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FABRICATION, ASSEMBLY AND TEST OF SOLAR SIMULATOR OPTICAL TRAIN ASSEMBLIES

Prepared for
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Contract NAS9-5805

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ABSTRACT

This report describes the manufacture of on-axis solar simulator modules for the NASA Manned Spacecraft Center at Houston, Texas. Manufacturing methods and process descriptions are given for electroformed nickel replica mirrors. Assembly and prealignment of the optical system subassemblies is discussed as are problem areas and solutions relative to the development of the system.

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SECTION 1

SUMMARY

This report discusses the techniques developed and the problems encountered in the manufacture of 60 optical train assemblies for the NASA Manned Spacecraft Center (MSC) on-axis solar simulator. The assemblies were purchased to upgrade the system capability by adding additional modules and increasing the volume illuminated in the environmental test chambers.

The optical train assemblies each consisted of three subassemblies: the collector, the throat, and the collimator. These assemblies were unique because they were assembled, optically aligned, and tested individually by EOS prior to shipment to MSC (prior trains had been aligned as complete assemblies only).

EOS manufactured the four different types of mirrors and support hardware used in the optical trains. An EOS subsidiary, Applied Optics and Mechanics (AOM), manufactured the four lens elements used in the system.

The most complex single process is the manufacture of the mirrors. The mirrors are front surface, nickel electroformed replicas bonded to a support casting which contains water cooling passages. The process used to manufacture these mirrors is discussed in detail in the body of the report. The replication process consists of making a structurally integral electro-deposition of nickel on a master matrix. This part is an electroform or replica which copies the master extremely accurately; and, in the case of a mirror, the surface quality is as good as the master used to produce it. The replica is separated from the master, trimmed to a hexagonal configuration, then bonded to an aluminum casting which is the support structure. The casting has

machined mounting points and a water cooling passage used to temperature control the mirror during operation.

EOS built the tooling used to produce the replicas on a prior contract (NAS9-5482); however, the details of the program are discussed in this report. The replica mirror surface is overcoated with a reflection enhancing series of materials which also protect the nickel surface. These coatings are applied by vacuum deposition and consist of a layer of chromium, then silicon dioxide, aluminum, and silicon dioxide again. The chromium provides good adhesion of the various overcoated layers of materials to the nickel. The aluminum provides high reflectivity in the solar spectrum.

The report includes a list of as-built drawings, which accurately represent the current configuration. EOS has recommended various design changes to improve maintenance, reduce costs, and provide interchangeability.

SECTION 2

INTRODUCTION

This report discusses the manufacture of 60 optical train assemblies for the space simulation chambers at the Manned Spacecraft Center in Houston, Texas. These assemblies form a part of the modular solar simulator system used in Chambers A and B. The optical system consists of radiant source, collection optics, vacuum transition weldment, and collimating optics.

The collector assembly consists of a primary collector (No. 1 mirror) and a secondary collector (No. 2 mirror), and a collector lens. The collector optics are housed in a frame shrouded with water cooling panels. Also included is a water-cooled pupil mask.

The throat assembly, which is the vacuum transition piece, supports the collimator and houses the intensity control system. It also contains a field lens which is part of the vacuum seal.

The collimator assembly re-expands the concentrated beam of energy coming through the throat and projects a parallel beam into the test volume. This is a cassegrainian system with a folding mirror (No. 3) and a collimating mirror (No. 4). It also contains a central optics system consisting of two lenses (collimator lens Nos. 1 and 2).

The tooling used to produce the replica mirrors, Nos. 1, 2, 3, and 4, was produced under Contract NAS9-5482, "Solar Simulator Optical Program Development Plan." It is discussed in this report since it was a pacing item in the production program.

This report also discusses the interface of the Optical Coating Improvement Program (NAS9-6708) which occurred during this program and resulted in significant changes to the delivery schedule, as did the first mirror refurbishment contract, NAS9-6659.

SECTION 3

DESIGN CHANGES

The optical train study (NAS9-5482) resulted in several design change recommendations which were finalized during this contract. All mirror castings were changed to provide integral water cooling passages and new mounting and adjusting devices. The interfacing support points in the collector assembly and the collimator support were also changed to accommodate the new differential screw adjuster mounts. Only minor changes in the collector assembly plumbing were made to simplify the plumbing and adapt to the new AND fittings in the Nos. 1 and 2 mirrors. The collimator assembly was drastically modified by changing the collimator support casting from a six-suspension-point design to a three-suspension point design. The collimating lens mount was replaced. In the replacement lens mount, the two lenses were centered and spaced in a precision aluminum casting and all the previous adjusters were eliminated. Assembly and alignment of this unit was greatly simplified.

SECTION 4

MIRROR MANUFACTURE

The replica mirrors used in the NASA-MSC solar simulator, as originally furnished by the RCA Service Company, were all manufactured by EOS. The Optical Train Assemblies Program continued the manufacture of the complete optical train at EOS. The mirrors have been manufactured in two facilities, both of which are separate from the assembly facility.

The mirror assemblies are of four types, all of which consist of a water-cooled aluminum casting and an electroformed nickel replica mirror. Electroforming is the process of building a structural part by electro-deposition on a master tool; and in this case, the tool is reusable. EOS used two types of tools to produce these mirrors, one of which is the reverse form of the electroformed mirror and is made from 17-4-PH stainless steel. The other unit is an electroformed nickel tool, made from a stainless master, with a curvature identical to the electroformed mirror.

There are several basic steps in the sequence of production, with the first step being construction of the replica tooling. Stainless steel has proven to be superior to any other metal and has produced large numbers of replications for these mirror configurations.

Once a master is available, the replica is electroformed directly on the master. After the proper thickness is achieved, the replica is parted from the master, and is epoxy-bonded to an aluminum casting which has a matching contour machined to match the electroformed replica contour. After bonding, the unit is given a preliminary optical test; if it is within specifications it is then sent to elox

machining. The elox machine is used to cut the electroform to the proper inner and outer shapes by electrical spark discharge.

After washing, deburring, and inspection, the mirror assembly is ready for a final optical test. The mirror optics and surface are rechecked to verify the preliminary optical test. If the mirror is acceptable, final buy-off is made.

From optical testing, the mirror assembly is sent to the vacuum coating area. The vacuum coating which is applied protects the surface and improves the reflectivity of the mirror assembly. The mirror assembly, with its paperwork, is boxed and shipped to the optical train assembly and alignment area.

4.1 MIRROR MASTER FABRICATION

The following paragraphs discuss the operations and techniques developed by EOS in the manufacture of tools to produce mirrors for the NASA-MSC solar simulator program.

During the past nine years, EOS has used several master making techniques, beginning with making mirror replicas from glass tools which were chemically silvered to make them conductive for the electroforming process. This technique was discarded in favor of plastic castings made in glass tools by spin casting. This, in turn, resulted in the free casting process where a parabolic shape was generated using a liquid plastic which was cured during rotation. These plastic concave parabolas were then used to electroform male or convex masters from which replicas could be made. Modifications of these techniques were used on the optical train mirrors. The double replication process, where a master makes a tool to be used for the actual replication, was used for the No. 4 mirror. Direct replication was used for all the

other mirrors. The original tools were made for the RCA program using mild-steel-chrome-plated masters which proved to be unsatisfactory due to the limited life of the tool. Therefore, on the Optical Train Program, all tools were made from 17-4-PH stainless steel, which has proven very satisfactory.

In order to evaluate the mirror master optical surface, a means must be used to progressively check the surface being machined. Machining to within 0.0008 in. can be achieved by means of a precision template; however, to obtain measurements to within 0.0001 and better, an electronic capacitance type probe is utilized.

Prior to attempting mirror master fabrication, an investigation was made to replace the equipment previously used for contour checks of the master contour surface.

The Turbo Machine, Inc. electronic probe assembly previously used for contour checks was no longer available. After many source inquiries, the equipment manufactured by Lyon Research Corporation was procured, since (see Fig. 1) it was felt this equipment could perform the same task as the previous hardware. All electronics checked out, and the micrometer carriage adapter modules were manufactured. Adaptation of the probe assembly into a precision micrometer carriage was completed (Fig. 2), and the readout console (Fig. 3) was adapted to the equipment used in the machining of each master.

