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OPTICAL REQUIREMENTS FOR THE
ULTRA-HIGH PRECISION STEREOCOMPARATOR

STATEMENT OF WORK

1. Scope

The subcontractor will supply and test an operating optical system for the Stereocomparator. The system consists of two substantially identical optical trains, one for viewing with each eye. The system is generally described by Drawing No. E-4650 and applicable specifications and requirements, together with the technical reports and communications prepared for the design contracts

[Redacted]

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2. Program Management and Control

[Redacted] is responsible for the timely completion of the subcontract and for maintaining the schedule of intermediate commitments established by the work program and the requirements of the Statement of Work.

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[Redacted] expects to work closely with [Redacted] during the performance of this subcontract to insure that there will be no delay due to interfacing problems or lack of understanding of the overall requirements.

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3. Furnished Materials STAT
 must furnish, as part of this subcontract, all equipment,
 materials, supplies, components, subassemblies, and any other
 device or service required for the performance of the work and not
 herein specified to be supplied STAT

4. Furnished Materials STAT
 will furnish to the following components and
 equipment: STAT

- a) Potentiometers
- b) Tachometers
- c) Motors
- d) Brakes
- e) Slip Rings
- f) Optical Bridge
- g) Servo motor power supplies for optical system tests. Total of
 6 units.
- h) Connectors and micro-switches

In order for to supply the proper items, must
 specify to the respective manufacturer's name, catalog
 numbers and applicable specifications as required for the
 design. STAT

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5. Acceptance Tests

The acceptance tests will be performed as described in the test procedures, Item 6.

There will be an initial acceptance test performed at the [] plant. For this purpose, [] will supply with the optical bridge which will be used to mount the various optical components during testing. Note that the various optical subassemblies will be permanently located (in a manner allowing removal and simple relocation as required) on the optical bridge, using hardened and ground locating pins or their equivalent in function.

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There will be a second test performed at the [] plant as part of the overall system test. This will be under the supervision of []

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There will be a final test performed after installation at the customer's site as part of the overall system test. This will be under the supervision []

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6. Test Procedures

The optical components will be tested as subassemblies and as an overall system which includes, but is not necessarily limited to:

- a) The illumination source and condenser assemblies.
- b) The objective assembly including the objective lenses, the rotating turret and the focussing mechanism.
- c) The reticle spot assembly and its individual functional components including the light source.
- d) The zoom lens assembly.
- e) The anamorph assembly and its rotation system.
- f) The image rotator assembly.
- g) The eyepiece switching assembly.
- h) The various fixed elements of the system such as beam-splitters, mirrors, relays, field lenses, filters, etc.
- i) Various subsidiary items such as the filter wheels, eyepiece safety shutters, etc.

Test procedures will be prepared by in English
 subject to review and approval . Two copies of the
 procedure for the first review will be supplied to within
 four (4) months from the start of the optical subcontract.
 will require one month to perform the review.

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One month thereafter, [] will provide four (4) revised
copies to [] for the second review. [] will require two
months to perform the review.

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One month thereafter, [] will provide twelve (12) revised
copies to [] as the final approved test procedures.

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7. Drawings

[] will furnish to [] two copies of any drawing revised by [] during the performance of the subcontract.

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The drawings are to be delivered to [] as soon as the revision is made, in order that [] may be cognizant of changes as soon as they occur.

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Upon the completion of the subcontract, [] will send two prints of each drawing, plan list, or specification

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Upon the completion of the subcontract, [] will send [] the original documents or tracings of the drawings, plan lists, specifications or source documents prepared during the optical design contracts []

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[] and this subcontract.

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8. Manuals

[] will prepare an initial set of two (2), followed by four (4) revised draft copies in English of operating instructions, maintenance instructions and spare parts lists. Included will be any requirements for special or non-American tools. STAT

The list of recommended spare parts will include a statement of anticipated life for each individual part.

The two (2) initial draft copies will be delivered to [] within five (5) months after the start of the contract. STAT

[] will review and return the revised or annotated initial draft copy to [] one (1) month later. STAT
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[] will deliver to [] the four (4) second revised copies in English eight (8) months after the start of the contract. STAT

[] will review and return the second revised copies to [] after three (3) months. STAT
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[] will deliver [] the final revised copies in English twelve (12) months after the start of the contract. SSTAT

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9. Reports

[] M will supply [] with monthly progress reports in English due as of the 20th day of each month, per specification No. DB-1001.

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These reports will show the status of the performance of the subcontract and will specifically point out the items of the program deviating from the plan and the schedule.

In addition, any technical problems will be reviewed and the appropriate corrective measures will be described in the report.

10. Performance Specifications

A. The performance specifications achieved by the optical system must be fully compatible with the requirements of the ultra-high precision stereocomparator taking into account that the least count of the measuring system is 0.1 micrometers. The level of optical performance actually achieved in the assembled optical system as determined by the acceptance tests will be the primary basis in acceptance or rejection of the optical system. In the event that the system or any part is rejected, then

[] will do their best to modify the optical system to achieve the desired results. In the event that the final performance still does not meet the specifications and it has been demonstrated that a best effort was made [] a renegotiation between [] will determine the value of this deficiency and determine the extent of recompense due

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[] Disagreements that could arise in application of this clause would be submitted to expert advice.

