuals. (A001, A004)

7.5 Requirement and Design Reviews

7.5.1 Kickoff Meeting

The Contractor shall host a kickoff meeting following the contract award at the Contractor's facility. The specifications and architecture will be reviewed and

clarified where required. Primary technical interfaces will be established between the government and the Contractor. Areas of high risk identified by the Contractor will be discussed. (A006)

7.5.2 System Requirements and Design Review (SRDR)

The Contractor shall conduct a SRDR within six weeks after contract award. The SRDR shall address the total system requirements for both hardware and software, including functional analysis, requirements allocations to meet the environmental and thermal specifications, test requirements, error allocation and management. The SRDR shall address program risk, reliability, maintainability, design trades, basis design approaches for hardware and software, cost trades, configuration management, interface planning and documentation. Draft ICD's will be presented in outline form. A schedule shall be presented at SRDR. The contractor's progress shall be tracked to the baseline schedule in the program progress reports. The Contractor shall not rebaseline the schedule (e.g. change original milestone dates) without Government approval. Contractor formats, terminology, processes, and procedures are acceptable. The SRDR shall be held at the contractor's facility. (A006).

7.5.3 Preliminary Design Review (PDR)

The Contractor shall conduct a Critical Design Review (CDR) that addresses the design of the hardware and software items. An outline in preparation for the CDR shall be provided which includes detailed outline of each hardware and software configuration item. The PDR shall address the functional requirements and proposed method of fulfilling these requirements.

7.5.4 Critical Design Review (CDR)

The Contractor shall conduct a Critical Design Review (CDR) that addresses the detailed design of each hardware and software configuration item. The CDR shall address the functional requirements and the detailed design's fulfillment of the requirements, as well as the technical, cost, and schedule risk for each hardware and software configuration item.

For hardware items, the CDR shall address the detailed drawings, electrical design; mechanical design; environmental and thermal design; power generation, distribution and grounding; electrical and mechanical interface compatibility, mass properties, reliability, maintainability, safety, transportability and handling, support equipment, test data, interface control drawings, quality assurance, and error allocation and management.

For software items, the CDR shall address the software detailed design, data base design, interface design, supporting documentation, software programmer's manual, software user's manual, and operation and support documents. The software items discussed at CDR shall be at a top-level macro view, with the specific software items to be addressed in the software review schedule. The CDR shall provide detailed schedules for meeting hardware and software milestones. The CDR shall be held at the contractor's facility. (A006)

7.5.5 Software Reviews

The Contractor shall propose a series of periodic software development reviews, appropriate to the individual tasks which shall focus on adequate monitoring of the software specifications, design, test structure and procedures leading to the delivery of the Operator's, User's, and Programmer's Manuals.

7.6 Meetings

The Contractor shall support progress meetings/reviews to be held once every other month (except in months when a formal review is held) at a location to be determined by the Government. Additional informal meetings designed to view progress or explain schedules may be held periodically at the contractor's facility.

7.7 System Safety

The Contractor shall apply an existing comprehensive safety program or develop and implement a comprehensive system safety program to provide for the continuous safety of all personnel and property in the design, fabrication, assembly, test, and operation of the telescope. The Contractor shall make maximum use of existing safety programs, procedures, processes, and formats. The System Safety and Hazard Analysis document is a deliverable. (A008)

7.7.1 System Safety Program

The acceptable level of risk shall be proposed on a case by case basis by the Contractor and shall be approved by the Government.

7.7.2 Hazard List and Analysis

The Contractor shall define and prepare a hazard analysis. The analysis shall address hazards associated with the systems operations and support and shall consider safety compliance. Maximum use shall be made of existing safety information, analysis, and procedures. The level of the safety lists, analysis, and assessments shall be proposed by the Contractor and approved by the Government. These lists, analyses, and assessments shall be submitted as appendices to the System Safety Hazard Analysis document (referred to in 7.7) during the specified revisions.