These probe assemblies were a successful aid in obtaining the required contours for each master. Required contours that were obtained, along with the optical surfaces achieved and material used, resulted in very good plating life on all masters. Some surfaces were machined to within 0.00001 in. of required contour.

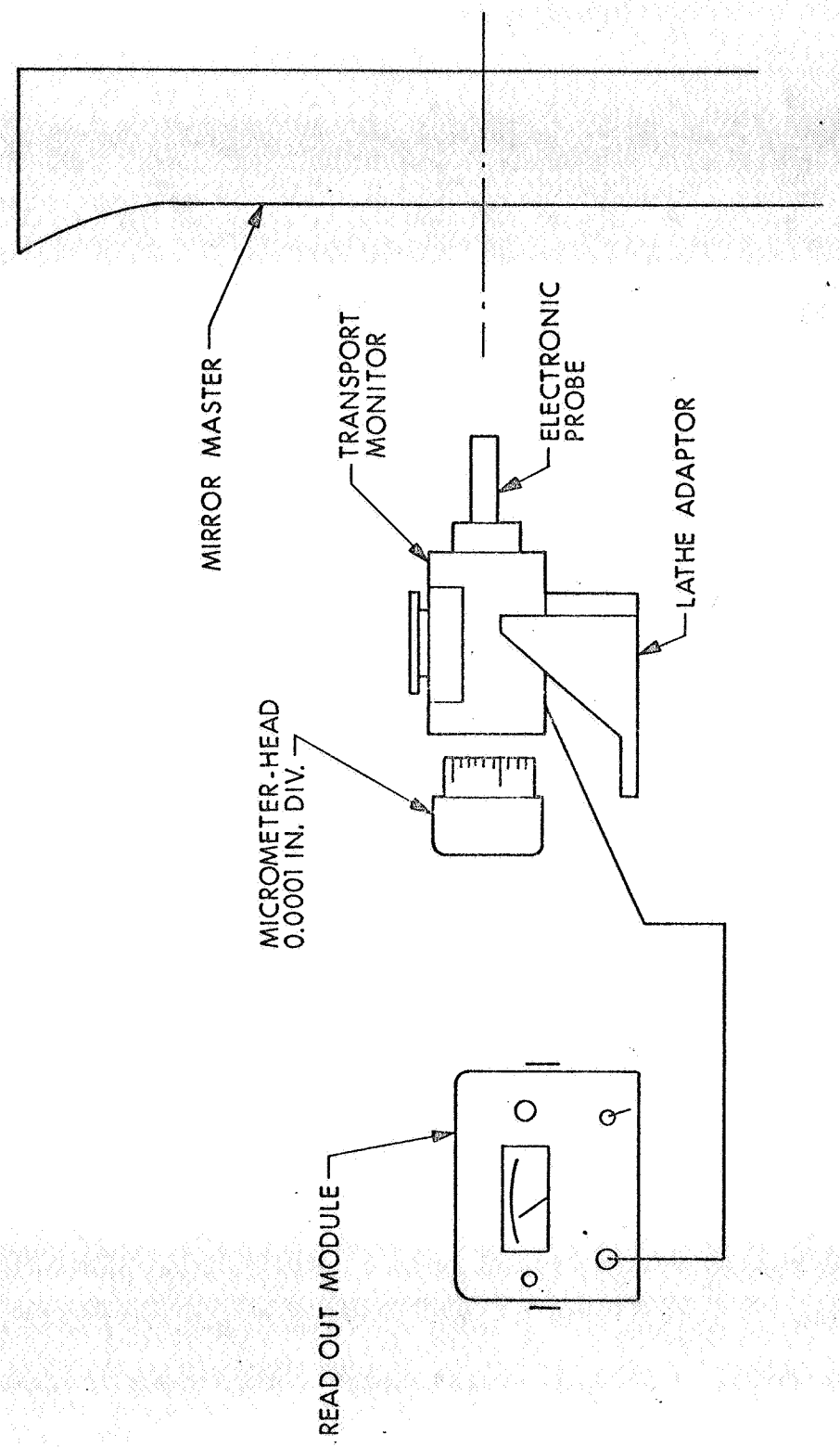
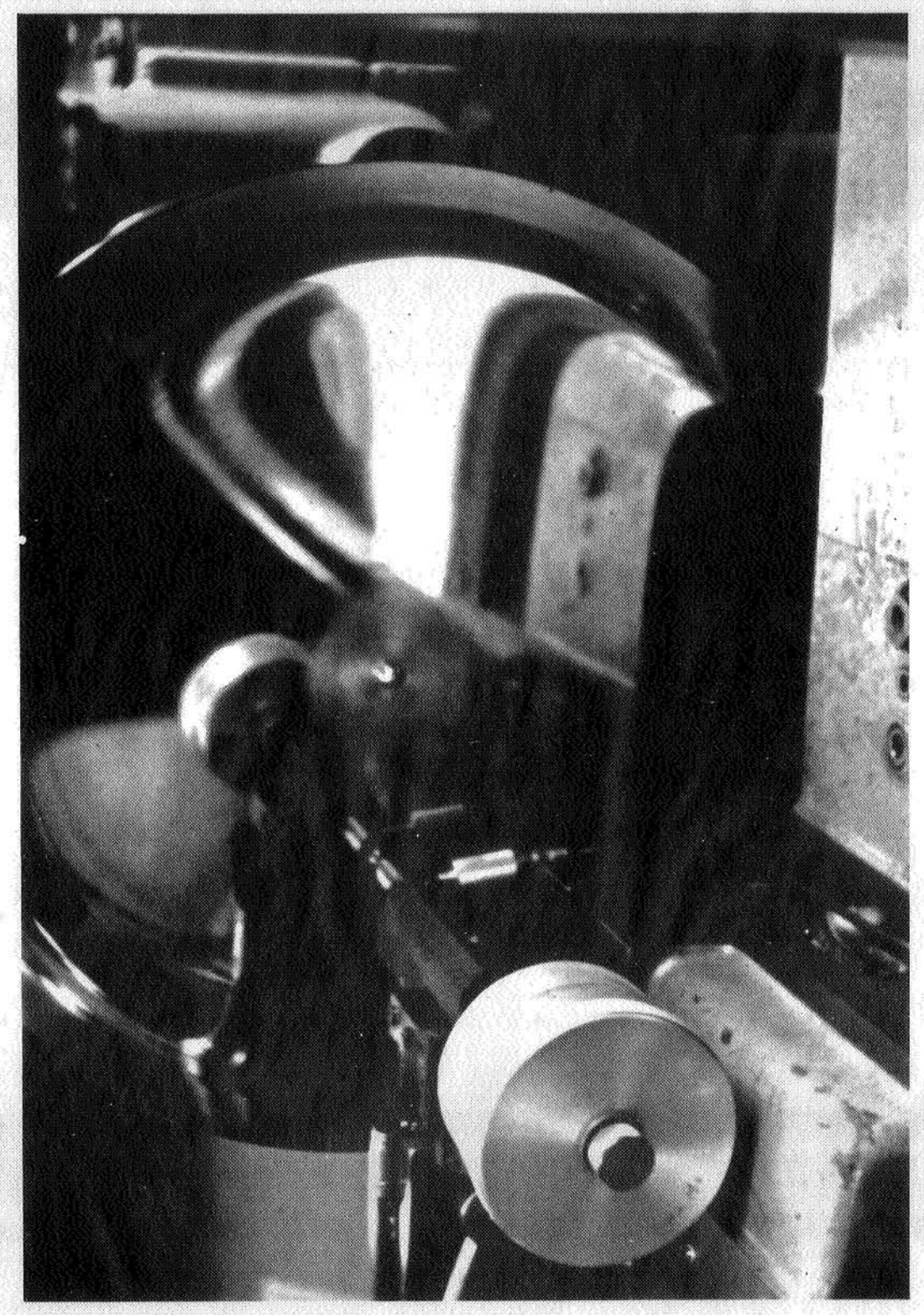


Figure 1. Schematic of Proximity Probe



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Figure 2. Precision Micrometer Carriage

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Figure 3. Precision Probe Showing Readout Console

The No. 4 master was checked during machining, using a horizontal arm and dial indicator setup.(Fig. 4). A similar device was used during optical grinding and polishing (Fig. 5). All checks used deviation from a radius as the basis for generation of the fourth order aspheric curve. Figure 6 shows typical data taken and graphed by this method.