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B. All equipment, components and devices in the light path or accessory to the holding or movement of the foregoing items in the light path must be included, installed and made operable [] The correction of errors or omissions in the optical system is the responsibility of

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[] Errors or omissions in the [] drawings must be rectified

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[] These drawing errors or omissions will in no way reduce the requirement that the optical system must perform to the specification, and must be compatible with the requirements of the Stereocomparator.

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C. The minimum resolution for the system as a whole must be as follows:

THRESHOLD CONTRAST RATIO

White Light

Magnification	F = 40 mm	Line Pairs per mm				
		<u>On Axis</u>	<u>1/3 of Field</u>		<u>Edge of Field</u>	
			T	S	T	S
20X	110	70	120	45	150	
37X	190	150	190	130	190	
50X	250	160	300	150	300	
100X	500	450	500	400	500	
123X	650	550	650	500	600	
200X	900	800	900	600	700	
F = 80 mm						
10X	50	45	50	40	45	
50X	250	230	250	105	145	
61.5X	330	300	330	110	150	
100X	500	450	500	275	350	

Monochromatic Light

Magnification					
F = 40 mm					
20X	110	102	102	55	150
37X	200	190	200	170	190
123X	670	670	670	600	600
200X	1080	1020	1020	800	1100
F = 80 mm					
10X	54	52	52	50	50
50X	260	240	240	140	160
61.5X	330	310	330	120	160
100X	540	500	540	400	480

- Based on 40° field of view.
- The line pairs set forth represent the worst case situation either saggital or tangential.
- Intermediate resolution figures shall be essentially linear with respect to the referenced point.

- D. Brightness at the eyepiece will be 0.2 stilbs minimum when viewing in stereo, for film densities between zero and 3.0. The minimum value of 0.2 stilbs will be achieved by appropriate modulation and adjustment of the light filter discs provided in the optical system.
- E. The distortion shall be not more than 1% over 67% of the field of view at all magnifications and less than 2% at the edge of the field.
- F. The flatness of the image in the field of view at the eyepieces will not be more curved than the values in the following tabulation. The reference point for image flatness is in the center of the field of view.

<u>40mm Objective</u>	<u>Center of Field</u>	<u>1/3 of Field</u>	<u>2/3 of Field</u>	<u>Edge of Field</u>
200X	0 diopter	0.33 diopter	0.8 diopter	1.0 diopter
123X	0 diopter	0.2 diopter	0.8 diopter	1.5 diopter
65.2X	0 diopter	0.2 diopter	0.6 diopter	1.5 diopter
37X	0 diopter	0.18 diopter	0.9 diopter	1.8 diopter
20X	0 diopter	0.2 diopter	1.0 diopter	2.0 diopter

<u>80mm Objective</u>	<u>Center of Field</u>	<u>1/3 of Field</u>	<u>2/3 of Field</u>	<u>Edge of Field</u>
100X	0 diopter	0.5 diopter	1.5 diopter	3.0 diopter
61.5X	0 diopter	0.3 diopter	1.2 diopter	2.1 diopter
36.6X	0 diopter	0.25 diopter	0.9 diopter	2.0 diopter
18.5X	0 diopter	0.25 diopter	1.0 diopter	2.0 diopter
10X	0 diopter	0.25 diopter	0.9 diopter	1.8 diopter

G. The magnification range shall be at least

10X to 100X with the 80mm objective, and

20X to 200X with the 40mm objective.

The magnification of the overall system shall be defined as the angular subtense at the eye of the final image formed at infinity, divided by the angular subtense of the object when placed 25 cms from the eye.

H. The interpupillary distance will be adjustable between 50 and 75mm.

The eyepiece eye-relief will be 20 ± 2 mm. The sight angle of the eyepieces will look downwards at an angle of $15^\circ \pm 1^\circ$ below the horizontal.

Independent continuous adjustment of one eyepiece will be provided over the range of $\pm 1^\circ$ vertical.

The axes of the eyepieces must be continuously adjustable at least between 0 and 6° in a horizontal converging assembly. Eyepiece focussing mounts will be provided for independent focussing.

I. The field stop will be apodized so that its edge is not sharp but subtends an angle of $1^\circ \begin{matrix} -0^\circ \\ +1/2^\circ \end{matrix}$ to the operator's eye.

J. The anamorphic expansion range will be at least 1:1 to 1:2 in any azimuth.

K. The adjustable filter wheel for the reticle illumination system will have a density range of 5:1 minimum. The density at the maximum

filter setting will be 5.0. The function of density versus angular position will be linear for the filter wheel.