8.0 WARRANTY PROVISIONS and MAINTENANCE AND SERVICE AGREEMENT

8.1 Warranty Provisions

On all components that have a manufacturers warranty, NRL will accept the carry-thru warranty. On custom components designed and fabricated by the Contractor, the Contractor shall provide the Government with a warranty for one year after acceptance of the telescope at the NRL site.

8.2 Maintenance and Service Agreement

The Contractor shall implement a comprehensive plan in accordance with section 3.8.

APPENDIX A: LIST OF PHYSICAL UNITS

Unit	Abbreviation
Degree of arc:	arcdeg
Second of arc:	arcsec
Radian:	rad
Joule of energy:	J
Milliradian:	mrad, millirad
Microradian:	microrad, mcrad
Nanoradian:	nrad
Kilometer:	km
Meter:	m
Foot:	ft
Centimeter:	cm
Millimeter:	mm
Micrometer:	mcm
Angstrom:	Å
Angular Velocity:	deg/sec
Angular accel:	deg/sec^2 or deg/sec/sec
Degree Celsius (centigrade):	C or deg C
Degree Fahrenheit:	F or deg F
Hour:	hr
Minute of time:	min
Second of time:	s
Hertz:	Hz
Kilogram:	kg
Pound:	lb
Ampere:	amp
Volt:	V
Watt:	W

Figure 3.0-1 Conceptual View of Telescope Gimbal System

SEE ATTACHMENT (2)

Figure 3.0-2 Functional Block Diagram of Telescope

SEE ATTACHMENT (2)

Figure 3.0-3 More Detailed Block Diagram of Telescope (Part 1)

SEE ATTACHMENT (2)

Figure 3.0-3 More Detailed Block Diagram of Telescope (Part 2)

SEE ATTACHMENT (2)

APPENDIX B

TELESCOPE DATA ITEM DESCRIPTIONS

A001	Management Plan	DI-MGMT-80004
A002	Status Report	DI-MGMT-80368
A003	Test Plans	DI-NDTI-80808
A004	Test/Inspection Report	DI-NDTI-80809A
A005	Technical Report-Study/Service	DI-MISC-80508
A006	Conference Report	DI-ADMN-31308
A007	Parts List	DI-ILSS-80134
A008	System Safety Hazard Analysis Report	DI-SAFT-80101A
A009	R&D Equipment Information Reports (including manuals)	DI-S-30599
A010	Developmental Design Drawings & Associated Lists (including manuals for COTS material)	DI-DRPR-81002
A011	Training Materials	DI-ILSS-80872

Software

B001	End Item Computer S/W	DI-MCCR-80700
B002	S/W Users Manual	DI-MCCR-80019A
B003	S/W Programmers Manual	DI-MCCR-80021A
B004	S/W Development Plan	DI-IPSC-81427