Many facilities in the Southern California area were evaluated prior to contracting for machining of the masters. They consisted of precision production, prototype, research and development, and first-article-type facilities. Equipment, personnel, and knowledge of the basic task were the three items required.

Each lathe to be utilized in machining these masters was thoroughly checked out. Excessive clearance in spindle bearings, both caster and camber were checked out, lathe bed and ways for accuracy and repeatability, and vibratory modes which might effect machining accuracy. At the same time, the adaptability of the probe measuring device was investigated. A check for voltage transients in the particular machine was made, since these would have to be filtered in order to maintain a clean signal for the operator during probe measurement checks.

After extensive evaluation, four vendors were selected and approved to manufacture support hardware and the mirror masters.

A total of seven stainless steel (17-4-PH) masters were machined, optically ground, and polished to be used in the production plating of mirrors for the optical train assemblies. Two master working tools were fabricated for each of the Nos. 1, 2 and 3 mirrors, and one master tool was fabricated for the No. 4 mirror.

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Figure 4. Check for Master Contour-Machining

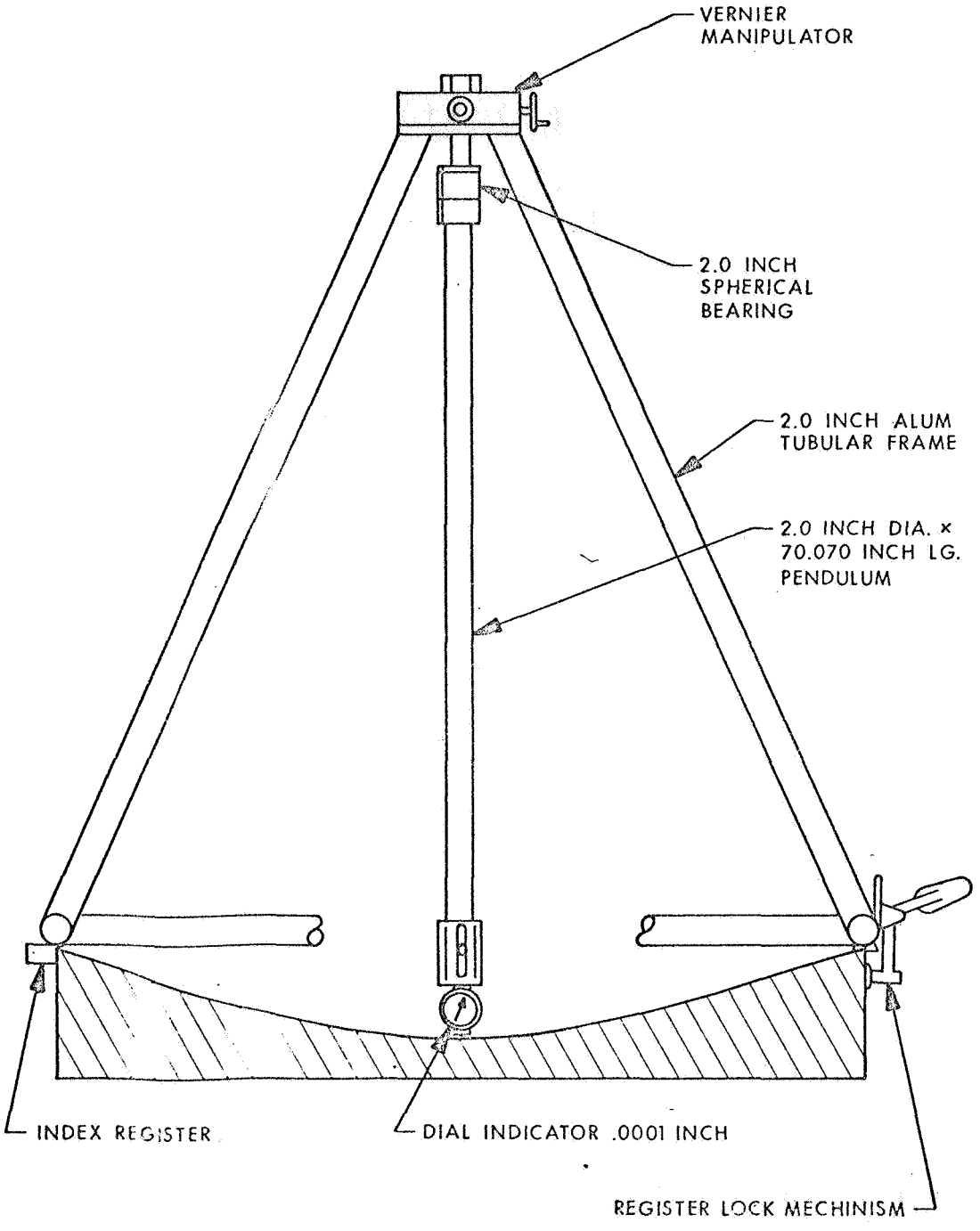
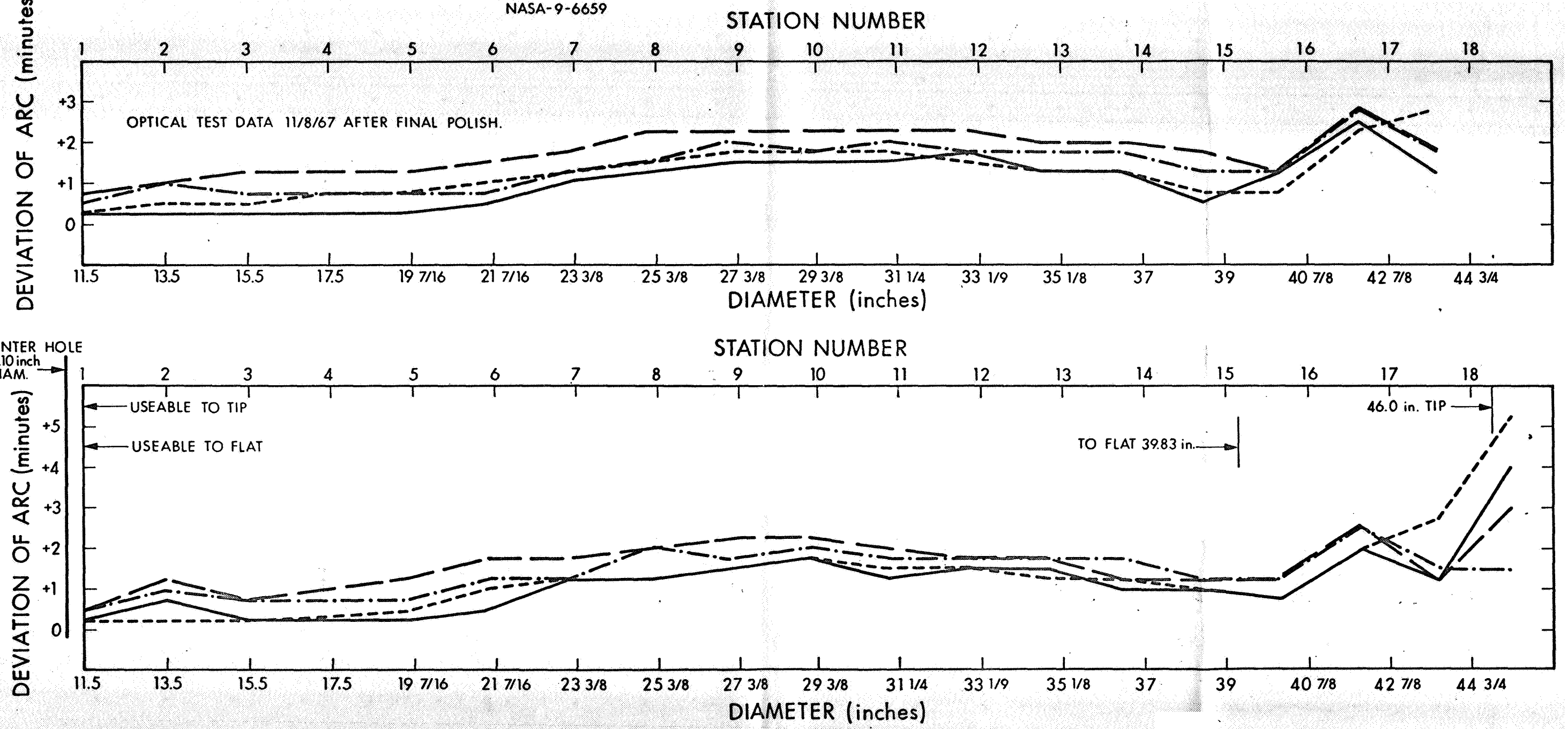


