SPECIAL REPORT

OPTICAL SYSTEMS GROUP

COMMON TRACKING MOUNT SPECIFICATION

WHITE SANDS MISSILE RANGE
REAGAN TEST SITE
YUMA PROVING GROUND
DUGWAY PROVING GROUND
ABERDEEN TEST CENTER
NATIONAL TRAINING CENTER
ELECTRONIC PROVING GROUND
HIGH ENERGY LASER SYSTEMS TEST FACILITY

NAVAL AIR WARFARE CENTER WEAPONS DIVISION, PT. MUGU
NAVAL AIR WARFARE CENTER WEAPONS DIVISION, CHINA LAKE
NAVAL AIR WARFARE CENTER AIRCRAFT DIVISION, PATUXENT RIVER
NAVAL UNDERSEA WARFARE CENTER DIVISION, NEWPORT
PACIFIC MISSILE RANGE FACILITY
NAVAL UNDERSEA WARFARE CENTER DIVISION, KEYPORT

30TH SPACE WING
45TH SPACE WING
AIR FORCE FLIGHT TEST CENTER
AIR ARMAMENT CENTER
ARNOLD ENGINEERING DEVELOPMENT CENTER
BARRY M. GOLDWATER RANGE

NATIONAL NUCLEAR SECURITY ADMINISTRATION (NEVADA)

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SPECIAL REPORT

COMMON TRACKING MOUNT SPECIFICATION

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Prepared by

OPTICAL SYSTEMS GROUP (OSG)
RANGE COMMANDERS COUNCIL

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TABLE OF CONTENTS

LIST OF TABLES iv

PREFACE v

CHAPTER 1: INTRODUCTION 1-1
1.1 Scope and Specific Objectives 1-1
1.2 Action Timeline for Completion of Task OS-27 1-1

CHAPTER 2: REQUIREMENT INTEREST SURVEY 2-1
2.1 Overview 2-1
2.2 Interest Survey Results and Additional Items Suggested by the Ranges 2-1
2.3 Results and Analysis of the Survey 2-2

CHAPTER 3: SPECIFICATIONS FOR LARGE TRACKING SYSTEM (LTS) 3-1
3.1 Pedestal 3-1
3.2 Trailer 3-3
3.3 Pedestal Enclosure 3-5
3.4 Control System/Tracking 3-5
3.5 Documentation and Training 3-5

CHAPTER 4: SPECIFICATIONS FOR SMALL TRACKING SYSTEM (STS) 4-7
4.1 Pedestal 4-7
4.2 Control System/Tracking 4-9
4.3 Documentation and Training 4-9

CHAPTER 5: INDUSTRY RESPONSE AND CONCLUSIONS 5-1
5.1 Industry Response to “Sources Sought” Statement 5-1
5.2 Conclusions 5-1

APPENDIX A: SOURCES SOUGHT SYNOPSIS A-1

APPENDIX B: PHOTO-SONICS RESPONSE B-1

APPENDIX C: L3-BRASHEAR RESPONSE C-1

LIST OF TABLES

Table 2-1. Requirements Rating Scheme 2-1
Table 2-2. Survey Ratings: Consolidated Results, Common Tracking Mount Specifications (Aug 2005) 2-3
Table 2-3. Survey Ratings: Kennedy Space Center (KSC) 2-5
Table 2-4. Survey Ratings: Pacific Missile Range Facility (PMRF) 2-7
Table 2-5. Survey Ratings: Sandia Laboratories 2-9
Table 2-6. Survey Ratings: Textron Maui 2-11
Table 2-7. Survey Ratings: White Sands Missile Range (WSMR) 2-13
Table 2-8. Survey Ratings: 46th Test Group (Holloman AFB Sled Track) 2-15
Table 2-9. Survey Ratings: Additional Items Suggested by Ranges 2-17

PREFACE

This report presents the results of Task OS-27 "Common Tracking Mount Specification" by the Optical Systems Group (OSG) of the Range Commanders Council (RCC). The information contained herein is a compilation of information obtained from OSG associate and member ranges that require optical tracking mounts, are involved in testing and training, and who provide facilities for test and evaluation. The objective of this effort is to provide tracking mount specifications so that the reader can more easily prepare purchasing documentation. The information in this report will facilitate the decision process for selecting the type of tracking mount(s) best suited for a particular application given a specific test site and testing environment.

The OSG would like to provide a special acknowledgement for production of this document for the RCC to the following individual:

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CHAPTER 1

INTRODUCTION

1.1 Scope and Specific Objectives

The purpose of Optical Systems Group (OSG) Task OS-27 is to develop a common tracking mount specification to be utilized by member ranges of the Range Commanders Council (RCC) in purchasing the next generation of optical tracking mounts under a requirements contract. The requirements contract is to be initiated at White Sands Missile Range (WSMR) and funded by RCC member ranges based on their specific needs.

1.2 Action Timeline for Completion of Task OS-27

The actions taken during this task completion are as follows:

Date	Action
Jan 2004	Began collecting requirement inputs from ranges
Apr 2004	Held working group meeting with ranges
Sep 2005	Generated and distributed requirements survey
Oct 2005	Held working group meeting to discuss survey results
Feb 2006	Generated specifications and obtained industry feedback
Mar 2006	Presented specifications and industry response to OSG members

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CHAPTER 2

REQUIREMENT INTEREST SURVEY

2.1 Overview

The initial requirements list for optical tracking mounts was based upon the inputs received from the ranges; the requirements were generated through various means, including one-on-one meetings and working group meetings with the ranges. The requirements were then distributed in a survey in order to gauge the general level of interest for each. Each respondent was asked to rate the requirements according to the following rating scheme:

TABLE 2-1. REQUIREMENTS RATING SCHEME

Rating	Description
1	Not desired
2	Desired, not required
3	Desired if cost not an issue
4	"Must have" requirement

2.2 Interest Survey Results and Additional Items Suggested by the Ranges

2.2.1 Interest Survey Results. Using the rating scheme of Table 2-1 above, the survey was sent to a variety of test ranges and laboratories for rating of the individual requirements. The consolidated results can be seen at Table 2-2. In Table 2-2, the ratings from each range providing input is shown, and the range average is shown in the next to last column (i.e. one vote per range/laboratory). Additionally, the last column shows the average of all individuals providing ratings (some ranges had more than one person submitting ratings). The input from each organization can be seen at Table 2-3 through Table 2-8 as follows:

Table 2-3. Kennedy Space Center (KSC)
Table 2-4. Pacific Missile Range Facility (PMRF)
Table 2-5. Sandia Laboratories
Table 2-6. Textron Maui
Table 2-7. White Sands Missile Range (WSMR)
Table 2-8. 46th Test Group (Holloman Air Force Base, Sled Track)

2.2.2 Additional Items Suggested by the Ranges. During completion of the interest survey, some ranges recommended additional items to be included in the specifications (See Table 2-9). The additional items suggested by the ranges were reviewed and some of them were incorporated into the specifications.

2.3 Results and Analysis of the Survey

Based on the survey results, it was determined that no single set of specifications could bridge the wide spectrum of requirements for size and payload. Therefore, two different sets of specifications were generated. The first set of specifications is for a large tracking system (LTS) and the second set of specifications is for a small tracking system (STS). Specifications for the LTS are shown in Chapter 3 and specifications for the STS are shown in Chapter 4. The individual components of the LTS and STS are listed in the following subparagraphs.

2.3.1 Components of the LTS. The components of the LTS specifications are:

a. Pedestal
b. Trailer
c. Pedestal enclosure
d. Control system/tracking
e. Documentation and training

2.3.2 Components of the STS. The components of the STS specifications are:

a. Pedestal
b. Control system/tracking
c. Documentation and training

TABLE 2-2. SURVEY RATINGS: CONSOLIDATED RESULTS, COMMON TRACKING MOUNT SPECIFICATIONS (AUG 2005)

Requirements \ Rating Organization [1, 2]		KSC	PMRF	Sandia Labs	Textron Maui	WSMR	46TG (HAFB Sled Track)	Range/Org Avg [3]	Indiv Avg [4]
a. Pedestal									
1	Large, 6 mounting platforms	2	4	1	2	3.4	2	2.40	3.05
2	Small, 2-4 mounting platforms	2	1	1	2	3.6	4	2.27	3.14
3	Low cost, 4 mounting platforms	1.5	1	1	2	1.3	3	1.63	1.38
4	1200 lb. Payload	1	4	1	2	3.1	1	2.02	2.71
5	1000 lb Payload	1.5	1	1	2	1.3	1	1.31	1.33
6	900 lb Payload	2.5	1	4	2	1.6	3	2.35	1.86
7	250 lb Payload	4	1	1	2	3.2	4	2.53	3.05
8	Digital control system	4	4	4	4	3.7	3	3.78	3.71
9	Indosyn encoders	2.5	1	1	3	3.9	3	2.39	3.38
10	Optical encoders	1.5	4	4	3	2.7	3	3.04	2.76
11	Weatherproof	4	4	4	3	3.3	4	3.71	3.43
12	Modular cabling	1.5	4	4	4	3.8	3	3.38	3.57
13	Stainless steel hardware	2.5	4	3	2	3.3	1	2.64	3.10
14	Acceleration 0-45	3	4	4	4	3.3	2	3.39	3.33
15	Acceleration 0-120	1	4	3	3	3.7	4	3.12	3.43
16	Velocity 0.6 - 45	3	4	4	4	3.3	2	3.39	3.33
17	Velocity 0.6 -120	1	4	3	3	3.7	4	3.12	3.43
18	Velocity dynamic range 1 - 1000	1.5	4	3	4	3.6	3	3.18	3.38
19	Servo drift	1.5	4	4	4	2.9	3	3.24	2.95
20	Transient response	2.5	4	4	4	3.8	3	3.55	3.67
21	Rate loop frequency response	1.5	4	1	4	3.3	3	2.81	3.10
22	Dynamic and static accuracy	1.5	4	4	4	3.5	2	3.17	3.33
23	Encoder strobe	1.5	4	4	4	3.2	3	3.29	3.16
24	Bearing system accuracy	1.5	4	4	4	3.1	3	3.26	3.05
25	Three point leveling and shock absorber system	2.5	4	4	3	3.8	3	3.38	3.62
26	Master bubble	2.5	4	4	2	3.9	3	3.24	3.67
27	Azimuth carriage assembly	2.5	4	2	4	3.8	3	3.22	3.57
28	Elevation tracking assembly	2.5	4	4	4	3.9	3	3.56	3.71
29	Center mounting structure movement	1.5	4	3	4	3.5	3	3.16	3.29
30	Side mount structure movement	2.5	4	3	3	3.9	3	3.23	3.62
31	Transport locks	2.5	4	1	3	3.5	3	2.84	3.29
32	Remote drive out of limit	2.5	4	1	3	4.0	3	2.92	3.62
33	Electronic pre-limits	2.5	4	4	3	4.0	3	3.42	3.76

TABLE 2-2 (CONTINUED). SURVEY RATINGS: CONSOLIDATED RESULTS COMMON OPTICAL TRACKING MOUNT SPECIFICATIONS (AUG 2005)