- L. The color temperature of the light source will be at least 5000° K.
- M. The reticle size shall be variable over a range of at least 4 to 1. The reticle minimum size must be approximately 1.5 times the diameter of a diffraction limited reticle. This results in a minimum reticle diameter of $2\mu\text{m}$ for the 40mm objective lens and $4\mu\text{m}$ for the 80mm objective lens in the film plane.
- N. The linear field in the focal plane of the 10X eyepiece shall be at least 18mm in diameter corresponding to an angular field of at least 40° .
- O. The image wander of the reticle system will be less than $\pm 1/4$ of a μ meter during operational adjustments of the reticle zoom, reticle anamorph, reticle image rotator, etc., either individually or together.
- P. The image wander will not be greater than $\pm 1/4$ of a μ meter during the travel of $\pm 1/32"$ of either objective lens during focussing. The image wander will not be greater than $\pm 1/2$ of a μ meter during maximum travel of either objective lens. Maximum travel will be at least 3 mm. During the maximum operational adjustments, either individually or together of the Zoom, Anamorph, Image rotator, eyepiece switching,

etc., the maximum image wander will be ± 10 minutes of arc for each eye.

- Q. The position error for all positions of the mechanical drives for the Zoom and Anamorph assemblies will not be more than $\pm 1\%$ for all causes for the absolute respective indicated optical parameters. The position error for all positions of the mechanical drive for the image rotator will not be more than $\pm 1/4^\circ$ for the absolute indicated optical parameters.
- R. The final image field must remain at an apparent constant brightness. This will be done by an illumination system Zoom condenser. The illumination value at the eyepieces will not be less than 0.025 stilb and under these conditions the operator can readily distinguish between an optical density of 0.1 in the range of 3.0 to 0.0.

11. Deliverable Items

A. One group of subassemblies consisting of the operating Stereocomparator optical system. This is generally described by Drawing E-4650 and the applicable specifications and requirements, together with the technical reports and communications relative to the Stereocomparator design effort. The schedule requires delivery thirteen (13) months after receipt of order.

B. Two copies of any information data such as revised drawings or plan lists or computations are to be sent as the information becomes available. STAT

C. Two sets of copies of the as-built drawings, specifications and data representing the assemblies as delivered and accepted These are to be delivered within two (2) months after acceptance of the assemblies. STAT

D. One set of the original tracings, drawings, specifications or data representing the final revised as-built assemblies delivered and accepted These are to be delivered within two months after acceptance of the assemblies. STAT
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E. Two copies of the test procedures in English for first review are to be delivered within four (4) months from the start of the subcontract. STAT

F. Four copies of the revised test procedures in English for the second review are to be delivered within six (6) months from the start of the subcontract. STAT

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- G. Twelve copies of the final revised test procedures in English are to be delivered [] within eleven months from the start of the subcontract. STAT
- H. Two copies of the test and inspection records of the performance tests made [] to qualify the assemblies for delivery and acceptance [] These are to be delivered [] at the time of performing the tests. STAT
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- I. [] representatives may elect to be present during all or part of the performance testing and/or qualification [] must notify [] thirty (30) days prior to the initial date of testing. STAT
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- J. Two copies of the Operating Instruction manuals in English for first review [] These are to be delivered [] within five (5) months from the start of the subcontract. STAT
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- K. Four copies of the revised Operating Instruction manuals in English for second review [] These are to be delivered [] within eight (8) months from the start of the subcontract. STAT
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- L. Twelve copies of the final revised Operating Instruction manuals in English. These are to be delivered [] within twelve (12) months from the start of the subcontract. STAT
- M. Two copies of the Maintenance Instruction manuals in English for first review [] These are to be delivered STAT

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- [] within five (5) months from the start of the subcontract. STAT
- N. Four copies of the revised Maintenance Instruction manuals in English for second review [] These are to be delivered [] within eight (8) months from the start of the subcontract. STAT
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- O. Twelve copies of the final revised Maintenance Instruction manuals in English. These are to be delivered [] within twelve (12) months from the start of the subcontract. STAT
- P. Two copies of the List of Recommended Spare Parts in English for first review [] These are to be delivered [] within five (5) months from the start of the subcontract. STAT
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The list is primarily based on the requirements to maintain operation of the Stereocomparator for a period of one year. However, if there are parts whose replacement could be expected at a longer interval than one year, then they should be included and so indicated. The estimated life of each recommended spare part must be shown.

- Q. Four copies of the revised List of Recommended Spare Parts in English for second review [] These are to be delivered [] within eight (8) months from the start of the subcontract. STAT
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- R. Twelve copies of the final revised List of Recommended Spare Parts in English. These are to be delivered [] STAT

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within twelve (12) months from the start of the subcontract.

- S. Seven copies of the monthly financial and technical reports in English per specification No. DB-1001. The reports are due on the 20th day of each month, and should represent the status of the work as of the last day of the preceding month.

- T. [] must deliver [] all alignment Targets, Resolution Targets, and Target film, etc., generated [] for use in testing the optical system or components of the Stereocomparator. The delivery of this material must coincide with the delivery of the [] optical system subassemblies. STAT

- U. [] must send to [] all deliverable items due under [] STAT

This is to be done as the material becomes available, or upon completion of the work represented by this specification.