See CLIN 0009, Section B for commercial S/W

Telescope SOW DIDs Data List

Para.	DID	Comments/Delivery and Frequency
3.1	A010	Mechanical drawings for telescope, telescope handling equipment, support equipment, and fixtures, Deliver 5 copies of drawings in both hard copy and magnetic media at FAT.
3.1.2	A005	Analysis of optical prescription. Deliver at telescope FAT.
3.1.3	A005	Analysis telescope clear aperture Deliver at telescope FAT.
3.1.4	A005	Analysis of field of view. Deliver at telescope FAT.
3.1.5	A003	Test plan on optical LOS repeatability. Deliver preliminary at CDR, and final at 2 weeks prior to testing.
	A004	Test/inspection report of optical LOS repeatability. Deliver at FAT.
	A005	Analysis of optical LOS repeatability. Deliver at FAT.
3.1.7	A005	Analyses of primary mirror mount. Deliver at FAT.
3.1.8	A005	Analysis of secondary mirror mount performance. Deliver at FAT.
3.1.9	A005	Analysis of mirror focus mechanism. Deliver at CDR.
3.1.10	A005	Study/analysis of telescope environmental performance, and survivability. Deliver at FAT.
	A009	R&D Equipment List, Interface Control Document telescope/Site ICD, draft outline at SRDR, (ICD 2) for telescope base/pedestal. Deliver at CDR.
3.1.10.1	A005	Analysis of operations in sunlight. Deliver at FAT.
3.1.11	A005	Analysis of telescope baffling. Deliver at CDR.
3.1.13	A005	Analysis of mounts for auxiliary instruments. Deliver at CDR.
3.1.15	A005	Documentation of procedure for alignment and removal and replacement of coudé mirrors. Deliver at CDR.
3.2.1	A005	Study/analysis of telescope configuration. Deliver at CDR.
3.2.2	A004	Test/inspection report of system optical quality, include: system wavefront, encircled energy, and transmittance. Deliver at FAT.
	A005	Analysis of system optical quality and optical budget. Deliver at FAT.
3.2.2	A005	Analysis of system optical quality, include: system wavefront, encircled energy, and transmittance. Deliver at FAT.
3.2.3	A005	Analysis of system obscuration. Deliver at FAT.
3.2.4	A004	Test/inspection report of mirror optical quality. Deliver at FAT.
3.2.6	A004	Test/inspection report on mirror coatings. Deliver at FAT.
3.2.7	A004	Test/inspection report of coudé path performance, deliver at CDR.
	A005	Analysis of coudé path performance. Deliver at CDR.
3.2.7.1	A004	Test/inspection report on coudé configuration. Deliver at CDR.
	A005	Analysis of coudé configuration. Deliver at CDR.
3.2.7.2	A005	Analysis of coudé mirror substrates and finishes. Deliver at CDR.
3.3.0.1	A004	Test/inspection report on mechanical description. Deliver at FAT.
	A005	Analysis of mechanical description. Deliver at CDR.
3.3.2	A003	Test plan for measuring angular velocity & acceleration. Deliver at CDR.
	A004	Test/inspection report on angular velocity and acceleration profiles. Deliver at FAT.
	A005	Analysis of angular velocity and acceleration profiles. Deliver at CDR.
3.3.3	A004	Test/inspection report of position sensing
	A005	Encoding performance. Deliver draft at CDR, final at FAT.
3.3.4	A003	Test plan for angular position sensor jitter. Deliver at CDR.
	A004	Test/inspection report on encoder jitter tests. Deliver at FAT
	A005	Analysis of angular position sensor jitter. Deliver at CDR.
3.4.7.1	A005	Analysis of timing relationship between the provided timing signals and the epoch of reported values and time tags. Deliver at FAT.
3.3.5	A003	Test plan for optical LOS jitter. Deliver at CDR.