Requirements \ Rating Organization		KSC	PMRF	Sandia Labs	Textron Maui	WSMR	46TG (HAFB Sled Track)	Range/Org Avg	Indiv Avg
b. Trailer									
1	Working deck	2.5	4	3	3	3.8	3	3.22	3.57
2	Air-conditioning and humidity controls	4	4	4	4	4.0	2	3.67	3.90
3	Transportability	1.5	4	4	3	3.9	3	3.23	3.57
4	Brakes	2.5	4	4	3	3.9	2	3.24	3.67
5	Power and distribution panel	2.5	4	4	3	3.9	3	3.41	3.71
6	Modular cabling	2.5	4	4	3	3.9	3	3.39	3.67
7	Safety features	1.5	4	4	3	3.7	3	3.21	3.48
8	Rugged cable interface	2.5	4	3	3	3.9	3	3.24	3.67
9	Rotation meters	2.5	4	4	3	2.2	3	3.12	2.48
10	Auto leveling	3	4	1	2	2.4	2	2.40	2.43
11	Metal jack stands	2.5	4	4	3	3.7	4	3.54	3.62
12	Towing hitch	2.5	4	4	3	3.7	4	3.54	3.62
13	Spare tire and wheel	1.5	4	4	3	2.3	2	2.81	2.43
14	Lifting rings	1.5	4	4	3	3.3	2	2.97	3.14
c. Pedestal enclosure									
1	Remote control open/close	3	4	4	2	3.2	2	3.03	3.14
2	One person operation with power	2.5	4	4	2	3.3	2	2.97	3.19
3	Two person operation without power	2.5	4	1	2	3.5	2	2.49	3.25
4	Safety straps	2.5	4	3	2	3.7	3	3.03	3.43
d. Control system/tracking									
1	Remote stick control	3	4	4	4	4.0	3	3.67	3.86
2	Slave to acquisition	2.5	4	4	4	3.8	4	3.72	3.71
3	TV tracking	2.5	4	4	4	3.7	3	3.54	3.62
4	Star calibration	2	4	4	4	3.5	2	3.24	3.33
5	Auto unwrap	1.5	4	4	4	3.6	2	3.18	3.38
e. Documentation and training									
1	Documentation	2.5	4	4	4	3.9	4	3.74	3.81
2	Factory training	2	4	3	3	2.6	4	3.10	2.70
3	On-site training	2	4	4	3	3.9	4	3.48	3.65

[1] Ratings: 1 - not desired, 2 - desired, not required, 3 - desired if cost not an issue, 4 - "must have" requirement.
[2] Organizations: Kennedy Space Center (KSC), Pacific Missile Range Facility (PMRF), Sandia Laboratories, Textron Maui, White Sands Missile Range (WSMR), and 46th Test Group, Holloman Air Force Base.
[3] Range/organizational average: Average of all input giving one vote to each organization (i.e. not a weighted average).
[4] Individual average: Average rating of each person providing input, noting that some organizations had more than one person providing input.

TABLE 2-3. SURVEY RATINGS: KENNEDY SPACE CENTER (KSC)

Requirements \ Rating Organization		KSC Response 1	KSC Response 2	KSC Average
a. Pedestal				
1	Large, 6 mounting platforms	2	2	2
2	Small, 2-4 mounting platforms	1	3	2
3	Low cost, 4 mounting platforms	2	1	1.5
4	1200 lb. payload	1	1	1
5	1000 lb payload	2	1	1.5
6	900 lb payload	4	1	2.5
7	250 lb payload	4	4	4
8	Digital control system	4	4	4
9	Indosyn encoders	2	3	2.5
10	Optical encoders	1	2	1.5
11	Weatherproof	4	4	4
12	Modular cabling	2	1	1.5
13	Stainless steel hardware	4	1	2.5
14	Acceleration 0-45	4	2	3
15	Acceleration 0-120	1	1	1
16	Velocity 0.6 - 45	4	2	3
17	Velocity 0.6 -120	1	1	1
18	Velocity dynamic range 1 - 1000	2	1	1.5
19	Servo drift	2	1	1.5
20	Transient response	4	1	2.5
21	Rate loop frequency response	2	1	1.5
22	Dynamic and static accuracy	2	1	1.5
23	Encoder strobe	2	1	1.5
24	Bearing system accuracy	2	1	1.5
25	Three point leveling and shock absorber system	4	1	2.5
26	Master bubble	4	1	2.5
27	Azimuth carriage assembly	4	1	2.5
28	Elevation tracking assembly	4	1	2.5
29	Center mounting structure movement	2	1	1.5
30	Side mount structure movement	4	1	2.5
31	Transport locks	4	1	2.5
32	Remote drive out of limit	4	1	2.5
33	Electronic pre-limits	4	1	2.5

TABLE 2-3 (CONTINUED). SURVEY RATINGS: KENNEDY SPACE CENTER

Requirements \ Rating Organization		KSC Response 1	KSC Response 2	KSC Average
b. Trailer				
1	Working deck	4	1	2.5
2	Air-conditioning and humidity controls	4	4	4
3	Transportability	2	1	1.5
4	Brakes	4	1	2.5
5	Power and distribution panel	4	1	2.5
6	Modular cabling	4	1	2.5
7	Safety features	2	1	1.5
8	Rugged cable interface	4	1	2.5
9	Rotation meters	4	1	2.5
10	Auto leveling	2	4	3
11	Metal jack stands	4	1	2.5
12	Towing hitch	4	1	2.5
13	Spare tire and wheel	2	1	1.5
14	Lifting rings	2	1	1.5
c. Pedestal enclosure				
1	Remote control open/close	2	4	3
2	One person operation with power	4	1	2.5
3	Two person operation without power	4	1	2.5
4	Safety straps	4	1	2.5
d. Control system/tracking				
1	Remote stick control	4	2	3
2	Slave to acquisition	3	2	2.5
3	TV tracking	3	2	2.5
4	Star calibration	2	2	2
5	Auto unwrap	2	1	1.5
e. Documentation and training				
1	Documentation	4	1	2.5
2	Factory training	3	1	2
3	On-site training	3	1	2

TABLE 2-4. SURVEY RATINGS: PACIFIC MISSILE RANGE FACILITY (PMRF)

Requirements \ Rating Organization		PMRF Response
a. Pedestal		
1	Large, 6 mounting platforms	4
2	Small, 2-4 mounting platforms	1
3	Low cost, 4 mounting platforms	1
4	1200 lb. payload	4
5	1000 lb payload	1
6	900 lb payload	1
7	250 lb payload	1
8	Digital control system	4
9	Indosyn encoders	1
10	Optical encoders	4
11	Weatherproof	4
12	Modular cabling	4
13	Stainless steel hardware	4
14	Acceleration 0-45	4
15	Acceleration 0-120	4
16	Velocity 0.6 - 45	4
17	Velocity 0.6 -120	4
18	Velocity dynamic range 1 - 1000	4
19	Servo drift	4
20	Transient response	4
21	Rate loop frequency response	4
22	Dynamic and static accuracy	4
23	Encoder strobe	4
24	Bearing system accuracy	4
25	Three point leveling and shock absorber system	4
26	Master bubble	4
27	Azimuth carriage assembly	4
28	Elevation tracking assembly	4
29	Center mounting structure movement	4
30	Side mount structure movement	4
31	Transport locks	4
32	Remote drive out of limit	4
33	Electronic pre-limits	4

TABLE 2-4 (CONTINUED). SURVEY RATINGS: PACIFIC MISSILE RANGE FACILITY			
Requirements \ Rating Organization		PMRF	Response
b. Trailer			
1	Working deck	4	
2	Air-conditioning and humidity controls	4	
3	Transportability	4	
4	Brakes	4	
5	Power and distribution panel	4	
6	Modular cabling	4	
7	Safety features	4	
8	Rugged cable interface	4	
9	Rotation meters	4	
10	Auto leveling	4	
11	Metal jack stands	4	
12	Towing hitch	4	
13	Spare tire and wheel	4	
14	Lifting rings	4	
c. Pedestal enclosure			
1	Remote control open/close	4	
2	One person operation with power	4	
3	Two person operation without power	4	
4	Safety straps	4	
d. Control system/tracking			
1	Remote stick control	4	
2	Slave to acquisition	4	
3	TV tracking	4	
4	Star calibration	4	
5	Auto unwrap	4	
e. Documentation and training			
1	Documentation	4	
2	Factory training	4	
3	On-site training	4	

TABLE 2-5. SURVEY RATINGS: SANDIA LABORATORIES

Requirements \ Rating Organization		Sandia Laboratories Response
a. Pedestal		
1	Large, 6 mounting platforms	1
2	Small, 2-4 mounting platforms	1
3	Low cost, 4 mounting platforms	1
4	1200 lb. payload	1
5	1000 lb payload	1
6	900 lb payload	4
7	250 lb payload	1
8	Digital control system	4
9	Indosyn encoders	1
10	Optical encoders	4
11	Weatherproof	4
12	Modular cabling	4
13	Stainless steel hardware	3
14	Acceleration 0-45	4
15	Acceleration 0-120	3
16	Velocity 0.6 - 45	4
17	Velocity 0.6 -120	3
18	Velocity dynamic range 1 - 1000	3
19	Servo drift	4
20	Transient response	4
21	Rate loop frequency response	1
22	Dynamic and static accuracy	4
23	Encoder strobe	4
24	Bearing system accuracy	4
25	Three point leveling and shock absorber system	4
26	Master bubble	4
27	Azimuth carriage assembly	2
28	Elevation tracking assembly	4
29	Center mounting structure movement	3
30	Side mount structure movement	3
31	Transport locks	1
32	Remote drive out of limit	1
33	Electronic pre-limits	4

TABLE 2-5 (CONTINUED). SURVEY RATINGS: SANDIA LABORATORIES		
Requirements \ Rating Organization		Sandia Laboratories Response
b. Trailer		
1	Working deck	3
2	Air-conditioning and humidity controls	4
3	Transportability	4
4	Brakes	4
5	Power and distribution panel	4
6	Modular cabling	4
7	Safety features	4
8	Rugged cable interface	3
9	Rotation meters	4
10	Auto leveling	1
11	Metal jack stands	4
12	Towing hitch	4
13	Spare tire and wheel	4
14	Lifting rings	4
c. Pedestal enclosure		
1	Remote control open/close	4
2	One person operation with power	4
3	Two person operation without power	
4	Safety straps	3
d. Control system/tracking		
1	Remote stick control	4
2	Slave to acquisition	4
3	TV tracking	4
4	Star calibration	4
5	Auto unwrap	4
e. Documentation and training		
1	Documentation	4
2	Factory training	3
3	On-site training	4

TABLE 2-6. SURVEY RATINGS: TEXTRON MAUI

Requirements \ Rating Organization		Textron Maui Response
a. Pedestal		
1	Large, 6 mounting platforms	2
2	Small, 2-4 mounting platforms	2
3	Low cost, 4 mounting platforms	2
4	1200 lb. payload	2
5	1000 lb payload	2
6	900 lb payload	2
7	250 lb payload	2
8	Digital control system	4
9	Indosyn encoders	3
10	Optical encoders	3
11	Weatherproof	3
12	Modular cabling	4
13	Stainless steel hardware	2
14	Acceleration 0-45	4
15	Acceleration 0-120	3
16	Velocity 0.6 - 45	4
17	Velocity 0.6 -120	3
18	Velocity dynamic range 1 - 1000	4
19	Servo drift	4
20	Transient response	4
21	Rate loop frequency response	4
22	Dynamic and static accuracy	4
23	Encoder strobe	4
24	Bearing system accuracy	4
25	Three point leveling and shock absorber system	3
26	Master bubble	2
27	Azimuth carriage assembly	4
28	Elevation tracking assembly	4
29	Center mounting structure movement	4
30	Side mount structure movement	3
31	Transport locks	3
32	Remote drive out of limit	3
33	Electronic pre-limits	3

TABLE 2-6 (CONTINUED). SURVEY RATINGS: TEXTRON MAUI		
Requirements / Rating Organization		Textron Maui Response
b. Trailer		
1	Working deck	3
2	Air-conditioning and humidity controls	4
3	Transportability	3
4	Brakes	3
5	Power and distribution panel	3
6	Modular cabling	3
7	Safety features	3
8	Rugged cable interface	3
9	Rotation meters	3
10	Auto leveling	2
11	Metal jack stands	3
12	Towing hitch	3
13	Spare tire and wheel	3
14	Lifting rings	3
c. Pedestal enclosure		
1	Remote control open/close	2
2	One person operation with power	2
3	Two person operation without power	2
4	Safety straps	2
d. Control system/tracking		
1	Remote stick control	4
2	Slave to acquisition	4
3	TV tracking	4
4	Star calibration	4
5	Auto unwrap	4
e. Documentation and training		
1	Documentation	4
2	Factory training	3
3	On-site training	3