Figure 5. No. 4 Master Pendulum Checking Fixture

UNIT P/N 614329
UNIT S/N 50X-AOM-N1XB
RESULTS OF REWORK ON 7056-90-05
BY SYSTEMS & INDUSTRIAL OPTICS & EOS

52 inch DIA 17-4-PH ST. ST.
NO. 4 MIRROR MASTER WORKING TOOL
OPTICAL TEST DATA
NASA-9-5805 &
NASA-9-6659



X AXIS LEFT —— ——
X AXIS RIGHT —·—·—
Y AXIS TOP ————
Y AXIS BOTTOM - - - - -

DATA DATE- 11-20-67

AFTER 53 HOURS OF OPTICAL POLISHING TO REDUCE ORANGE PEEL.

Figure 6. No. 4 Master Measurement Graph

The two No. 1 mirror assemblies were to be machined as follows: one unit at the EOS Foothill Boulevard facility; the second unit at the Fansteel Company in Torrance, California. No. 2 masters were also sent to two independent facilities. The first unit was to be machined at Omneco, Inc., of Sun Valley, California; the second at Quintesco, Inc., of Azusa, California. The No. 3 mirror masters were selected to be processed at Quintesco, Inc., Azusa, California. Along with the No. 1 mirror, the No. 4 mirror master was to be machined at the Fansteel Company in Torrance, California.

The precision measuring probe assemblies were manufactured by Mardelle Industrial Products of Monrovia, California.

After being selected for the appropriate master, each billet of 17-4-PH stainless steel was X-rayed and ultrasonically inspected. Any defects detected were reviewed and analyzed. If the defect would hinder final product accuracy and optics, it was reforged and examined again. One billet for the No. 1 master had an inclusion through the center which was not critical to machining operations.

After thorough examination and evaluation, each stainless steel billet was shipped to the cognizant vendor for machining. Each facility made setups for each mirror master. Overarm assemblies were manufactured and checked out on their machines (Fig. 7). Some welding was required on the No. 1 units (center posts) and a complete flange weldment ring was required on the No. 4 assembly.

Upon completion of the unit setup and checkout, the rough billet was installed in the lathe and dressed up so that each could be faced off and cut to approximate diameter.

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Figure 7 Program Assembly Head in No. 1 Master Contour Check

When the truing of the material was completed, a rough machine cut was made to bring all required dimensions to within 0.020 in. The rough cut unit was then removed from the lathe and a dye penetrant check made. There was no evidence of cracks in the surfaces of any of the units checked and processing continued.

After final machining, each unit was heat-treated to a hardness of 38 to 42 Rockwell C. While each unit was being heat treated, the probe measuring devices were set up in the machines and checked out. After the heat treated unit, along with certifications, was returned, it was set up in the lathe and closely checked. The precision electronic probe was then checked out and aligned with the system.

Upon completing the new setup, scans of the contoured surface were made with the electronic probe to determine the contour itself. Each scan was recorded and rechecked until satisfactory achievement of repeatable data were obtained (Figs. 8 and 9).

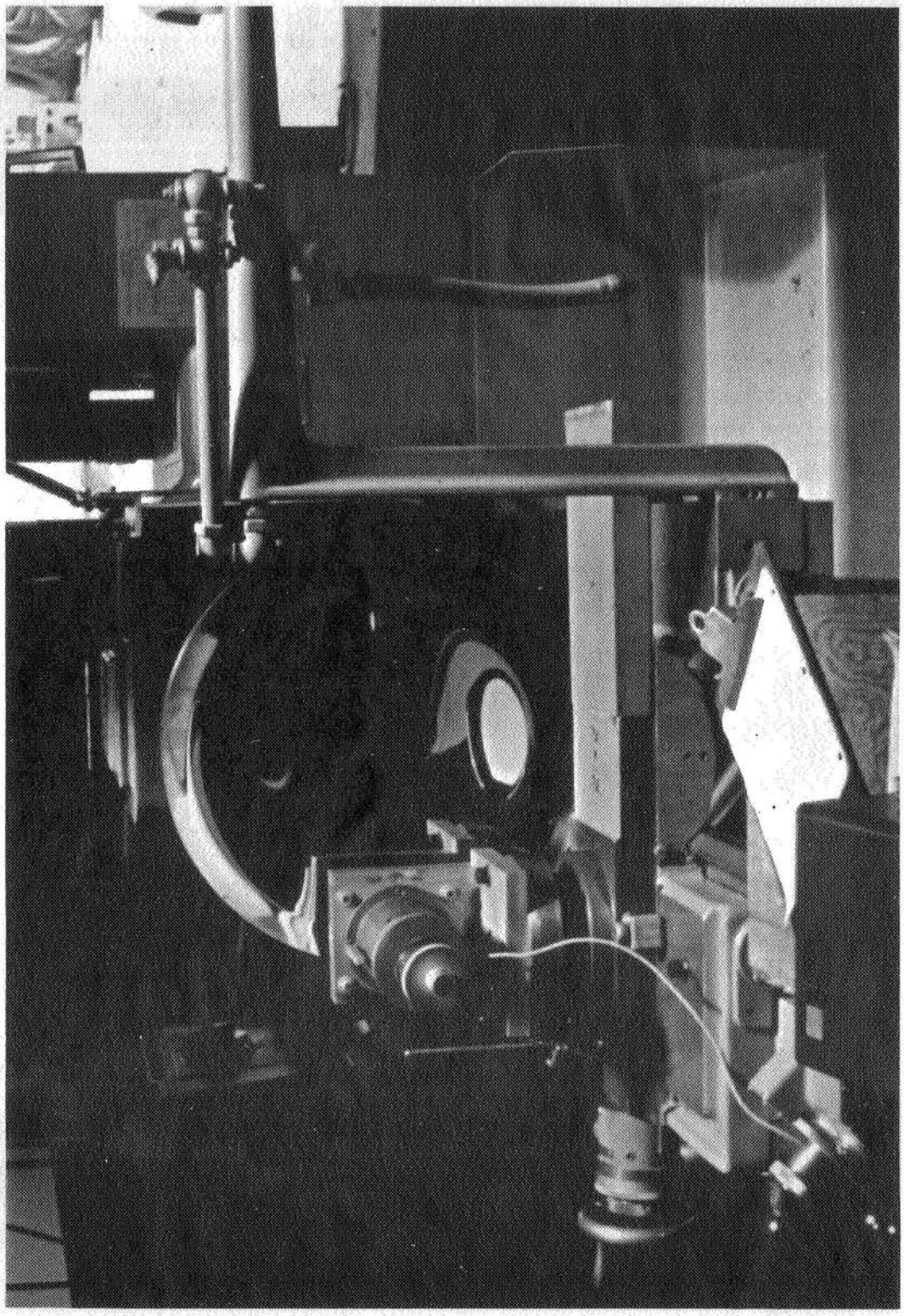
When satisfactory contours were obtained, all machining was stopped and probe checks rerun. If the unit was acceptable for contour and machine finish (4 to 10 rms), it was removed from the machine.