	A004	Test/inspection report of optical LOS jitter. Deliver at FAT
	A005	Analysis of optical LOS jitter, deliver at CDR. Deliver at CDR.
3.3.6	A003	Test Plan for optical LOS step response. Deliver at CDR.
	A004	Test/inspection report of optical LOS step response. Deliver at FAT.
	A005	Analysis of optical LOS step response. Deliver at CDR.
3.3.7	A005	Analysis of balance and ancillary load capacity. Deliver at CDR.
	A009	R&D Equipment Report, Balance & Weight Capacity ICD. Deliver draft outline at SRDR and final 6 months after contract award. (ICD #3)
3.3.8	A009	R&D Equipment Report, Cable routing & gimbal connection ICD. Deliver draft outline at SRDR and final at FAT. (ICD #4)
3.3.9	A004	Test/inspection report on beam path conditioning. Deliver at FAT.
	A009	R&D Equipment Report, Beam Path Conditioning ICD. Deliver draft outline at SRDR, final at FAT.
3.3.10.1	A005	Analysis of gimbal system stopping performance. Deliver at CDR.
3.3.10.2	A004	Test/inspection report on gimbal system braking system. Deliver at FAT.
3.3.10.3	A005	Study/analysis of telescope protection system. Deliver at CDR.
3.3.12	A005	Analysis of Telescope Availability Draft at CDR. Final at FAT.
3.4.0.1	B001	Source and executable code for Real-Time TCS. Deliver at FAT.
	B002	Software User's Manual for Real-Time TCS software. Deliver at FAT.
	B003	Software Programmer's Manual for Real Time TCS software. Deliver at FAT.
3.4.1	A009	VME Interface ICD. Deliver draft at Kick-off meeting and final at CDR.
3.4.1.3	B001	Source and executable code for Functional Level Gimbal Dynamics Analysis. Deliver at FAT
	B002	Software User's Manual for Functional Level Gimbal Dynamics Analysis. Deliver at FAT.
	B003	Software Programmer's Manual for Functional Level Gimbal Dynamics Analysis. Deliver at FAT.
3.4.1.7	A004	Test/inspection report of time response of commands from TUI, MCU, and ECS to Real Time TCS. Deliver draft at CDR, final at FAT.
3.4.2.1	A010	Developmental Drawings/Schematics of the Gimbal electronics. Deliver 5 hard copies and magnetic media at FAT.
3.4.2.2	A004	Test/inspection report on the non-COTS and COTS digital gimbal electronics performance. Deliver at FAT.
	A010	Developmental Drawings/Schematics and manuals of the COTS and non-COTS gimbal electronic systems. Deliver at FAT.
3.4.3.3	A005	Analysis of time tag accuracy. Deliver draft at CDR. Final at FAT.
3.4.9	B001	Source and executable code for the Power Up Diagnostics. Deliver at FAT.
	B002	Software User's Manual for the Power Up Diagnostics. Deliver at FAT.
	B003	Software Programmer's Manual for the Power Up Diagnostics. Deliver at FAT.
3.5	B001	Source and executable code for the TUI computer software. Deliver at FAT.
	B002	Software User's Manual for the TUI computer software. Deliver at FAT.
	B003	Software Programmer's Manual for the TUI computer software. Deliver at FAT.
3.5.5	B001	Source and executable code for the low level board diagnostics software. Deliver at FAT.
	B002	Software User's Manual for the low level board diagnostics software. Deliver at FAT.
	B003	Software Programmer's Manual for the low level board diagnostics software. Deliver at FAT.
3.5.7	A004	Tests/inspection report of control function performance. Deliver draft at CDR and final at FAT.
	B001	Source code for Control functions. Deliver at FAT.