TABLE 2-7. SURVEY RATINGS: WHITE SANDS MISSILE RANGE (WSMR)

Requirements \ WSMR Ratings		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Avg
a. Pedestal																	
1	Large, 6 mounting platforms	3	4	3	1	2	4	4	4	4	4	4	4	4	4	2	3.4
2	Small, 2-4 mounting platforms	2	1	3	4	4	4	4	4	4	4	4	4	4	4	4	3.6
3	Low cost, 4 mounting platforms	1	1	1	4	2	1	1	1	1	1	1	1	1	1	1	1.3
4	1200 lb. payload	2	4	2	1	1	4	4	4	4	4	4	4	4	4	1	3.1
5	1000 lb payload	2	1	3	1	1	1	1	1	1	1	1	1	1	1	3	1.3
6	900 lb payload	3	1	3	1	4	1	1	1	1	1	1	1	1	1	3	1.6
7	250 lb payload	1	1	2	3	4	4	1	4	4	4	4	4	4	4	4	3.2
8	Digital control system	1	4	3	4	3	4	4	4	4	4	4	4	4	4	4	3.7
9	Indosyn encoders	4	4	4	3	3	4	4	4	4	4	4	4	4	4	4	3.9
10	Optical encoders	3	1	3	3	1	4	3	3	3	3	3	3	3	3	2	2.7
11	Weatherproof	4	3	4	3	3	4	4	3	3	3	3	3	3	3	3	3.3
12	Modular cabling	4	4	3	4	4	2	4	4	4	4	4	4	4	4	4	3.8
13	Stainless steel hardware	3	3	2	2	3	1	4	4	4	4	4	4	4	4	4	3.3
14	Acceleration 0-45	1	1	4	4	3	4	4	4	4	4	4	4	4	4	1	3.3
15	Acceleration 0-120	4	4	3	3	4	2	4	4	4	4	4	4	4	4	4	3.7
16	Velocity 0.6 - 45	1	1	4	4	3	4	4	4	4	4	4	4	4	4	1	3.3
17	Velocity 0.6 -120	4	4	3	3	4	2	4	4	4	4	4	4	4	4	4	3.7
18	Velocity dynamic range 1 - 1000	4	1	3	4	3	4	4	4	4	4	4	4	4	4	3	3.6
19	Servo drift	4	4	4	3	3	4	4	2	2	2	2	2	2	2	4	2.9
20	Transient response	2	4	4	4	3	4	4	4	4	4	4	4	4	4	4	3.8
21	Rate loop frequency response	4	3	4	4	3	3	4	3	3	3	3	3	3	3	4	3.3
22	Dynamic and static accuracy	4	4	4	4	4	4	4	3	3	3	3	3	3	3	4	3.5
23	Encoder strobe	3	3	4		3		4	3	3	3	3	3	3	3	4	3.2
24	Bearing system accuracy	3	3	3	1	3	4	4	3	3	3	3	3	3	3	4	3.1
25	Three point leveling and shock absorber system	4	4	4	1	4	4	4	4	4	4	4	4	4	4	4	3.8
26	Master bubble	4	4	4	3	4	4	4	4	4	4	4	4	4	4	4	3.9
27	Azimuth carriage assembly	4	4	3	2	4	4	4	4	4	4	4	4	4	4	4	3.8
28	Elevation tracking assembly	4	4	3	3	4	4	4	4	4	4	4	4	4	4	4	3.9
29	Center mounting structure movement	3	4	4	4	4	4	4	3	3	3	3	3	3	3	4	3.5

TABLE 2-7 (CONTINUED). SURVEY RATINGS: WHITE SANDS MISSILE RANGE (WSMR)																	
30	Side mount structure movement	4	4	3	4	4	3	4	4	4	4	4	4	4	4	4	3.9
31	Transport locks	4	4	4	4	4	4	4	3	3	3	3	3	3	3	4	3.5
32	Remote drive out of limit	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4.0
33	Electronic pre-limits	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4.0
b. Trailer																	
1	Working deck	3	4	3	4	4	4	4	4	4	4	4	4	4	4	3	3.8
2	Air-conditioning and humidity controls	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4.0
3	Transportability	3	3	4	4	4	4	4	4	4	4	4	4	4	4	4	3.9
4	Brakes	4	4	4	3	4	4	4	4	4	4	4	4	4	4	4	3.9
5	Power and distribution panel	4	4	3	4	4	4	4	4	4	4	4	4	4	4	4	3.9
6	Modular cabling	4	4	3	4	4	3	4	4	4	4	4	4	4	4	4	3.9
7	Safety features	4	4	4	3	4	4	1	4	4	4	4	4	4	4	4	3.7
8	Rugged cable interface	4	4	4	4	4	3	4	4	4	4	4	4	4	4	4	3.9
9	Rotation meters	4	3	2	2	4	3	4	1	1	1	1	1	1	1	4	2.2
10	Auto leveling	2	3	2	1	3	3	4	2	2	2	2	2	2	2	4	2.4
11	Metal jack stands	4	4	3	4	4	4	1	4	4	4	4	4	4	4	4	3.7
12	Towing hitch	4	4	3	4	4	4	1	4	4	4	4	4	4	4	4	3.7
13	Spare tire and wheel	2	4	4	2	4	4	4	1	1	1	1	1	1	1	4	2.3
14	Lifting rings	2	4	4	2	2	3	1	4	4	4	4	4	4	4	4	3.3
c. Pedestal enclosure																	
1	Remote control open/close	3	4	2	4	3	4	4	3	3	3	3	3	3	3	3	3.2
2	One person operation with power	4	3	3	3	4	4	4	3	3	3	3	3	3	3	4	3.3
3	Two person operation without power	4	4	4	2	1	4	1	4	4	4	4	4	4	4	4	3.5
4	Safety straps	4	4	4	2	4	4	1	4	4	4	4	4	4	4	4	3.7
d. Control system/tracking																	
1	Remote stick control	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4.0
2	Slave to acquisition	1	4	4	4	4	4	4	4	4	4	4	4	4	4	4	3.8
3	TV tracking	1	4	4	4	4	3	4	4	4	4	4	4	4	4	4	3.7
4	Star calibration	1	3	2	4	3	3	4	4	4	4	4	4	4	4	4	3.5
5	Auto unwrap	1	3	3	4	4	3	4	4	4	4	4	4	4	4	4	3.6
e. Documentation and training																	
1	Documentation	4	4	3	4	4	4	4	4	4	4	4	4	4	4	4	3.9
2	Factory training	2	3	3	2	4	4	4	2	2	2	2	2	2	2		2.6
3	On-site training	3	4	4	3	4	4	4	4	4	4	4	4	4	4		3.9

TABLE 2-8. SURVEY RATINGS: 46th TEST GROUP (HOLLOMAN AFB SLED TRACK)

Requirements \ Rating Organization		HAFB Response
a. Pedestal		
1	Large, 6 mounting platforms	2
2	Small, 2-4 mounting platforms	4
3	Low cost, 4 mounting platforms	3
4	1200 lb. payload	1
5	1000 lb payload	1
6	900 lb payload	3
7	250 lb payload	4
8	Digital control system	3
9	Indosyn encoders	3
10	Optical encoders	3
11	Weatherproof	4
12	Modular cabling	3
13	Stainless steel hardware	1
14	Acceleration 0-45	2
15	Acceleration 0-120	4
16	Velocity 0.6 - 45	2
17	Velocity 0.6 -120	4
18	Velocity dynamic range 1 - 1000	3
19	Servo drift	3
20	Transient response	3
21	Rate loop frequency response	3
22	Dynamic and static accuracy	2
23	Encoder strobe	3
24	Bearing system accuracy	3
25	Three point leveling and shock absorber system	3
26	Master bubble	3
27	Azimuth carriage assembly	3
28	Elevation tracking assembly	3
29	Center mounting structure movement	3
30	Side mount structure movement	3
31	Transport locks	3
32	Remote drive out of limit	3
33	Electronic pre-limits	3

TABLE 2-8 (CONTINUED). SURVEY RATINGS 46th TEST GROUP HOLLOMAN AFB SLED TRACK		
Rating Organization / Requirements		HAFB Response
b. Trailer		
1	Working deck	3
2	Air-conditioning and humidity controls	2
3	Transportability	3
4	Brakes	2
5	Power and distribution panel	3
6	Modular cabling	3
7	Safety features	3
8	Rugged cable interface	3
9	Rotation meters	3
10	Auto leveling	2
11	Metal jack stands	4
12	Towing hitch	4
13	Spare tire and wheel	2
14	Lifting rings	2
c. Pedestal enclosure		
1	Remote control open/close	2
2	One person operation with power	2
3	Two person operation without power	2
4	Safety straps	3
d. Control system/tracking		
1	Remote stick control	3
2	Slave to acquisition	4
3	TV tracking	3
4	Star calibration	2
5	Auto unwrap	2
e. Documentation and training		
1	Documentation	4
2	Factory training	4
3	On-site training	4

TABLE 2-9. SURVEY RATINGS: ADDITIONAL ITEMS SUGGESTED BY RANGES
GPS and electronic compass for automatic bore sighting and orientation alignment
Remote stow/unstop
Small deployable lifting apparatus for lens assemblies
Integrated wing adjustments for bore sighting lens (slide table arrangement)
Onboard multi-image display as alignment tool
Automatic axis brakes when not energized
Center platform width large enough to accommodate 36-in diameter
Large pedestal with operator seat
Large pedestal with azimuth (Az) and elevation (El) rail adjustments
T-bolt mounting on platforms
1500 lb payload capacity
Azimuth carriage lockdown
Azimuth carriage physical stop
Elevation carriage +/- 100 degrees rotation from vertical
Alarmed and hardened storage for classified material
Trailer approved for military helicopter carry
Easily removed operator seat for alternate equipment
1000 lb balancing weights
Slip rings
Additional tracking requirements to include: 2 arc second RMS pointing calibration using stars; pointing calibration on a per sensor basis; point and click user interface for tracking and pointing (using video sources); provide equations of motion for all track modes; Track modes for stars, planets, missiles, satellites and non-deterministic targets; Multi-target tracks; Tracking on Nominal Ephemeris File; Filtered track response to acquisition sources; Multiple acquisitions sources with statistics to evaluate quality; Database of satellite element sets; Accept inter-range vectors; Real-time sun avoidance; Open-loop and rate aided joystick tracking; Transition from slave to open-loop tracking; Select Azimuth position to avoid cable unwrap during mission; Scriptable and remote operations; Automated pointing calibrations; Laser operations and laser ranging
Nasmyth and coude path for optical instruments/sensors
Source code provided
Operator display of encoder position
Isolation of trailer from pedestal with pedestal mount to camera pad seismic block
Capability to drive elevation to "dump" position
Lift rings on pedestal for lifting from trailer
Stick polarity reversal
PC-104 hardware instead of versaModule Eurocard (VME) bus
Auto focusing tables for lenses
Tie down points for the platform

TABLE 2-9 (CONTINUED). ADDITIONAL ITEMS SUGGESTED BY RANGES
Integral steps or ladders for easy deck access from the ground
Switchable and recessed deck and pedestal lighting
Stay close to a KTM/LAT with state-of-the-art, affordable, improvements
Focus on making the setup faster and failure proof
Focus on modularity
Keep decreasing manpower in mind. May have to spend more on technology to make up for fewer people
Spare parts up front.
GPS differentially corrected instrument.
Painted yellow safety ring and strobe warning light when under power
Elevation dump and automatic target boards
Velocity deviation should be down to ~0.004 deg/sec for sidereal tracking
The velocity loop bandwidth should be 10x the position loop bandwidth and the current loop bandwidth should be at least 10x the velocity loop. The sample rate for each loop should be 10x - 20x the bandwidth.
Machined surface for use with calibrating levels
Safer step ladders
Warranty
Platform length 48", width at least 26"
Any special tooling or jigs required to maintain system
Digital system source code
Built-in storage for jack stands, winches, etc. in trailer
1200 lb payload - large pedestal, 250 lb payload - small pedestal
Continuous azimuth rotation
Delete requirement for camera control cavities in pedestal
Elevation rotation -15 to 195 degrees
Independent interlocks with unique indicators
Air brakes on trailer
Non-skid surface on trailer

CHAPTER 3

SPECIFICATIONS FOR LARGE TRACKING SYSTEM (LTS)

The large tracking system consists of a pedestal and an enclosure for that pedestal, mounted on a mobile trailer. Individual components of the tracking system are as follows:

Pedestal	Paragraph 3.1 (below)
Trailer	Paragraph 3.2
Pedestal enclosure	Paragraph 3.3
Control system/tracking	Paragraph 3.4
Documentation and training	Paragraph 3.5

Based on coordination by the Optical Systems Group (OSG) with the ranges, specifications for each component are designated as either *required* or *highly desired*.