After final machine contour, the mirror master was carefully packaged and shipped to the optical polishing facility. At this time, all setups were made and all polishing and grinding tool heads molded.

Grinding operations were started and the tooling had a short break-in period due to the high accuracy of the machined finish. Grinding compounds used were Barnsite grit of various sizes and water lubricant. Grinding continued until the entire surface lost its reflective finish and had a dull grey appearance. All grinding then stopped, and a dye penetrant test was rerun to check for cracks or any other defects.

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Figure 8. Typical Setup and Contour Surface Check on No. 2 Master



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The dye and developer was cleaned off of the contour surface and preparations then made for a cross template setup. An aluminum cross template was manufactured which had the approximate contour. A mixture of epoxy was applied to the contour edge of the cross template. The template was then placed onto the master and allowed to remain 24 hours to cure.

After the epoxy had cured, the template was removed from the master and returned to the thin films section to have an aluminized coating applied to the contour edge of the template. The cross template was then optically tested to compare the optics of the master to the required optics needed on the NASA mirrors. If the optical test was within limits and acceptable, the unit was polished. If optical defects did exist, the unit was returned for more grinding.

Optical polishing is a long extensive process. The same tooling was used for polishing as was used for the grinding operations, with the exception of the padding which makes contact with the optical surface.

The medium used for the final polishing was Lindsey compound of various grit sizes. Water was the lubricant, and, as the polish of the surface increased, less lubricant was used. The surface was continuously polished until the acceptable reflective optical surface was achieved. No scratch or dig specifications were used, because the best optical surface obtainable was all that was accepted.

Upon completion, the unit was carefully wrapped in lens tissue, covered entirely with surgical cotton and Kem-pack, and crated for shipment.

In the case of the No. 4 master, the unit was then optically tested as per O.T. 1000, Appendix A. The Nos. 1, 2 and 3 mirror masters were proof plated then optically tested (OT1000, Appendix A).

It was felt that each master manufactured should have an optical clear aperture at least 2 in. in diameter larger than the end product optical clear aperture.

The following table relates the mirror assembly size to the mirror master size used in mirror replication processing:

Mirror No. and P/N	Mirror Diameter	Master Diameter
No. 1, P/N 614330	27.0 in. ±0.060 in.	31.0 in. (2 each)
No. 2, P/N 614577	16.62 in. ±0.060 in. 0.000	20.0 in. (2 each)
No. 3, P/N 614576	12.25 in. ±0.060 in.	17.0 in. (2 each)
No. 4, P/N 614320	46.0 in. ±0.060 in. (Hex)	52.0 in. (1 each)

The Nos. 1, 2, and 3 mirror replications were plated directly on the 17-4-PH stainless steel masters. Optical surface conditions remained acceptable through most of the platings. The masters were removed periodically from the plating line to clean up the digs and minor scratches that occurred during cleaning operations. (Prior to the unit returning to the plating cycle, the surface was cleaned and air-dried.) Even though precautions were exercised, the optical surface still picked up minor digs and scratches and had to be removed from service periodically and optically polished to insure acceptability. The required tolerance of ±4 minutes of arc was achieved and held throughout the plating cycles.

Plating life of the No. 1 masters was not as expected. Three times during plating, the No. 1 masters received minor damage. One master had a circular ring scratched into the surface from making contact with a misaligned anode basket. Two other times the surface was scratched from parting replicas and improper cleaning.

Over a period of time, the optical contour surface exhibited an orange peel appearance. This did not effect the optical performance of the end product mirror; however, the surface did degrade possibly sooner than expected.

Plating life on the two masters for the No. 1 mirror was as follows:

S/N 27X-AOM-NIX had a total of 36 platings
S/N 27X-AOM-N2X had a total of 73 platings

No. 2 mirror plating was very successful and did not require considerable rework of the master.

Surface degradation consisted mainly of digs and scratches on the optical surface. This was due to cleaning and parting operations. The masters were removed from the plating area once during service and optically polished.

Plating life on the two masters for the No. 2 mirror was as follows:

20-XAOM-N1 had a total of 43 replicas
20-XAOM-N2 had a total of 89 replicas

The No. 3 mirror masters were very successful in completing plating cycles. Mirror distortion due to stresses occurred periodically and caused a few rejections. These spherical mirrors are manufactured to within one-half minute of arc optically, and the slightest stress or handling problem causes deformation of the optical surface.

Plating life of the two No. 3 masters was as follows:

S/N 17XAOM-N1 yielded 66 replicas
S/N 17AXOM-N2 yielded 87 replicas

The No. 4 mirror replica assembly was plated on submaster assemblies. These submasters were made on the 17-4-PH stainless steel master tool.

Fourteen No. 4 submasters were replicated for the first 40 No. 4 mirrors. An additional five No. 4 mirror submasters were manufactured to complete the last 20 optical train mirrors.

The surfaces of most of the mirror masters held up well. Contours were within the required limits mechanically, and final optics test performance was within tolerance. With continuous monitoring of the stresses during the plating process, the average yield per master was adequate. More platings were obtained from the optical train masters than from any others previously manufactured.

The problem of the orange peel condition was traced to surface hardness of the master. There appears to be a crust layer on the optical surface which has hard and soft areas. Periodically, this orange peel effect appears from the plating process (possible solution etch), but it has been corrected by optical grinding and polishing.

Another problem that has been noted on the No. 4 master during the orange peel observation is a grain structure pattern. The gran structure can be seen if the surface is observed closely, but does not affect optical performance. Cause of the grain structure has not been determined.

Along with the above problems, porosity appeared twice in the seven masters machined. One No. 1 master had a hole 0.100 in. wide by 0.030 in. deep and 0.924 in. long. This cavity completely disappeared by the time final machining was completed.

There is a porous area at about the 48-inch diameter on the No. 4 master. This cavity is 1.010 in. long, 0.060 in. wide, and 0.030 in. deep. During submaster plating, this area is masked off. This deformity

appears on all replications; however, during mirror processing, this area is cut off since it is not in the useable area.

As outlined, the surface of some masters had the orange peel problem and the appearance of grain structure. This problem has been investigated, and it was noted that the stainless material was air melted. Air melting retains some of the mill inpurities in the end product, and may cause the imperfections noted in the master blanks.

4.2 REPLICATION

The replication of mirrors by electroforming is an old process developed to a high degree in the past nine years by EOS. This process involves plating a thick deposit of metal on a mandrel or master, then separating the deposit from the master. In this process, the electrodeposited metal is nickel, but almost any metal may be used. The two main reasons nickel is selected are its strength and its ability to reduce internal stresses to a minimum. The following paragraphs will discuss the process details sequentially.

Prior to commencing production plating, the particular plating tank to be used is drained of all plating solution and thoroughly cleaned. The tank liner is checked for blistering, cracks, delamination, and chaffing. All mechanical hardware is examined and repaired or replaced as necessary.

Upon completing the above, all electrical wiring and hardware is functionally tested. All rectifiers, temperature controllers, and recording devices are systematically checked.

The mirror master plating setup is then established. An anode basket containing nickel chips is set into the tank and centered. The rotator assembly (master retainer) is functionally checked and centered, then swung over the anode basket and adjusted and locked into place. After the plating setup is made, the rotator is swung out of the tank.

Following the basic mechanical portion of the plating setup, the plating bath solution is pumped through a filter into the plating tank. The solution consists of nickel concentrate, deionized water, and additives. When the required amount of solution has been introduced into the tank, power is applied to the immersion heaters and the tank temperature is raised to production requirements.

When the required temperature is achieved, a strip test, a pH test, and a bath analysis are made. The plating bath parameters are closely checked as is the electro-mechanical support hardware. Any required solution changes are made to meet the solution parameters. Meanwhile, all support gear is checked out to assure proper operation during plating. The rotator is completely checked out, including all electrical circuitry and secondary support equipment.

During the solution checkout phase, the mirror master assembly is being thoroughly cleaned. Cleaning consists of using a thin solution of Barnsite polishing compound and water, and scrubbing the optical contour sourface. After scrubbing, the master surface is rinsed with distilled water and air dried.