	B002	Software User's Manual for Control Functions, Deliver at FAT.
	B003	Software Programmer's Manual for Control Functions. Deliver at FAT.
3.7.1	A009	Telescope Operator's Manual w/pretest checklist, run procedures, and emergency procedures. Deliver draft at CDR and final at FAT.
3.7.3	A004	Tests/inspection report of control system S/W performance. Deliver draft at CDR and final at FAT.
	B001	Source Code for Control System S/W. Deliver at FAT.
	B002	Software User's Manual for Control System S/W. Deliver at FAT.
	B003	Software Programmer's Manual for Control System S/W. Deliver at FAT.
3.8.1	A005	Analysis of telescope availability. Deliver draft at CDR and final at FAT.
3.8.1.1	A002	Status report on Availability. Deliver at SRDR and CDR.
3.8.2	A005	Study/analysis of telescope system reliability. Deliver at CDR
3.8.3.1	A005	Study/analysis of maintainability, deliver at CDR.
3.8.3.2	A009	R&D Equipment Report covering maintenance procedures. Deliver at FAT.
3.8.4	A007	Recommended Spare Parts List. Deliver at CDR.
3.8.5	A001	Management Plan for quality assurance. Deliver at SRDR.
3.8.6	A007	List of support equipment. Deliver at FAT.
4.4	A001	Management Plan for storage plan. Deliver at FAT.
4.15	B002	Software User's manual for Telescope Simulator, deliver at CDR.
	B003	Software Programmer's manual for Telescope Simulator. Deliver at CDR.
5.1	A004	Test/inspection report for Telescope Acceptance Testing. Deliver at CDR.
	A001	Acceptance Test Plan. Deliver draft 3 months following SRDR, and final 2 weeks prior to testing.
5.2	A004	Test/inspection report on telescope workmanship. Deliver at FAT.
6.1	A001	Management Plan for shipping (appendix to Management Plan of 7.1). Deliver at FAT.
6.2	A001	Management Plan for installation. Deliver at FAT.
6.3	A011	Training Materials. Deliver at FAT.
7.1	A001	Management Plan. Deliver at Kickoff meeting.
	A002	Status Report. Deliver monthly, 10 working days after end of period.
7.4	A001	Management Plan for Software Management. Deliver at SRDR.
	A004	Test/inspection report on software testing results. Deliver at FAT.
7.5.1	A006	Conference report on Kick-off meeting. Deliver 2 weeks following meeting.
7.5.2	A006	Conference report on SRDR. Deliver 2 weeks after review.
7.5.3	A006	Conference report on CDR. Deliver 2 weeks after review.
7.7	A008	System Safety and Hazard Analysis Report. Deliver at FAT.

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FIGURES 3.0-1, 3.0-2, 3.0-3 (Part 1) & 3.0-3 (Part 2)

for NRL
ONE METER, MOBILE, GIMBALLED TELESCOPE SYSTEM

15 JANUARY 1999

Solicitation Number N00173-98-R-CB04
Attachment (2)