3.1 Pedestal

3.1.1 Required Specifications.

a. 1200+ lbs. payload
b. Six (6) mounting platforms
   (1) One on each side outboard of the elevation axis bearing assemblies, 48 inches in length and 26 inches wide
   (2) One in between the elevation axis bearing assemblies
   (3) Each with over and under mounting access
   (4) Each of the six platforms bearing weight 200 lbs
   (5) Width of center platform wide enough to accommodate at least a 24-inch diameter lens
   (6) Standard T-bolt mounting slots
c. Digital control system (preferably PC104 architecture)
   (1) Position-loop architecture to handle non-linear amplifier/load combination (i.e. current saturation)
   (2) Diagnostics
   (3) Remote control and monitoring of safety functions
   (4) Automatic characterization and notch (for payload changes)
   (5) Programmable filters
   (6) Storable configurations with easy retrieval
d. At least 21-bit encoders, inductosyn or optical
e. Acceleration - Continuously variable from 0 to at least 45 deg/sec^2
f. Velocity - Continuously variable from 0.6 to at least 45 deg/sec
g. Modular cabling interfaces for improved troubleshooting and technological adaptation on tines
   (1) 1 - 10 video lines with isolated feed-through
   (2) 6 Ethernet (shielded CAT-6 and covered RJ-45 receptacles)
   (3) 4 - 6 fiber optics pairs (single-mode)
   (4) 1 - 2 VSR-192 cables (12 fibers each)

(5) 4 - 6 RS232/422 cables
(6) FDA cabling
(7) 2 - 4 trigger lines
(8) 2 - 4 IRIG lines
(9) Digital cameral controls

h. Transient response - When a 0.5 volt step input is applied to the drive input, the tachometer output shall not overshoot the final velocity by more that 5 percent and shall be damped to 2 percent within 1 cycle.
i. Three-point leveling and shock absorber system
   (1) Stationary base assembly of the pedestal interfacing with the trailer base structure
   (2) Leveling screws: 6 minute, circular (bulls eye) installed for viewing when performing pedestal leveling procedures
j. Master bubble level with range of 10 arc seconds and resolution of +/- 2 arc seconds
k. Azimuth carriage assembly
   (1) Two cavities that will provide space for camera control or other electronics
   (2) Rotation of 335 degrees in each direction from the center point, for a total of 670 degrees
   (3) Analog dc voltage output proportional to the rotation of the azimuth axis
l. Elevation tracking assembly
   (1) Transport locks at 0, 90 and 180 degrees
   (2) Rotation of 180 degrees
   (3) Analog dc voltage output proportional to the rotation of the elevation axis
   (4) Perpendicular to azimuth axis, with full weight load, throughout entire range of travel to within +/- 5 arc seconds
m. Side mounting structure shall allow for +/- 4 inches of vertical movement
n. Ability to remotely drive pedestal out of the limit
o. Electronic pre-limits to prevent driving axis into the hard stop

3.1.2 Highly Desired Specifications.

a. Weatherproof
   (1) Operable in all weather conditions
   (2) Temperature and humidity controlled electronic bays
b. Velocity - Dynamic range of 1000 to 1 (i.e. at 15 deg/sec average velocity, the actual velocity deviation must not exceed +/-0.015 deg/sec)
c. Energized servo system random drift shall not exceed 1 degree over a 3 minute interval of time, where the source of the drift includes all internal system fluctuations due to temperature, vibration, and aging of the component parts.
d. Acceleration - Continuously variable from 0 to 120 deg/sec2
e. Velocity - Continuously variable from 0.6 to 120 deg/sec
f. Stainless steel hardware
g. Rate loop frequency response bandwidth at least 14 Hz

h. Encoder Strobe
   (1) Low transistor-transistor logic (TTL) pulse
   (2) Data available for reading within 600ns of falling edge
   (3) Data latched until rising edge
i. Bearing System Accuracy
   (1) Bearing runout no greater than +/- 3 arc seconds
   (2) Azimuth and elevation wobble no greater than +/- 2 arc seconds
j. Azimuth slip rings
k. Bearing System Accuracy
   (1) Bearing runout no greater than +/- 3 arc seconds
   (2) Azimuth and elevation wobble no greater than +/- 2 arc seconds
l. Center mounting structure
   (1) Adjustable through +/- 2 degrees of arc
   (2) Indexing reference to allow package to be removed and reinstalled to within +/- 0.125 degrees of original position
m. Transport locks shall be electrically interlocked with the servo system
n. Dynamic and static accuracy - The encoder system shall provide mount position to an accuracy of +/- 0.00137 degrees during tracking (about 5 arc seconds).

3.2 Trailer

3.2.1 Required Specifications.

a. Working deck for the user and housing for the electronics
   (1) 12 - 15 feet length
   (2) 6.5 - 7 ft wide
   (3) 33 - 36 inches off the ground
   (4) Expanding sides for additional 15 inches of work surface on each side
   (5) Gross weight of pedestal, electronics and enclosure not to exceed 10,000 lbs
b. Air-conditioner and humidity controls in the trailer for the electronics
c. Transportability
   (1) Good axels, tires and shock absorption
   (2) Air-ride suspension
   (3) 4 tire axles
   (4) Air hitch
d. Brakes
   (1) Service brakes on all wheels
   (2) Electric brakes on each wheel, controlled from and operated simultaneously with the brakes of the towing vehicle
e. Power and distribution panel (PDU)
   (1) Combination power ON/OFF switch and circuit breaker
   (2) Separate circuit breakers for each side of the azimuth carriage assembly
   (3) Common, high-quality ground for both tines and electronics enclosure
   (4) Self-cleaning ground connection at trailer i/o panel
   (5) Power cable reel:
      - Accessible for maintenance
      - Built-in, ratchet-stop, automatic return

- 50 ft or more of 5 conductor No. 8 AWG with ground, vermin resistant, neoprene type insulation, copper electrical power cable
- Male connector, 60 amp, 240 volt dc, 400 volt ac, Russell Stoll 3128W, 4-pin + GND on power cable end

(6) Reset able/ replaceable surge suppressor with clearly visible diagnostic indicators
(7) Voltage and current meters visible day and night for each phase of the applied 208V, three-phase, 4 conductor, 60 Hz ac power.
(8) Nothing phase-sensitive
(9) Four (4) standard 120V ac, 60 Hz, single phase, three-wire female, GFI-protected convenience receptacles
(10) Some/all convenience receptacles tied to user-provide UPS
(11) Filtered (UPS) and non-filtered busses
(12) Servo chassis input filtered to minimize noise
(13) Motor cabling heavily shielded to minimize switching noise transmission

f. Modular cabling interfaces for improved troubleshooting and technological adaptation for trailer I/O
(1) 2-6 fibers for mount control
(2) 9-port video
(3) 2-4 fiber pairs for digital video and/or digital timing distribution
(4) 4-6 general purpose fiber optic pairs
(5) 1-2 VSR-192 cables (50 to 100 percent spares)

g. Ruggedized cable interfaces
h. Metal jack stands
i. Towing hitch - standard military type pintle compatible with Holland RCXE 1230

3.2.2 Highly Desired Specifications.

a. Safety features
(1) Deck surface paint for danger areas
(2) Power kill switch on operator's console and front and back of trailer
(3) Warning light / indicator for live servo
(4) Trailer stairs wide enough for someone carrying equipment
(5) Trailer stairs on both sides of tongue as well as rear

b. Lifting rings at each corner of the trailer, designed for lifting trailer and pedestal with full payload
c. Rotation meters visible day and night
d. Auto leveling of trailer
(1) Very low speeds necessary to achieve required accuracy
(2) Variable speeds necessary to make system usable

e. Spare tire and wheel assembly
f. Shock absorber for the hitch assembly

3.3 Pedestal Enclosure

3.3.1 Required Specifications.

Almost all specifications were identified as "Highly Desired."

3.3.2 Highly Desired Specifications.

a. Remotely-controlled open/close
b. One person operation with power
c. Two person operation without power
d. Safety straps to prevent inadvertent side opening

3.4 Control System/Tracking

3.4.1 Required Specifications.

a. Remote stick control
b. Slave to acquisition source
c. TV tracking

3.4.2 Highly Desired Specifications.

a. Star calibration capability
b. Auto unwrap
c. Digital system source code
d. Real-time sun avoidance
e. Multi-target tracking

3.5 Documentation and Training

3.5.1 Documentation.

a. Hardcopy and electronic
b. Detailed theory of operation
c. Maintenance instructions for motor, bearing, encoder
d. Major component removal and replacement instructions
e. Verification of encoder accuracy, orthogonality, bearing wobble and run out
f. Electrical drawings and schematics
g. Parts list

3.5.2 Training.

a. On-site operational and maintenance training.
b. Optional factory training.

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CHAPTER 4

SPECIFICATIONS FOR SMALL TRACKING SYSTEM (STS)

The small tracking system consists of a pedestal and an enclosure for that pedestal, mounted on a mobile trailer. Individual components of the tracking system are as follows:

Pedestal	Paragraph 4.1 (below)
Control system/tracking	Paragraph 4.2
Documentation and training	Paragraph 4.3

Based on coordination by the Optical Systems Group (OSG) with the ranges, specifications for each component are designated as either *required* or *highly desired*.