Personnel from the Process Control area inspect the surface for cleanliness and scratches. If acceptable, Process Control issues acceptance, and plating process preparation continues.

After the cleaning procedure is complete and acceptable, the master surface outer area is masked off along with the outer edge diameter. (This is accomplished by the use of plastic platers tape). The back side of the master is then coated with a stop-off material, which covers the master area (back side) attachment hardware, and rotator shaft.

When all preparations are complete and acceptable, Process Control reinspects all parameters and gives the go-ahead to start the plating cycle. The rotator is then repositioned, the master is submerged into the plating bath, and the plating cycle is started.

All pertinent data such as start time, voltage, amperage, and solution temperatures are recorded. As the strip testing and solution analysis are made, their results are recorded on the plating sheet and also permanently filed in the Process Control Laboratory. These records are

maintained during the complete plating cycle (Fig. 10). Upon completion of the plating cycle, the stop time is recorded, the auxiliary systems are shut down, and the mirror master is readied for bath removal.

Removal from the bath is accomplished by swinging the rotator out of the plating tank and resting it on the side of the tank on bottoming stops. Immediately, the master-replica is rinsed off with deionized water to 'dilute' the residue plating solution, washed thoroughly, and air dried.

At this time, the unit replica is identified by mirror master number and replica number. When identification is made, the back surface area of the replica is examined for pits, deformation, cracks, etc. The replica is then pneumatically parted from the master and, along with the optical surface of the master, is rinsed and washed. The master surface is then covered with a protective cover.

The mirror replica is now examined for damage or deformation, and any other obvious defects. All paperwork and permanent records are checked, and, if all criteria are in order, Process Control schedules the mirror replica to be used for mirror production fabrication.

NOTE

In cases of a first-run replica in production, the unit is cut up into 1-in. strips after it is parted and examined. Thickness checks are made every 0.250 in. along each strip. This test is called a "profile test." Data from this check relates the uniformity of the plating application and are also an aid in checking all parameters in the plating cycle. All pertinent data are fed back to the plating supervisor who in turn requests changes in bath solutions if required.

ELECTRO-OPTICAL SYSTEMS, INC.
A Subsidiary of Xerox Corporation

TANK NO. _____

STRESS TEST AND ANALYSIS RECORD

ELECTRO-DEPOSITION LABORATORY - DEVELOPMENT AND PRODUCTION DEPARTMENT

DATE _____ TIME _____

SOLUTION TYPE _____ NAME: _____ TEMP _____ °F Ph _____ DENSITY _____

NICKEL METAL CONTENT _____ oz/gal., NICKEL CHLORIDE _____ oz/gal., BORIC ACID _____ oz/gal.,

REMARKS _____

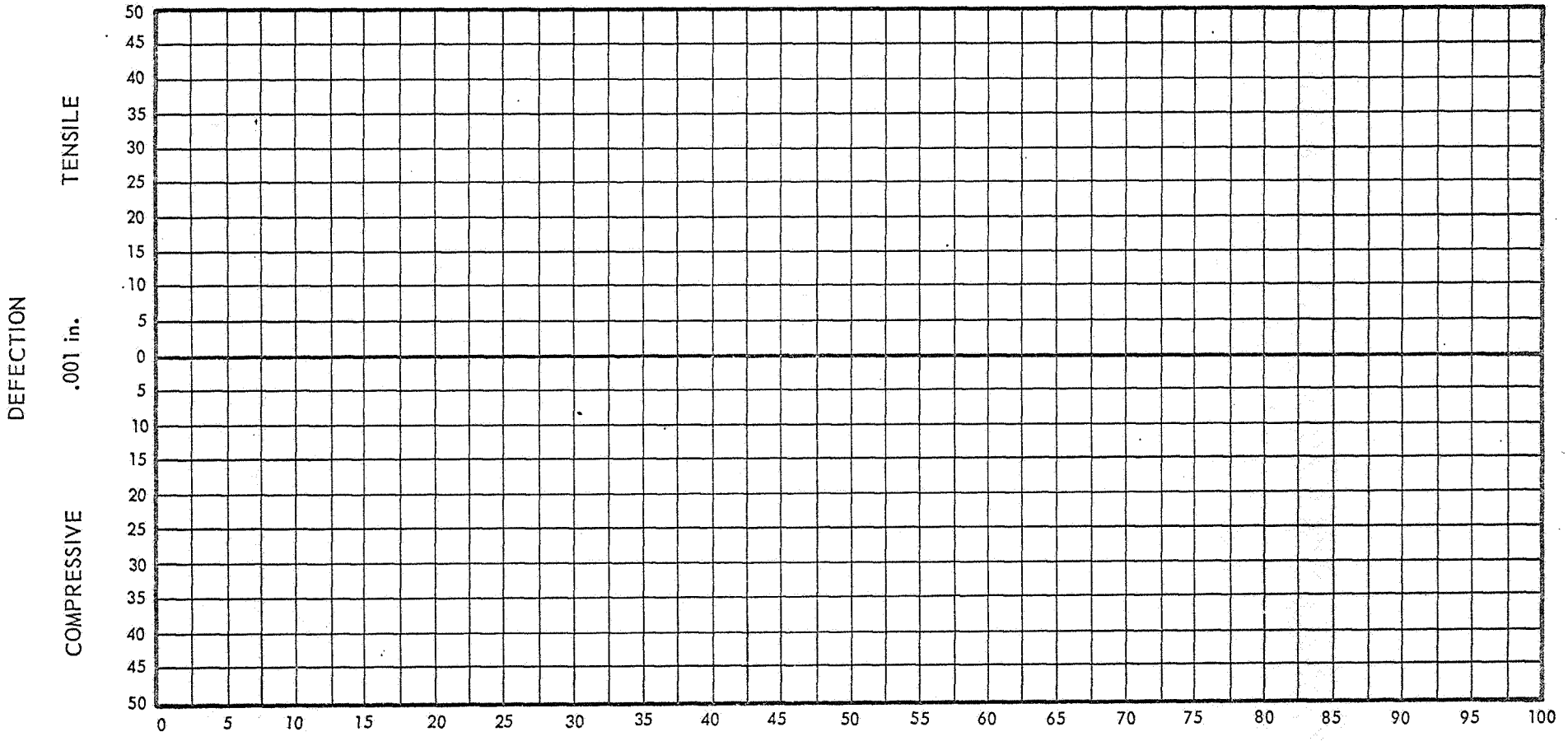


Figure 10

The purpose of the strip test is to provide techniques for the measurement of stress in electrodeposited nickel and control of plating variables to maintain optimum stress levels.

Measurement of stress in electrodeposited nickel is performed by plating a rectangular area of exactly 0.01 sq ft on one side of a stainless steel bar (6 in. x 0.5 in. x 0.010 in.). The remainder of the strip is masked off with tape. A deposit of 0.0005 in. of nickel is electrodeposited onto the exposed area. Two strips are plated simultaneously and the two deflections are averaged to the nearest thousandth of an inch.

Stress in the nickel deposit causes the strip to deflect toward or away from the measuring device as illustrated in Fig. 11. Measurement of the plus or minus deflection (strain) gives the Tensile (+) or Compressive stresses (-) of the strips being evaluated. This data is recorded and fed back to the plating line so adjustments and changes can be made. The deflection of the strip test sample, as shown in Fig. 12, is a function of the average current density and the solution temperature. Point deflection may be converted to internal residual stress by use of Fig. 12.

In order to maintain the proper current density-residual stress balance, strip tests were required at least once a day. Due to the response of the plating bath to daily chemical additions, and the effect of the plating cycles, strip testing was increased to two-hour interval checks. These parameters are controlled closely as noted, and all acceptable mirrors were within the specified plating stress range.

Periodically, plating stresses caused deformed mirrors which were out of optical tolerances and consequently were rejected. Based on the optical test results, the plating stresses are closely controlled and adjustments are made when required after each optical test.