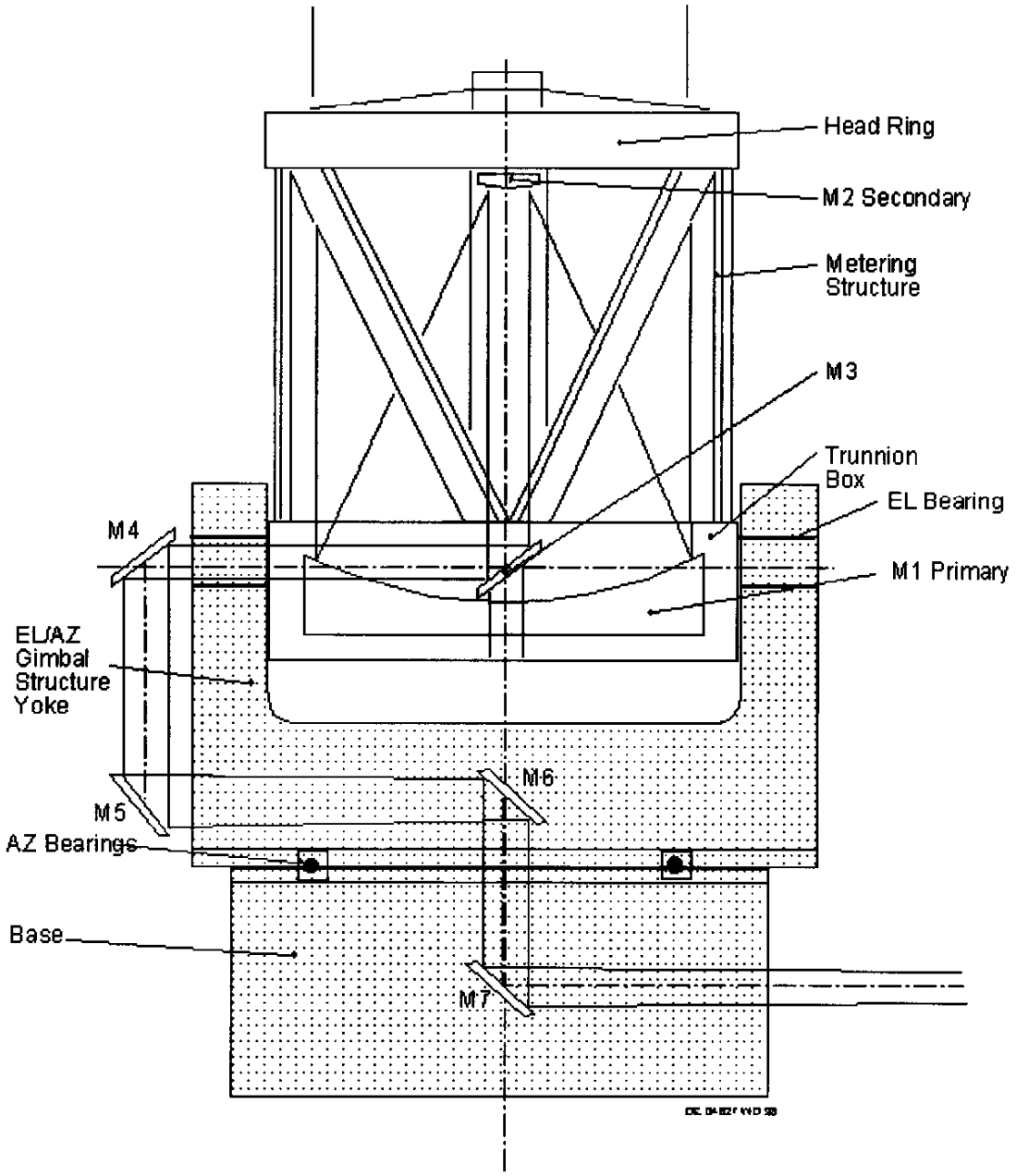

Figure 3.0-1 Conceptual View of Telescope Gimbal System
(For illustrative purposes only)