4.1 Pedestal

4.1.1 Required Specifications.

a. 250 lbs. payload
b. 2 to 4 mounting platforms
   (1) One on each side outboard of the elevation axis bearing assemblies
   (2) Each with over and under mounting access
c. Digital control system, preferably PC104 architecture
   (1) Position-loop architecture to handle non-linear amplifier/load combination, i.e. current saturation
   (2) Diagnostics
   (3) Remote control and monitoring of safety functions
   (4) Automatic characterization and notch (for payload changes)
   (5) Programmable filters
   (6) Storable configurations with easy retrieval
d. At least 21-bit encoders, inductosyn or optical
e. Acceleration - Continuously variable from 0 to at least 120 deg/sec^2
f. Velocity - Continuously variable from 0.6 to at least 120 deg/sec
g. Modular cabling interfaces for improved troubleshooting and technological adaptation on tines
   (1) 1 - 10 video lines with isolated feed-through
   (2) 6 Ethernet (shielded CAT-6 and covered RJ-45 receptacles)
   (3) 4 - 6 fiber optics pairs (single-mode)
   (4) 1 - 2 VSR-192 cables (12 fibers each)
   (5) 4 - 6 RS232/422 cables
   (6) Frequency domain analysis (FDA) cabling
   (7) 2 - 4 trigger lines
   (8) 2 - 4 Inter Range Instrumentation Group (IRIG) lines
   (9) Digital cameral controls

h. Transient response - When a 0.5 volt step input is applied to the drive input, the tach output shall not overshoot the final velocity by more that 5 percent and shall be damped to 2 percent within 1 cycle.
i. Three-point leveling and shock absorber system - Leveling screws: 6 minute, circular (bulls eye) installed for viewing when performing pedestal leveling procedures
j. Master bubble level with range of 10 arc seconds and resolution of +/- 2 arc seconds
k. Azimuth carriage assembly
    (1) Two cavities that will provide space for camera control or other electronics
    (2) Rotation of 335 degrees in each direction from the center point, for a total of 670 degrees
    (3) Analog dc voltage output proportional to the rotation of the azimuth axis
l. Elevation tracking assembly
    (1) Transport locks at 0, 90 and 180 degrees
    (2) Rotation of 180 degrees
    (3) Analog dc voltage output proportional to the rotation of the elevation axis
    (4) Perpendicular to azimuth axis, with full weight load, throughout entire range of travel to within +/- 5 arc seconds
m. Side mounting structure shall allow for +/- 4 inches of vertical movement
n. Ability to remotely drive pedestal out of the limit
o. Electronic pre-limits to prevent driving axis into the hard stop

4.1.2 Highly Desired Specifications.

a. Weatherproof
    (1) Operable in all weather conditions
    (2) Temperature and humidity controlled electronic bays
b. Velocity - Dynamic range of 1000 to 1 (i.e. at 15 deg/sec average velocity, the actual velocity deviation must not exceed +/-0.015 deg/sec)
c. Energized servo system random drift shall not exceed 1 degree over a 3-minute interval of time, where the source of the drift includes all internal system fluctuations due to temperature, vibration, and aging of the component parts.
d. Acceleration - Continuously variable from 0 to 120 deg/ sec^2
e. Velocity - Continuously variable from 0.6 to 120 deg/sec
f. Stainless steel hardware
g. Rate loop frequency response bandwidth at least 14 Hz
h. Encoder Strobe
    (1) Low TTL pulse
    (2) Data available for reading within 600ns of falling edge
    (3) Data latched until rising edge
i. Bearing System Accuracy
    (1) Bearing runout no greater than +/- 3 arc seconds
    (2) Azimuth and elevation wobble no greater than +/- 2 arc seconds
j. Azimuth slip rings
k. Center mounting structure
    (1) Adjustable through +/- 2 degrees of arc

(2) Indexing reference to allow package to be removed and reinstalled to within +/- 0.125 degrees of original position

l. Transport locks shall be electrically interlocked with the servo system

m. Dynamic and static accuracy - The encoder system shall provide mount position to an accuracy of +/- 0.00137 deg during tracking (about 5 arc seconds).

4.2 Control System/Tracking

4.2.1 Required Specifications.

a. Remote stick control
b. Slave to acquisition source
c. TV tracking

4.2.2 Highly Desired Specifications.

a. Star calibration capability
b. Auto unwrap
c. Digital system source code
d. Real-time sun avoidance
e. Multi-target tracking

4.3 Documentation and Training

4.3.1 Documentation.

a. Hardcopy and electronic
b. Detailed theory of operation
c. Maintenance instructions for motor, bearing, encoder
d. Major component removal and replacement instructions
e. Verification of encoder accuracy, orthogonality, bearing wobble and run out
f. Electrical drawings and schematics
g. Parts list

4.3.2 Training.

a. On-site operational and maintenance training.
b. Optional factory training.

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CHAPTER 5

INDUSTRY RESPONSE AND CONCLUSIONS

5.1 Industry Response to "Sources Sought" Statement

In an effort to investigate the suitability and appropriateness of the procurement specifications presented in Chapter 3 and Chapter 4, White Sands Missile Range published a "Sources Sought" request on the WSMR contracting web site (see Appendix-A).

In response to the Sources Sought, several companies submitted input. The companies included Photo-Sonics, L3-Brashear, Orbit, and Boeing-SVS. Only Photo-Sonics and Brashear responded directly to the specifications (see Appendix-B and Appendix-C respectively). Orbit submitted standard brochures and Boeing-SVS stated that they were interested in submitting input later. Should the reader require more information, he should contact the individual company(s) directly.

5.2 Conclusions

As indicated by the industry response section, there are several companies interested in designing and selling the OSG community the next generation of tracking mount. If any range is ready to pursue the contract for a new generation tracking mount, WSMR is ready to handle the procurement effort.

Although private industry is quite capable of building tracking mounts to the specifications contained herein, it will be costly. Given the general lack of funding available for the development of an entirely new tracking mount, ranges may want to consider a refurbishment effort instead. Recently, WSMR and the National Aeronautics and Space Administration (NASA) joined in an effort to refurbish all of the NASA Kineto Tracking Mount (KTM) instruments and integrate a remote control system. Several companies are now marketing digital control systems that can be adapted to different instrumentation. Most of these include the options listed in the Control System specifications contained in this document (see Chapter 3 and Chapter 4).

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APPENDIX A

SOURCES SOUGHT SYNOPSIS

The following is a synopsis of what was published on the WSMR contracting webpage.

General Information

Document Type:	Sources Sought Notice		Original Archive Date:	May 05, 2006
Solicitation Number:	W9124Q-06-LTS		Current Archive Date:	May 05, 2006
Posted Date:	Feb 08, 2006		Classification Code:	66 -- Instruments & laboratory equipment
Original Response Date:	Mar 06, 2006		Set Aside:	N/A
Current Response Date:	Mar 06, 2006			

Contracting Office Address

ACA, White Sands Missile Range, Directorate of Contracting, Bldg 143, 2nd Floor, Crozier Street, White Sands Missile Range, NM 88002-5201

Description

White Sands Missile Range (WSMR) has been tasked with developing a common tracking mount specification to be utilized in acquiring the next generation of optical tracking systems. The old Kineto Tracking Mounts designed and procured during the mid t o late 1980s have surpassed expectation for life-cycle mission support at member Ranges of the Range Commanders Council (RCC). While many systems still function, they are composed of numerous obsolete components and sub-systems. The future demands a specification for a new tracking system to serve the future requirements of the Ranges be developed and replacement of the old systems executed. Requirements have changed over time and will change into the future. The new tracking systems should have commonality across the ranges to reduce cost, provide the platform for the digital future while maintaining the accuracy to be the platform of choice for precision optical data collection and the versatile capabilities of the previous platforms. WSMR is seeking comments through this sources sought announcement that address the proposed specifications and industry capabilities. Required and desired specifications for the Large Tracking System (LTS) and Small Tracking System (STS) are available at http://www.wsmr.army .mil/docpage/pages/sol_stat.htm. This is a request for submission of comments only and not a request for proposals. The information obtained through this announcement will be condensed and presented to the Optical Systems Group in late March by a WSMR representative and utilized in formulating a realistic set of specifications to be used in a competitive purchase of the next generation of tracking systems. Comments must be submitted electronically to Nan Tindal at nan.tindal@us.army.mil and must be received NLT 4:00 PM MST on 06 March 2006.

Point of Contact

Martha S. Robles, (505)678-4936
Email your questions to ACA, White Sands Missile Range at roblesms@wsmr.army.mil

Place of Performance

Address: ACA, White Sands Missile Range Directorate of Contracting,
Bldg 143, 2nd Floor, Crozier Street White Sands Missile Range NM

Postal Code: 88002-5201, Country: US

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APPENDIX B

PHOTO-SONICS RESPONSE

Response to the Sources Sought Preliminary Specification for a Large Tracking System (LTS)

March 6, 2006

PHOTO-SONICS, Inc.

820 S. Mariposa Street
Burbank, CA 91506
Phone: 818 842-2141
FAX: 818 842-2610
Email: mail@photosonics.com

White Sands Sources Sought for LTS and STS

PHOTOSONICS OPTICAL TRACKING SYSTEMS

Optical Tracking Mounts have evolved from early manually controlled positioning systems to extremely complex data gathering observation platforms connected to enterprise range data systems. With the increasing sophistication of the range missions, Photo-Sonics has added digital control electronics and high level user interfaces for calibrating and controlling the tracking mount. These controls have been developed to enable our customers to use the tracking mount to its fullest capability. Photo-Sonics' systems homologation insures that each component is selected and developed so that it does not become the weak point preventing the system from performing at the accuracy level required for critical use.

Photo-Sonics Tracking Mounts are designed for critical use requirements. Critical use requirements are those for gathering time, space, and position information where the *highest accuracy* is required, in addition to providing engineering sequential data consisting of high speed film or digital images.

The philosophy is that TSPI data should be captured at the highest accuracy possible at the mount so that it requires the *minimum amount of interpolation* to insure meaningful results. At the same time the tracking mount should provide a platform capable of supporting the payload weight requirements without degrading performance. Optical data should be taken at the highest resolution, with appropriate sensors and lenses, to meet the mission requirements. Photo-Sonics offers superior calibration methods for ensuring the highest possible accuracy.

Photo-Sonics tracking mounts support the heaviest payloads in the industry allowing the greatest flexibility in configuration and range mission. Our tracking mounts can be configured for a single station solution by supporting the largest number of instruments and on-board interfaces to other range data systems. The tracking mount includes a trunnion and base computer to simplify the platform wiring and data pathways. A fiber optic interface is offered for connection to remote console or range control center. Taken together these improvements define the standard for tracking mount performance.

The Photo-Sonics' family of Optical Tracking Systems have many common features. We use solid castings for the azimuth trunnion. The castings are force-aged to ensure long term stability. Our mobile mounts are configured with a 4 jack system to provide the stability of the payload under high dynamic conditions. We use heavy trailers to provide a stable base for the pedestal and to support the additional equipment needed in the field. We manufacture our motors to our specifications that are ideally suited to the performance requirements of the Tracking Systems.

All of our tracking mounts are using the Photo-Sonics' Argus 2000 Digital Control System for a remote control capability, diagnostics, star calibration, multi-target tracking, target simulation, integration to the range control center, multiple coordinate systems etc. Other integral parts of the Argus 2000 are the digital servo amp, ac filters, digital encoders, and computer controls.

Background

This section provides a brief technical description of two of the tracking mounts manufactured by Photo-Sonics. Our response consists of a series of modifications to these existing tracking mounts to satisfy your requirements so the descriptions we offer are relevant to the new configurations we are offering.

1. Cine-Sextant and Cine-Sextant II - Large Class Tracking System

The Cine-Sextant was designed and manufactured beginning in 1963. A total of 100 systems were manufactured through 1981. Since the mid-1970's we began refurbishing and upgrading Cine-Sextants. In 1988, we designed rare earth torque motors for the elevation axis and began offering an all-electric system with a pulse-width modulated power amplifier, electric jacks, dumping capability, and many more features indicated in your request for information. Today, we offer a complete integrated system for this mount with a digital amplifier and Argus 2000 Digital Control System with a long list of new features.

Dynamic Accuracy of Cine-Sextant II

The accuracy of a tracking mount system under high dynamic conditions is of paramount importance. The accuracy of the Cine-Sextant II is derived from the following:

- **Single Solid Casting** – The azimuth trunnion is produced from a single casting that provides support for the elevation motors. It is force-aged to ensure long-term stability.

48-INCH BEARING – THE 48-INCH HIGH PRECISION BEARING WITH BASE AND TRUNNION CASTINGS HAND SCRAPED USING A PROPRIETARY METHOD OF SCRAPING BEFORE THE BEARING IS INSTALLED.

- **Large Heavy trailer –** The Cine-Sextant has a large and heavy trailer with dual axels. The heavy trailer provides a stable base for the pedestal and houses the equipment required to support the hydraulic actuators.

- **Jacks** – The Cine-Sextant II uses 4 custom motorized jacks designed and manufactured specifically to hold the weight of the tracking mount and provide

stability of the payload under high dynamic conditions. The use of four jacks provides superior stability over the use of a three-jack configuration. It has been shown that to achieve the same degree of stability as in a four-jack system, the three jacks system would require the length between jacks to be *twice as long*.

- **Elevation Motor Bearing** – The elevation motor housings of the Cine-Sextant II are made of steel. After the housing is cast, heat-treated, and machined to a high degree of accuracy, the bearings are pressed into the housing.