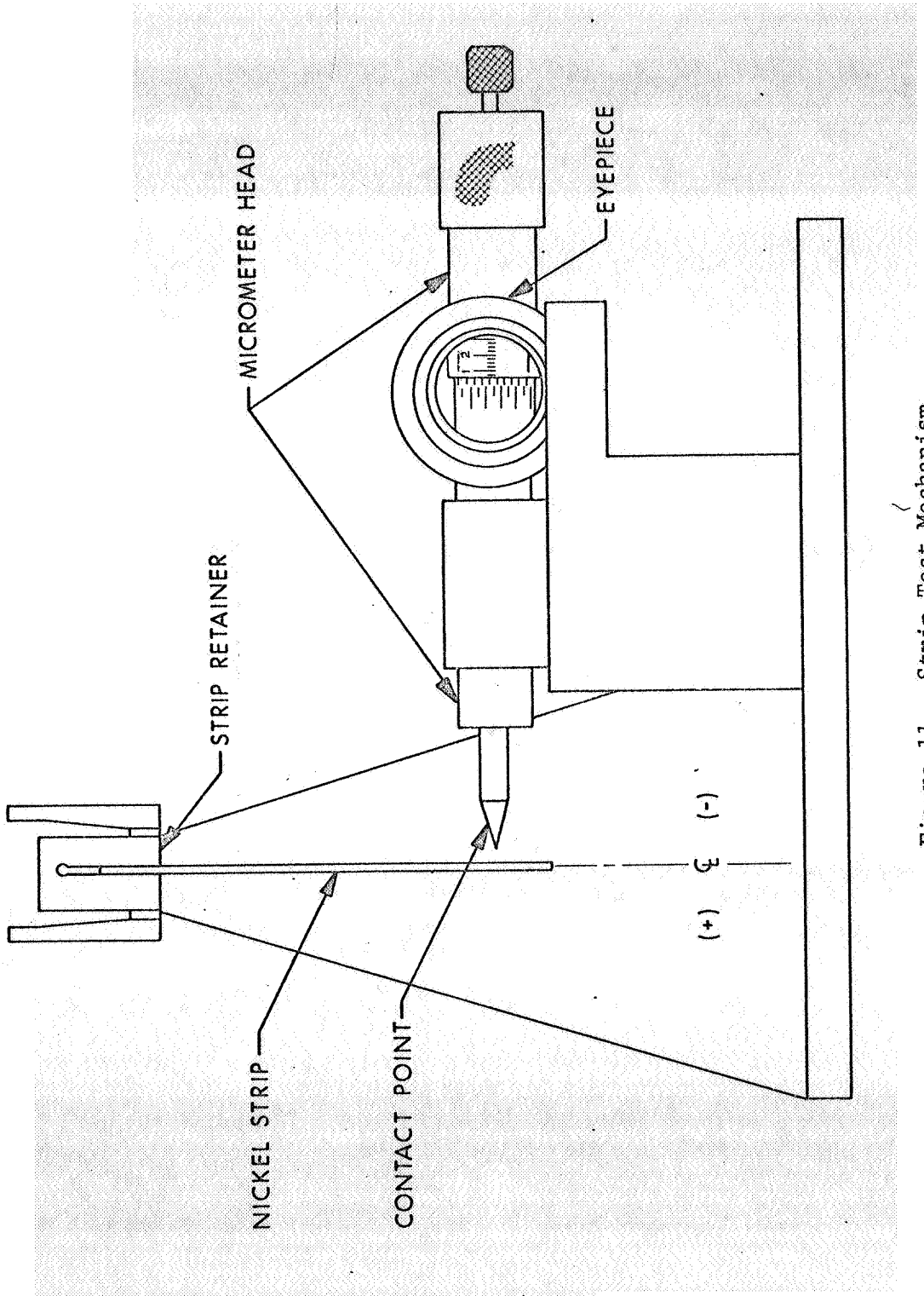


Figure 11. Strip Test Mechanism

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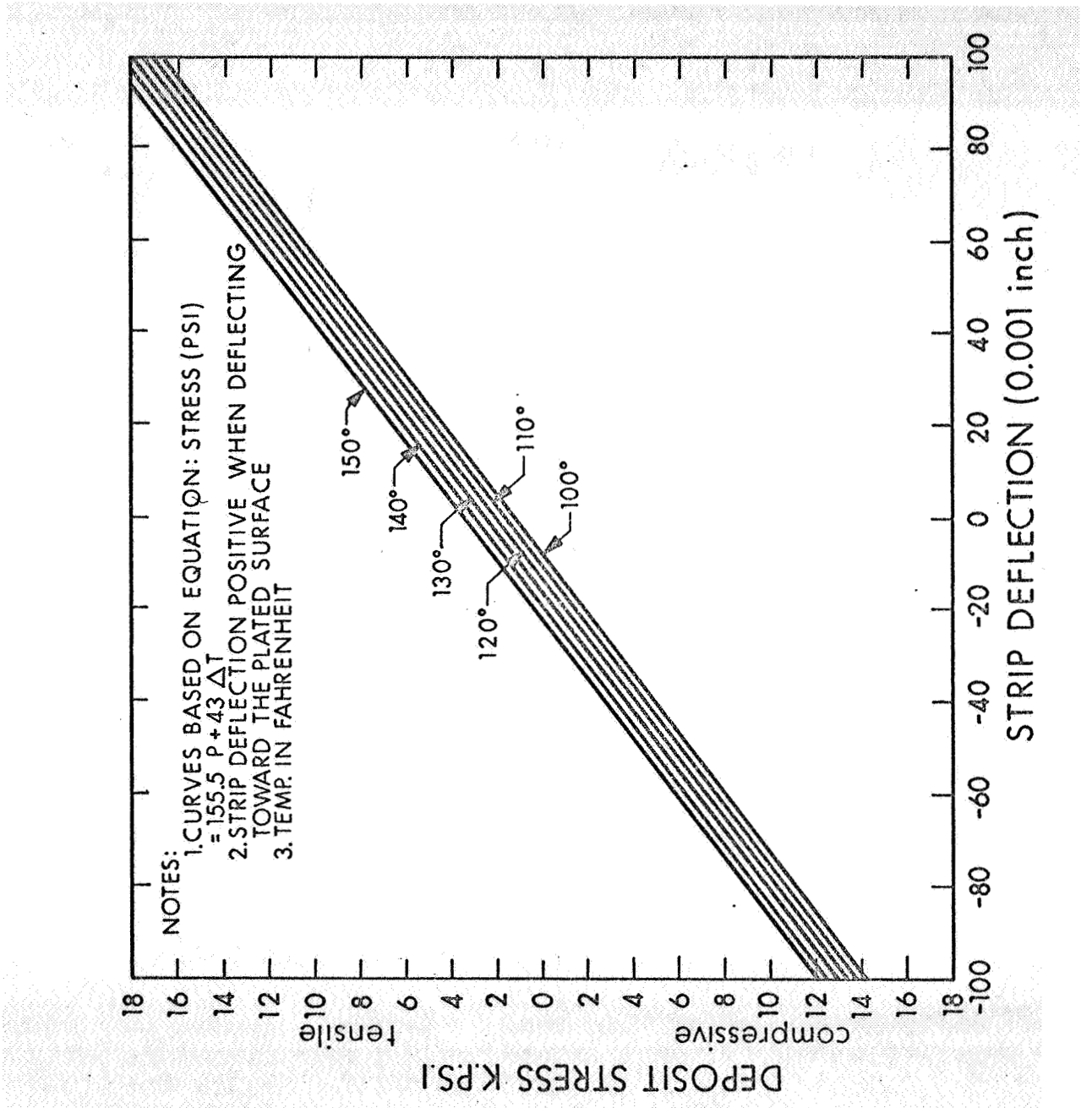


Figure 12. Stress versus Temperature Graph

The main plating problem encountered was the flat "S" curve on the No. 2 replicas. The slightest change in the plating stress would cause the optical geometry to be out of tolerance. These mirror replicas are to be maintained at an optical tolerance of ±3-1/2 minutes of arc, and are very susceptible to change in plating stresses. This is common for flat mirrors, as the forces required for movement are much less than those required for mirrors with smaller radii of curvature. The same is true for the No. 4 replica, especially with the increased surface area involved.