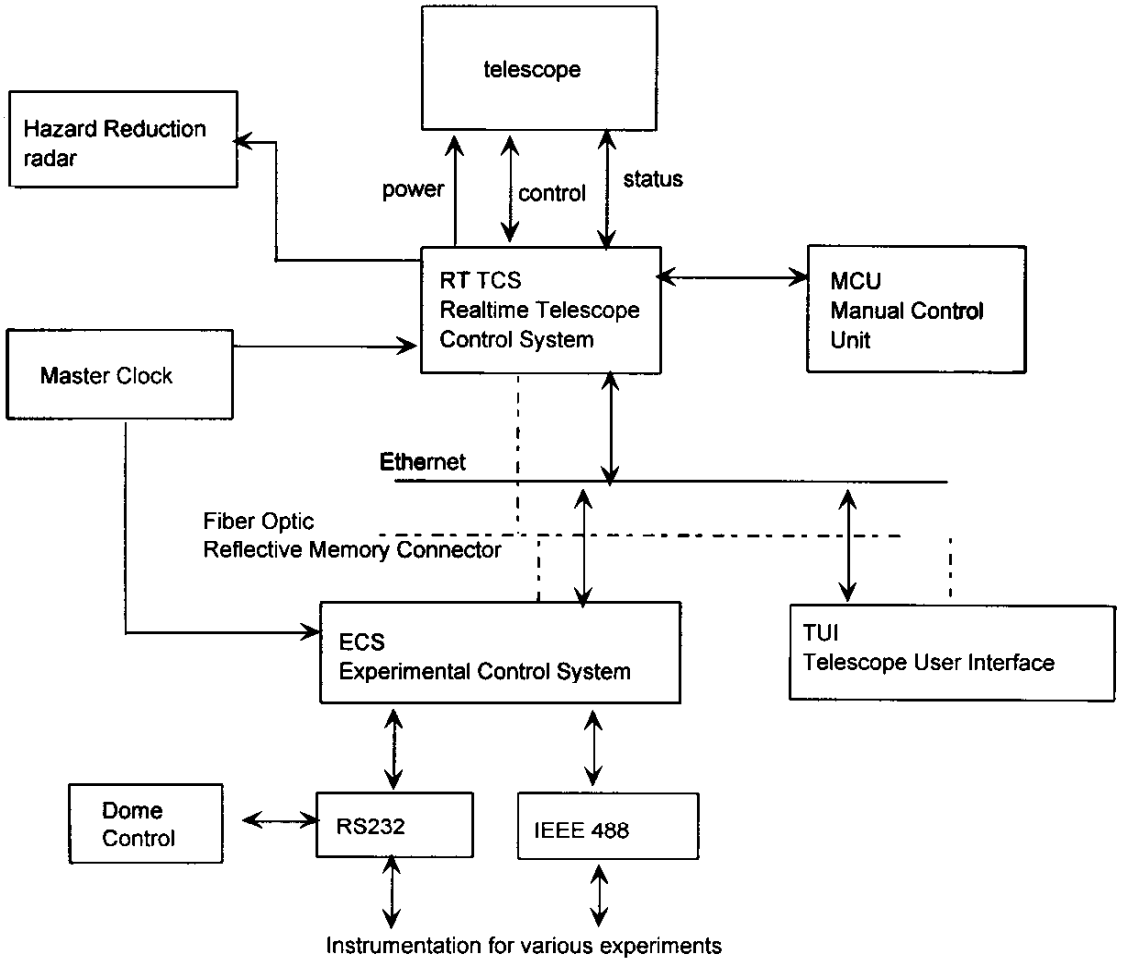

Figure 3.0-2. Functional block diagram of Telescope.