- **Elevation Motor Shafts –** The elevation motor shafts of the Cine-Sextant II are 7 ¼ inches in diameter and are connected directly through the center of the equipment platforms.

- **Cross Member –**A massive cross member connects the motors on the inside of the trunnion with 27 - ½ inch bolts and maintains a ridged connection between the two payload platforms. This ridged link between the payload arms prevents the whiplash effect between the two platforms that would significantly reduce the natural frequency and maximum bandwidth of the system.

  Cine-Sextant II Accuracy:
  Bearing Wobble: +/- 5 arc seconds
  Bearing Run-out: +/- 5 arc seconds
  Non-Orthogonality: +/- 5 arc seconds

Performance of Cine-Sextant II

The second most important parameter for a tracking mount is performance. The dynamic performance of the Cine-Sextant II is derived from the following:

- **Azimuth Motor –**The Cine-Sextant II uses 1900-foot pound azimuth torque motors.

- **Elevation Motors** – The Cine-Sextant was originally designed with hydraulic actuators that provided up to 1600 pounds of instantaneous torque. This high torque provided both high dynamic performance with heavy payloads and the ability maintain good tracking performance with a significant weight imbalance. We currently install two 550 foot pound torque motors on the Cine-Sextant II which also provides excellent dynamic performance with a significant weight imbalance.
  The elevation motor of the Cine-Sextant II provides the highest possible torque in the smallest possible package size. We achieved this by designing a custom motor housing and armature. Other tracking mount manufacturers buy a motor and install it in a supplemental housing that is designed to be secured to the tracking mount. We designed a motor housing that is an integral part of the motor itself complete with bearing, magnets and brush holders. No supplemental housing is required.

- **Payload** – The original Cine-Sextant was designed for a payload of 1000 pounds, but payloads of much higher weight can be achieved now with the Cine Sextant II with some reductions of accuracy and dynamic performance.

Cine-Sextant II Dynamic Performance:
AZ Bandwidth: 8 Hz
EL Bandwidth: 12 Hz

AZ Acceleration: 88 degrees second ^{2}
EL Acceleration: 250 degrees second ^{2}

AZ Velocity: 100 degrees second
EL Velocity: 100 degree second

(The velocity is normally limited to 100 degrees per second. This can be increased as required.)

2. Compact Tracking Mount – Middle Class Tracking System

Compact Tracking Mount

In 1988 Photo-Sonics recognized the need for a smaller class of high performance tracking mount. Lighter payloads were anticipated and operation of the system by a single man was a critical requirement. As a result, Photo-Sonics designed the Compact Tracking Mount (CTM).

Accuracy of Compact Tracking Mount

The accuracy of the CTM is derived from the following:

- **Solid Casting** – Same as the Cine-Sextant. The azimuth trunnion is produced from a single casting. It is force-aged to ensure long-term stability.

40-INCH BEARING – THE BEARING IS 8 INCHES LESS THEN THE CINE-SEXTANT WITH THE SAME FLATNESS SPECIFICATION. THE BASE AND TRUNNION CASTINGS ARE HAND SCRAPED BEFORE THE 40-INCH BEARING IS INSTALLED.

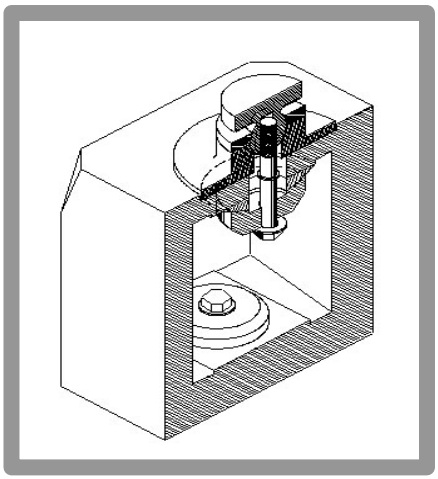
- **Small Heavy-Duty Trailer –** The CTM has a compact heavy duty single axel trailer. The main structure of the trailer is made of steel tubing to provide a stable base for the pedestal. The trailer is an integral component of the accuracy solution.
- **Jacks** – The CTM also uses four custom jacks designed and manufactured specifically to hold the weight of the tracking mount and provide stability of the payload under high dynamic conditions. The jack consists of a precision steel shaft and housing and includes both lock and limit switches.

- **Jack Blocks – Special** jacks and jack blocks were designed that allow the jack blocks to be secured to both the jacks and a prepared concrete site. This configuration will allow accuracies normally associated with a fixed site tracking system while maintaining a very mobile capability.

- **Elevation Motor Shafts –** The elevation motor shafts of the CTM are 15 inches in diameter and are connected to 3-inch thick side plates with 15 - 3/8 inch bolts. The payload platform is made from a single casting and connects directly to the side plate with a ball screw to move the platform up and down and locking bolts to secure the platforms to the side plates.

- **Cross Member Bridge** – The CTM side plates are connected with an upper bridge and a front bridge. The combination of side plates, payload platforms and bridge provides the structural integrity needed to ensure high dynamic accuracy, a high natural frequency, and maximum system bandwidth.

  Compact Tracking Mount Accuracy:
  Bearing Wobble: > 8 arc seconds
  Bearing Run-out: > 8 arc seconds
  Non-Orthogonality: > 8 arc seconds



Performance of Compact Tracking Mount

The CTM was designed with the payload positioned low and close to the center of rotation to reduce the moment of inertia to maximize the dynamic performance. The CTM uses side plates with ±3" of vertical travel. The dynamic performance is derived from the following:

- **Azimuth Motor –** The CTM incorporates a custom 1500 foot pound azimuth torque motor. The motor is designed as an integral part base assembly. The motor magnets are fastened directly to the base casting and the armature is installed directly in the base. This configuration provides the most torque in the smallest package.

- **Elevation Motors** – The CTM is equipped with two 375 foot pound torque motors that provide excellent dynamic performance**.**

- **Payload** – The CTM was designed for a payload of 600 pounds, but payloads of much higher weight can be achieved with reductions of accuracy and dynamic performance. The first Compact Tracking Mounts sold to the Government of Sweden had over an 1100 pound payload, which included and 280 pound radar mounted on the overhead bridge.

  Compact Tracking Mount Dynamic Performance:
  AZ Bandwidth:
  EL Bandwidth:

  AZ Acceleration:
  EL Acceleration:

  AZ Velocity:
  EL Velocity

Common Features of Proposed Large Tracking Systems

Pedestal Enclosures

We would propose two options:

- **A Kevlar Soft Cover with motorized mechanism to open and close it.-** The mechanism to open and close would possibly be hydraulics and controllable from a remote location. The Kevlar is light weight and extremely durable. It can be punctured but not cut with a knife. The material also can be fiberglass reinforced to enhance its weather resistant qualities. This is a low cost solution providing good security and good weather resistant qualities.

- **A hydraulically controlled hard cover is also possible.** This would also be remotely controllable. This cover is a high cost solution providing excellent security and excellent weather resistant qualities.

The design of any cover is dependent on the size and placement of the desired payload.

Encoders

Photo-Sonics prefers to use absolute optical encoders in our tracking systems. We currently use 23-bit systems that provide data for recording positional information and feedback for our servo system. The benefits of optical encoders are as follows:

- Reliability - The optical encoders we use require no external electronics, which has significantly enhanced the reliability of these devices from years past.

- Maintenance – The removal and replacement is simplified.

- Accuracy – The accuracy of an optical encoder is not entirely dependent on the method or accuracy of the installation of the encoder in the tracking mount.

- Payload Noise – Optical encoders are immune to EMI and RFI that may be generated by the payload.

- Cost – While still more expensive than Inductosyn position transducers, the cost of optical encoders has dropped significantly over the years, and the benefits of using optical encoders far outweigh the added cost.

Slip rings

Slip rings can be installed in all Photo-Sonics tracking mounts. A detailed analysis of present and future payload requirements should be made before defining the slip ring configuration.

Servo Amplifier

PC-104 architecture

Argus 2000 Digital Control System (DCS)

The modern test range is the product of decades of development and improvisation in the integration of sensor equipment, data acquisition platforms and specifically tracking mounts, and IT infrastructure to support the accumulation and transmission of the test results to meet the needs of its customers. The Argus 2000 Digital Control System has been conceived to provide complete setup, management, and runtime operating environment for any Optical Tracking Mount instrumentation platform including full remote control capabilities. The accuracy of TSPI data and the quality of images obtained during testing is wholly dependent on the care taken during mission setup, the inherent limitations imposed by the testing methods, and how the actual optical tracking system is operated. So this is the area we must address to get the best test results possible. Photo-Sonics has taken the lead in developing best practices for the calibration, mission setup, and operation of optical tracking mounts and instrumentation platforms.

One of the most important features of Argus 2000 is that all the sensors used on the tracking system are fully integrated into the computer system and software. This is necessary to provide the following features:

- Simulation Mode to assist in system set-up and operator evaluation and training.
- Touch Screen Interface
- Nominal Trajectories
- Preplanned event and configuration scripts
- Single Station Solution
- Automatic measurement of tilt and wobble (miss-level)
- Automatic control of the sensors (start, stop, trigger, auto-focus)
- Automatic control of dual gate auto tracker (auto-zoom, scripts, etc)
- Operator control from multiple locations (start, stop, trigger, manual focus & zoom, etc)
- Remote control
- Comprehensive real-time fault detection, reporting, and recording
- Metric operation (focusing & zooming)
- Automated star and target board calibration of each sensor
- Target simulation system
- Real-time systematic error correction
- Priority based mechanism for automatic selection of best tracking and range data.
- Rate-aided (acceleration mode) and aim-point offset tracking

Argus 2000 Digital Control System with C Hook — Some thought has been given to providing an open architecture software environment for Argus 2000. Photo-Sonics offers a unique ‘C’ Hook feature that allows customers to link their own special software extensions to the Argus Runtime engine. The OSG community can enhance, and then share among its members, these extensions so that the capabilities of Argus are increasing with the special needs of the test ranges. Photo-Sonics is also continually enhancing the basic capabilities of Argus by implementing customer requested features. The C Hook program provides the capability to the range for customizing the system but still retaining the full benefits of a commercial product with normal support, software maintenance, updates, and revision control.

The Argus 2000 DCS takes care of the alignment and calibration of the recording sensors to the tracking sensors. A boresight alignment procedure is used to ensure proper mechanical alignment of the optical axis of each sensor. Proper alignment is required to ensure that the target is visible in the field of view of each sensor while the target is being tracked.

Most ranges today are moving toward remote console controls for protection of personnel and equipment in hazardous test environments, as well as enabling the sharing of information and duties between range control centers. The ability of the range to support remote consoles is somewhat dependent whether there is a communication infrastructure in place to support high data rate real-time communications. Argus 2000 uses fiber optic or microwave connections for transmitting video, data, and timing information that can be transported to any location.

Argus 2000 has been designed with the capability of being a Single Station solution where this is possible or desirable. The use of the Argus DCS as a slaving platform either generating or receiving Time-Space Position-Information (TSPI) help predict target location, can be easily integrated into the overall range wide data network.

RESPONSE TO LARGE TRACKING SYSTEM (LTS) REQUEST

Photo-Sonics is pleased to present three options to OSG for the Large Tracking System.