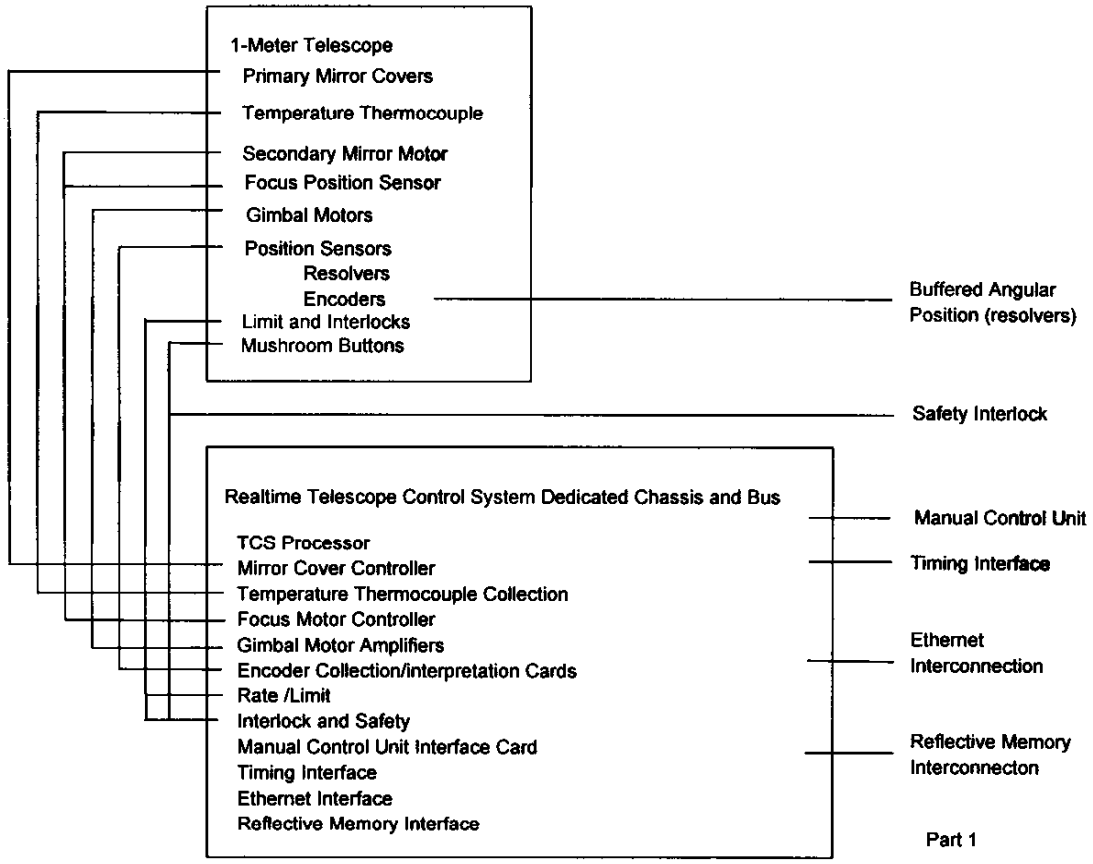

Figure 3.0-3 More Detailed Block Diagram of Telescope (part 1)

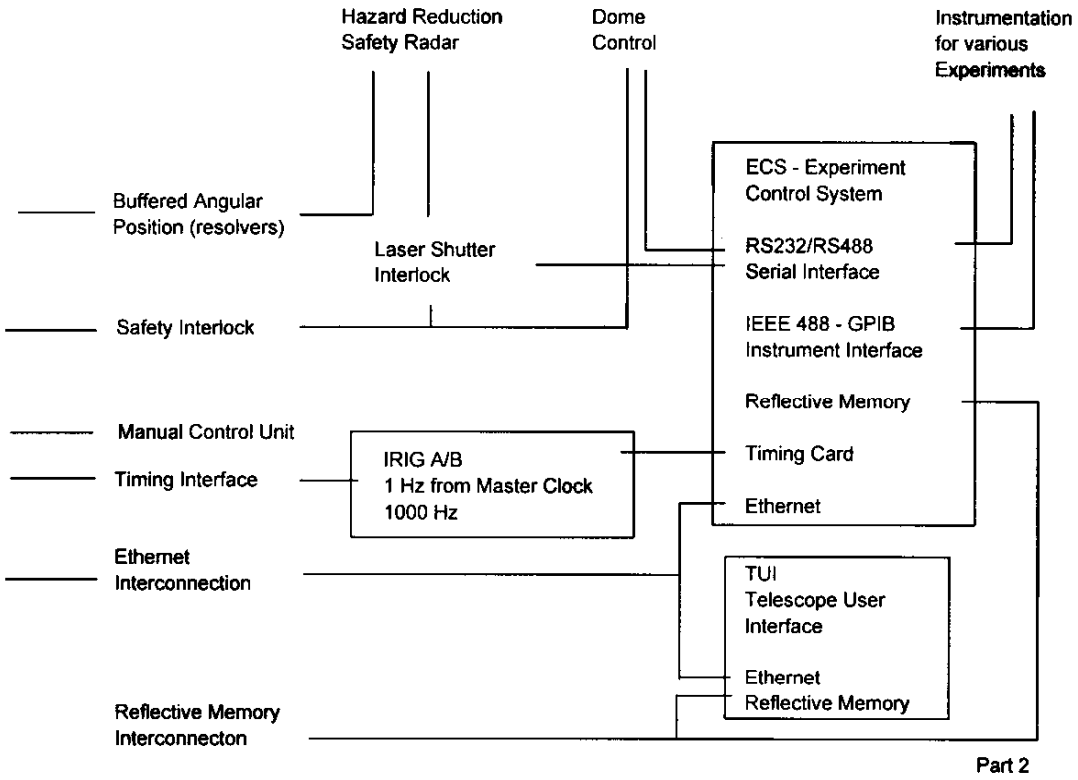

Figure 3.0-3 More Detailed Block Diagram of Telescope (part 2)

OPTIONAL SPARE PARTS

ITEM NO.	Nomenclature	Qty.	Unit Price	Total Price

(To be completed at time of award)