Option One - Cine-Sextant II

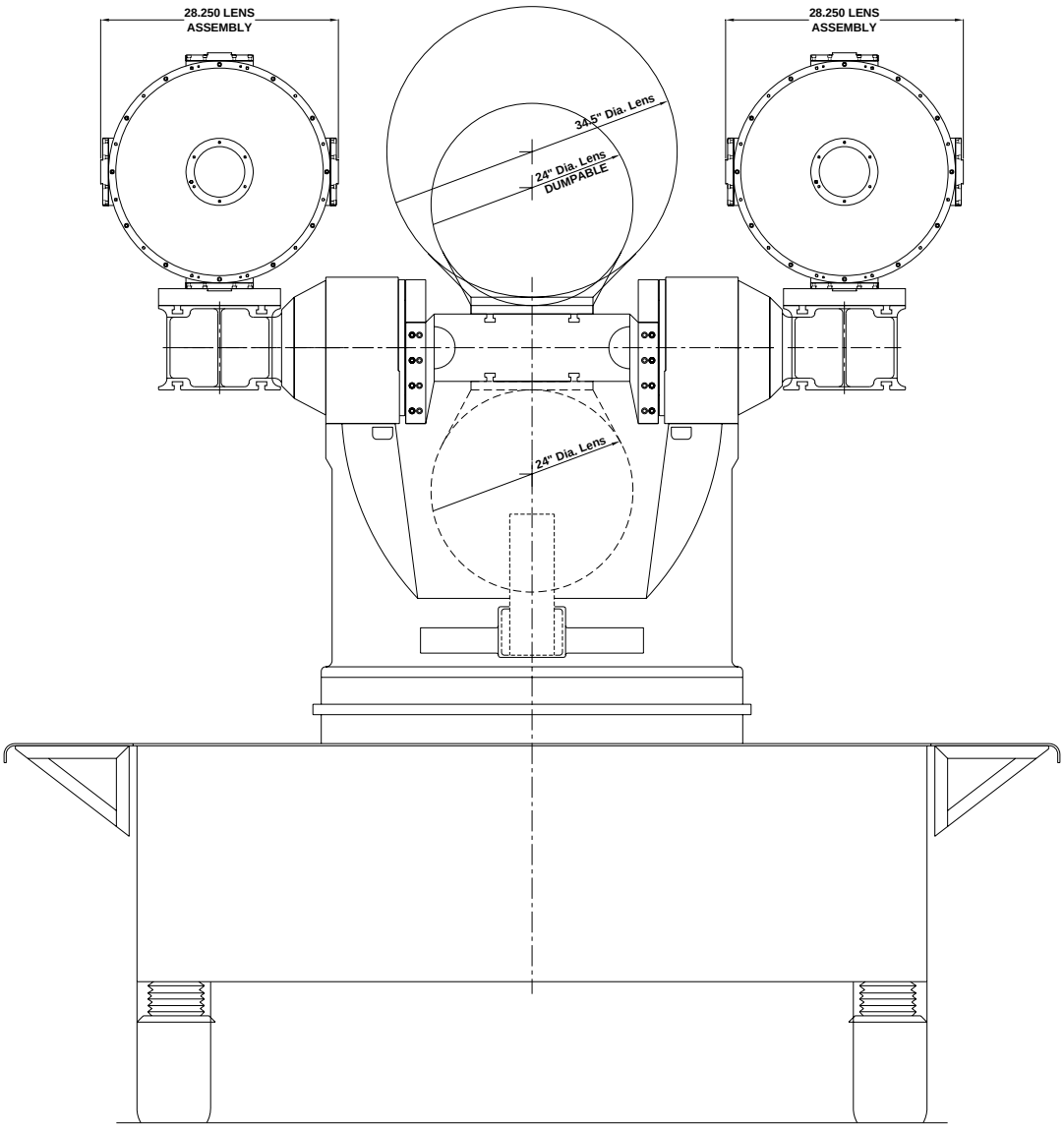
The first configuration offered for the Large Tracking System is Photo-Sonics' certified ***Cine-Sextant II Tracking System*** with standard trailer modifications.

The Cine-Sextant II is currently our largest, most versatile tracking platform. These systems have been proven performers on the ranges of the world for more than 45 years. Over 100 units were delivered. The original Cine-Sextant was a 13,000 pound tracking system that carried a payload of 1000 pounds or more. These systems had hydraulic elevation actuators and 1900 foot pound azimuth torque motors. Today's configuration of this mount, the Cine-Sextant II, includes the latest digital control systems with remote control console, digital servo amplifier, high performance, high bandwidth torque motors enabling heavy payloads and versatile payload configurations with large optics/ range-only radar/ laser rangefinders, etc.

Used Cine-Sextant tracking mounts can be obtained from various U.S. ranges and totally remanufactured by Photo-Sonics to a performance level that is unmatched anywhere in the world. The structural elements of these mounts are extremely durable and intact and stabilized over time so that they are actually stronger than a new casting. They do not have the deformation problems of competitive mounts built to a lower standard of structural integrity and are in fact as-good-as-new.

Photo-Sonics takes these mounts down to the bare metal and hand scrapes the metal surfaces that support the bearing so that the mount has a movement like a precision watch. Every component is either replaced or refurbished to a like-new condition. This is not a cosmetic refurbishment, but a totally remanufactured critical use tracking mount. We would expect that the savings, in an acquisition program for multiple Cine-Sextant II tracking mounts utilizing the existing inventory of Cine-Sextants on the U.S. test ranges, to be $200,000 to $300,000 per mount depending on the feasibility of refurbishing the trailer.

Cine-Sextant with a RC Optical lens with a 28 ½ inch outside diameter



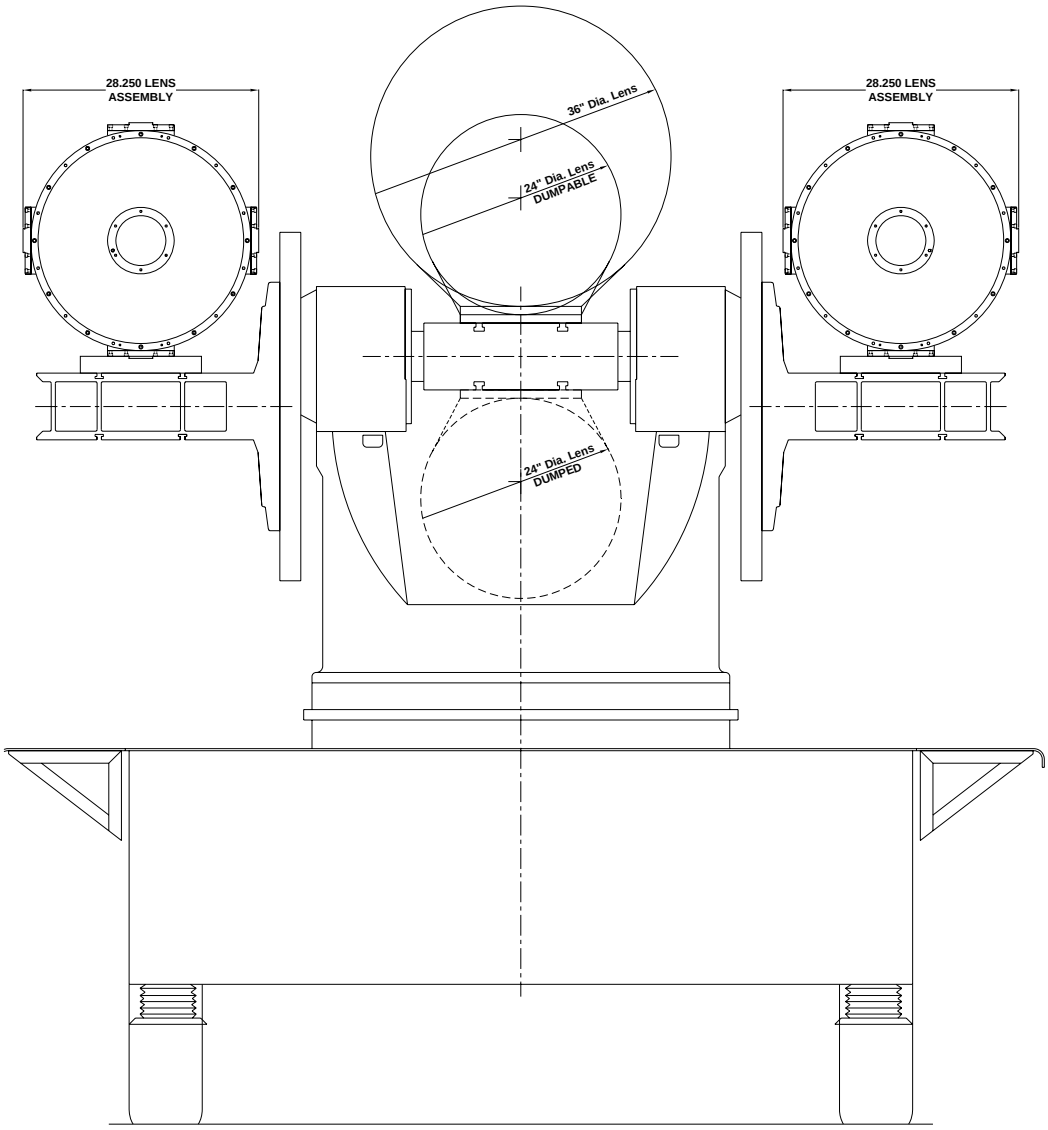
Cine-Sextant II

- Standard Cine-Sextant II with ***bolt-on*** center mounted crossbar providing upper platform area for a 34.5” diameter lens assembly. The lower platform is shown with a 24” diameter lens assembly in the dumped position.
- This optional crossbar can be removed and the mount ***can be reconfigured (by the customer) for man-in-the-mount operation*** with the installation of the operator seat and controls...
- Pictured is a 28.5” diameter lens assembly installed on the standard outboard side platforms showing the generous clearance area for optics both above and below.
- The Cine Sextant II has two 550 foot pound torque motors and weight balance is not a critical issue. The System will operate very well with a significant weight imbalance.

- By foregoing the use of side platforms with vertical travel assemblies we also gain the benefit of ***walk around area on the upper deck***. In fact the whole trunnion is smaller and narrower and sheds quite a bit of unneeded weight.
- Also note the generous space for underside payloads in the side arms. This gives us the capabilities to integrate auto-focus tables and deeper rear camera systems on the lower sidearm platforms.
- Finally our options for mount coverings are greatly expanded with the overall reduced width dimensions of the trunnion assembly and sidearms. The Cine-Sextant II also has front trailer bays available to install the motors and electronics for a power operated enclosure.

Option Two – Cine-Sextant LTS

The second configuration offered is a new ***Cine Sextant LTS*** pedestal and trailer with modifications to the Cine Sextant pedestal configuration to enable 4” of travel for the side mounting platforms.



Cine-Sextant LTS

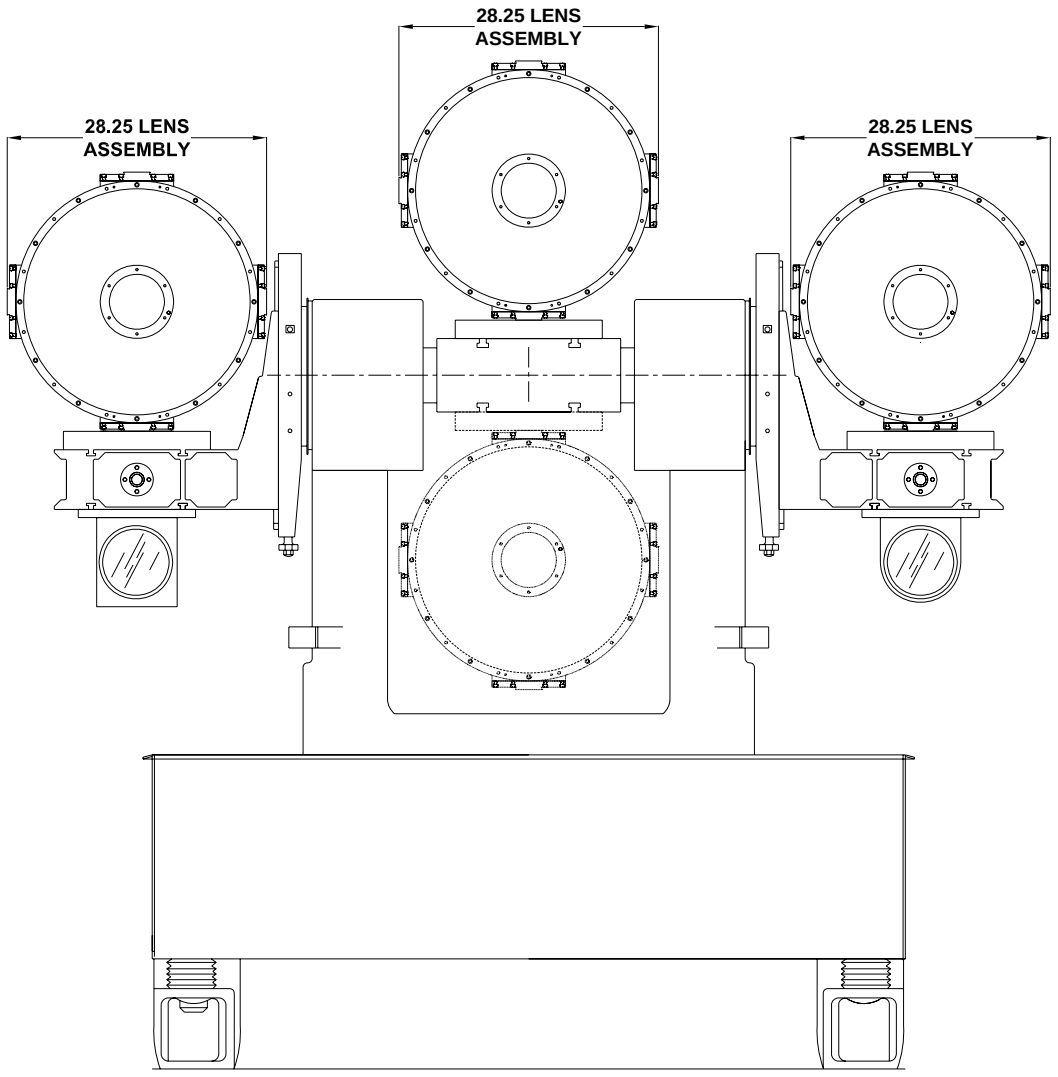
- Cine-Sextant II with modifications for permanent center mounted platform and side plates with ±4 inch vertical travel is shown.
- The use of ***26 inch side platforms*** is necessary since the installation of large diameter lenses cannot be installed on platforms of a standard width without interference with the side plate. Pictured are 28.5" diameter lens assemblies on the side platforms.
- The outboard platforms are connected with an eight inch tubular shaft that runs directly through the motors and center platform. This configuration offers the maximum rigidity and accuracy. This also means that there is ***no man-in-the-mount*** option.
- Dump with 24 inch diameter lens assembly is shown. Note: This is the maximum sized lens assembly that can be dumped. However, dumping is not essential to the accuracy of this mount since it uses the Argus DCS with ***star cal per instrument***.
- Generous area is also provided in this configuration for lower side mounted payloads

- Walking area on top of mount is reduced by the wider sidearms. Expanding sides are shown to increase desk area.
- This mount also has trailer bay space available for motorized electronics for the enclosure system.
- The ***side plates can be adjusted ±4" vertically*** for the best moment weight distribution for different payload configurations.

Option Three – Compact LTS

Our third configuration offered is a ***Compact LTS*** and is a derivative of our Compact Tracking Mount (CTM). To achieve a payload of 800 pounds on the out board platforms and 800 pounds in the center, we modified the design to require a shaft through the two motors and removed the man on the mount option. In this configuration we propose the payload side arms to have a width of 20" as shown in the drawing.

(See next page)



Compact LTS

- Small and light weight, the current CTM weighs 6500 pounds with the trailer. For the CTM-LTS the pedestal, trailer and lightweight shelter are ***targeted to be 10,000 pounds***.
- The current CTM trailer length will be increased to accommodate more support electronics, environmental control equipment. The trailer depicted above is 7 feet wide.
- 20" width, 48" length (lightweight design) side mounting platforms with 4" travel are shown. 26 inch platforms are possible.
- The operators ***can maintain most of the equipment while standing on the ground*** with the side platforms at the lowest position of travel. Trailer extensions are also possible.
- The drawing above depicts a trunnion that is larger than the standard CTM.
- The outboard platforms are connected with an eight inch tubular shaft that runs directly through the motors and center platform. This configuration offers the maximum rigidity and accuracy. ***No man-in-the-mount option*** is possible with this design.

- Will achieve more than required dynamic performance of 45 degrees second ^{2} acceleration but probably not 120 degrees second ^{2}. We estimate 90 to 100 degrees second ^{2}
- The bearing accuracy of the system can be increased by manufacturing the motor housing out of steel rather than aluminum.

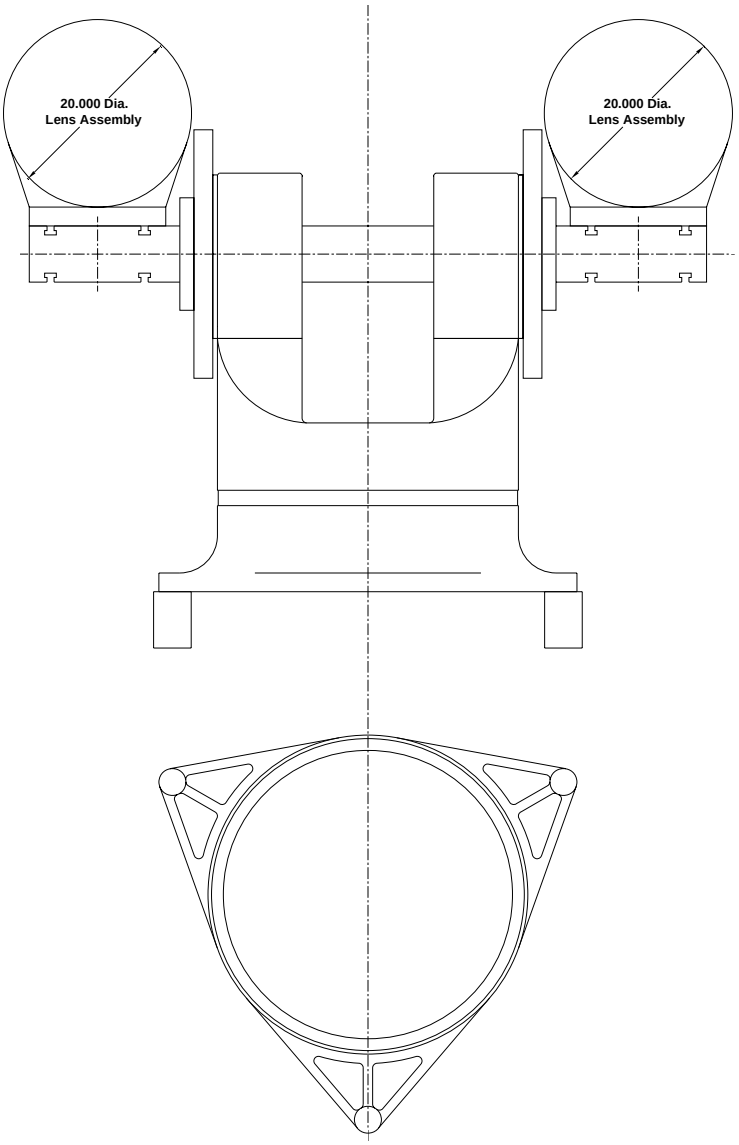
RESPONSE TO SMALL TRACKING SYSTEM (STS) REQUEST

Photo-Sonics has been working on a new remote controlled lightweight mount for some time.

Mini-Sextant

The ***Mini-Sextant*** is designed to achieve the objectives identified in the specification for a Small Tracking System with the 4" of vertical movement for the side mounting platforms and the dynamic performance and accuracy requested.

These mounts are using the Argus Digital Control System for remote unmanned operation. It is anticipated that these mounts will be used in a fixed configuration (no trailer) such that they will be transported on a flatbed and installed into a fixed pad for a specific mission. If a mobile mount configuration is required we could design a small trailer to accommodate this mount.



Mini-Sextant LTS

- Side mounting platforms with 4” vertical movement
- 250-400 pound payload capability
- Argus Digital Control System full remote control
- Pictured on the upper platform is Photo-Sonics 100” lens
- This mount uses slip rings for free rotation without stops.
- Shown is a Photo-Sonics designed elevation motors with high performance in a small housing.
- The base of the pedestal is a solid casting.

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APPENDIX C

L3-BRASHEAR RESPONSE

Dear Ms. Robles:

Brashear is pleased to respond to the referenced Sources Sought Notice for Large and Small Tracking Systems. Brashear has developed and manufactured many kinds of tracking systems over the years and has enjoyed an excellent working relationship with the various U.S. Government Test and Evaluation (T&E) Ranges and facilities. Initially, Brashear manufactured 14 of its Kineto Tracking Mounts (KTMs) in the early 1980's, delivering 10 to Yuma Proving Grounds and 4 to White Sands Missile Range (WSMR). In 1984, Brashear was awarded a Requirements Contract by WSMR to manufacture additional KTMs, eventually manufacturing 120 such tracking systems under that contract. Producing 12 additional KTMs for several other customers brought the total manufactured to 146. Brashear KTMs, dubbed the "Work Horse of The Range" by its users, are in service on nearly all U.S. Government T&E Ranges.

After careful study and evaluation of the Notice's specifications, Brashear feels confident that it can design and manufacture a KTM that will fully meet the U.S. Government's need for a Large Tracking System. The majority of the Solicitation's general requirements have been historically met by the Brashear KTM. The "Highly-desired Specifications" are generally very similar to many such requirements that arose from recent T&E Range, and other specific, U.S. Government programs, and that were subsequently satisfied by modifications designed by Brashear and incorporated into recent highly successful KTM refurbishments and upgrades, new KTM builds, and other similar range system applications.

Brashear has also delivered significant numbers of other smaller tracking and electro-optical systems with capabilities and features that would satisfy the U.S. Government's needs for Small Tracking Systems:

- Cinetheodolites
- Model 266 Laser Fire Director
- Model 066-1, -2/T, -3 Fire Control Systems and Electro-Optical Pedestals
- Model 033-2/T Fire Control Systems and Electro-Optical Pedestals (including Gun Star)
- Lightweight Shipboard Electro-Optical System (LSEOS)

Through its heritage and ongoing support of various range and other electro-optical projects and programs, Brashear can meet the U.S. Government's needs for both Large Tracking Systems …

- Payloads through 1200+ pounds
- Up to 6 mounting platforms
- Digital control systems
- At least 21-bit encoders, inductosyn or optical
- Continuously variable acceleration
- Continuously variable velocity
- Modular cabling interfaces

- Transient response
- Three-point leveling and shock absorber system
- Master bubble level
- Azimuth carriage assembly
- Elevation tracking assembly
- Vertically adjustable side mounting structures
- Remote drive capability
- Electronic pre-limits to avoid “hard stops”
- Transport locks that electrically lock with the servo system
- Compliant range-worthy trailers and enclosures
- Engineering and design capability to address highly desired specifications

… and Small Tracking Systems

- 250 pounds payload
- 2 to 4 mounting platforms
- Digital Control System, PC104 architecture
- At least 21-bit encoders, inductosyn or optical
- Continuously variable acceleration
- Continuously variable velocity
- Modular cabling interfaces
- Transient response
- Three-point leveling system
- Master bubble leveling
- Azimuth carriage assembly
- Elevation tracking assembly
- Vertically adjustable side mounting structures
- Remote drive capability
- Electronic pre-limits to avoid “hard stops”
- Transport locks that electrically lock with the servo system
- Engineering and design capability to address highly-desired specifications

Brashear appreciates the opportunity to reply to this Notice and looks forward to the U.S. Government’s requests for proposal for Large and Small Tracking Systems, regardless of type and quantity. In the meantime, please feel free to contact us with any questions or needs for further information you might have:

Technical	Jim Stevenson	412-967-7996jim.stevenson@L-3Com.com
Contracts	Dave Yodens	412-967-7345 dave.yodens@L-3Com.com

Sincerely,

/s/ Dave Yodens
Contracts/Subcontracts Manager

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**** NOTHING FOLLOWS ****