In order to maintain the stress parameters, the pH and temperature must be controlled within required limits. The temperature is monitored and controlled within ±2°F. During the plating runs, the pH is monitored and control is held with 0.2 of the required pH level.

During the plating cycles, a chemical analysis was made on each of the plating days. The critical constituents and the amount of each (chloride, boric acid, and nickel) were determined by the EOS Standard Chemical Analysis Procedure, dated 11/20/67, and EOS Directive 35-1, dated 10/25/66. If and when chemical additions are required, they are added during the second shift. This is done so the new additions can disperse into the plating bath and analysis, and strip tests can be run prior to commencing the plating cycle.

The chemical content required in the plating bath has a definite range to be maintained. These parameters are monitored continually, and any additions are noted and added as referenced above.

4.3 MIRROR CASTINGS

Four casting configurations were used in this contract. All four were redesigned during the Solar Simulator Optical Program Development Plan (NAS9-5482) to provide a more positive water seal and temperature control. The No. 1 and No. 4 castings underwent a major change in that all were modified to provide a continuous integral path coolant flow passage.

Vendor selection for the procurement of these units was based on competitive bids to a fixed delivery schedule. Previous experience with the casting suppliers for the earlier program (NAS9-1097) gave some insight into the potential problems on delivery and quality. All suppliers were surveyed by EOS Quality Assurance prior to the performance of any work.

The MSC-selected casting designs were the least expensive designs based on cost estimates supplied by EOS; and, as with any new designs, compromises were made. The new castings all used an integral water passage of some type and were provided with new mounting points which are not interchangeable with the early types. All the new units could be used in the early systems, but required adapter kits to be designed and manufactured. The water cooling passage in the new No. 1 mirror used a casting which required the welding of rings to form the cooling passage. The early type used an epoxy-bonded aluminum spinning to form the sealed passage. This new unit provided theoretical advantages which became less evident during manufacture.

Several problems appeared which ultimately became costly. The first problem, a distortion which occurred during welding, was of sufficient magnitude to prevent machining of the contour which mates to the back of the replica mirror. This problem was solved by building tooling to

retain the unit by clamping and preheating prior to and during the actual welding. The next problem was caused by portions of the aluminum ring sagging into the water passage, preventing sufficient water flow and weld porosity during the 150-psi pressure test. This was prevented by flow and pressure checks after the first welding pass. Problems also occurred with some units which passed all tests prior to coating the water passages and then incurred stoppages or flow restrictions during the coating process. These were caused by machining chips which only packed when a high viscosity fluid passed through the castings. This problem will be discussed in more detail in the section on water passage coatings which follows.

The No. 2 castings were changed very slightly in their design, and the changes resulted in no new major problems.

The No. 3 casting design was also roughly the same as the early units. The only major change was the vacuum impregnation of the casting with epoxy for vacuum integrity and corrosion resistance. This process was very successful, and no No. 3 castings were rejected in helium leak check.

The Nos. 2 and 3 castings are similar in that they both have open cavities through which the water courses rather than containing continuous cooling passages.

The No. 4 casting requires a helium-leak test and uses a different cooling approach. This unit has stainless steel tube cast integral in the unit, rather than a composite as shown in Fig. 13. Stainless steel mounting inserts were also cast in place. The tubing assemblies were welded to a spider prior to casting to hold them in the proper position. They were also helium-leak checked prior to casting, and this resulted in two failures. One failure was discovered during the hot water test after bonding, and one unit failed the helium leak test. The unit that

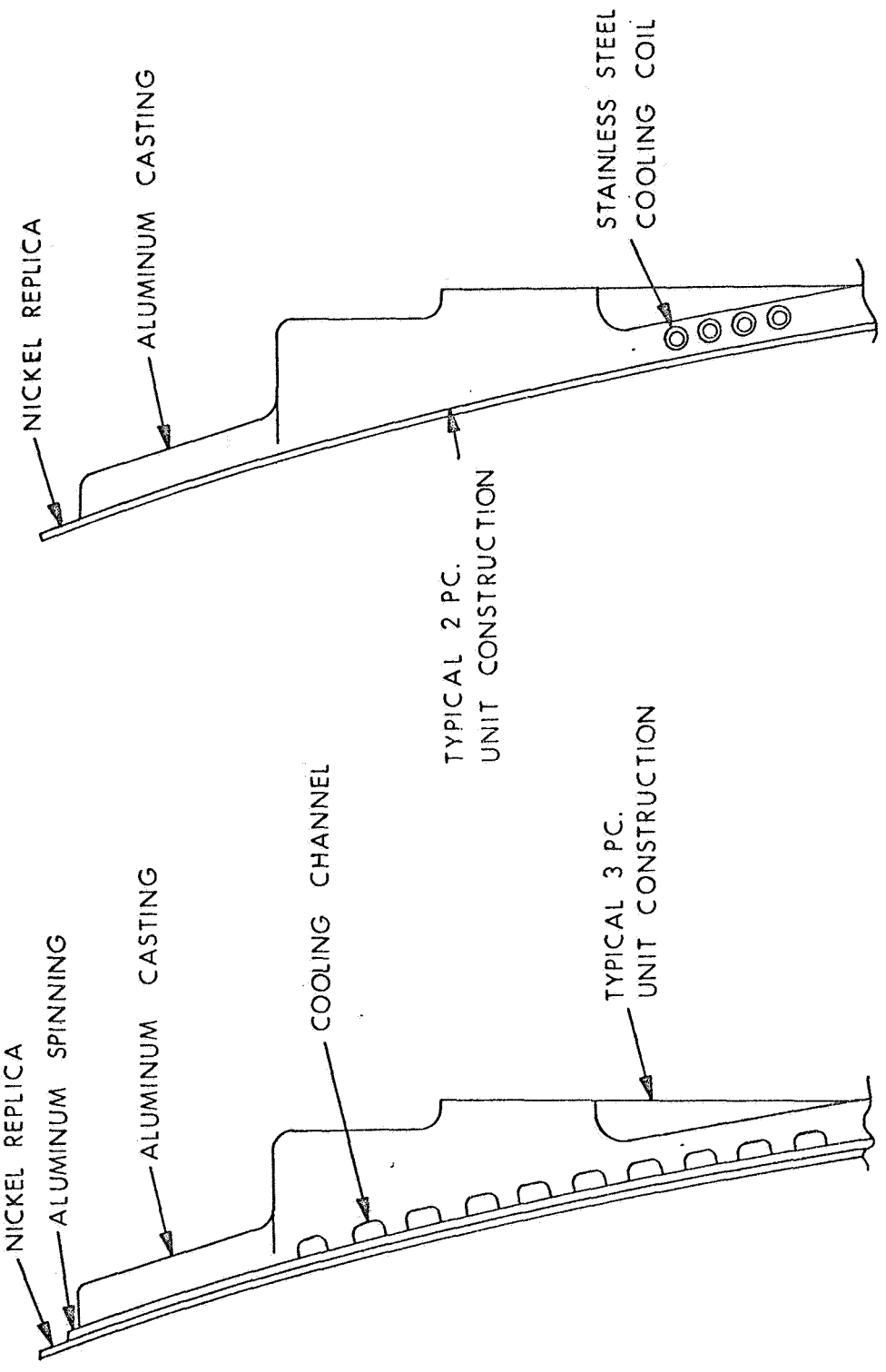


Figure 13. Two and Three Piece Casting Construction Comparison

leaked on water flow was damaged during machining when a tap drill penetrated the stainless tubing. The unit which failed the helium test leaked as a result of a casting void weld repair which apparently damaged the tubing. This defect was not located until the final collimator helium-leak check.

4.4 MIRROR CASTING COATING

The contract requires corrosion protection in the mirror water cooling passages. The No. 4 mirror is the only unit which does not have an unprotected aluminum interior, since it has a cast-in stainless steel coil. The No. 3 mirror was vacuum impregnated which gives a fair degree of corrosion protection. But this was done primarily for vacuum sealing since this unit, like the No. 4 mirror, is in vacuum during system operation. The No. 1 and No. 2 mirrors are both welded to form the water cooling passages. The No. 2 mirror has an open cavity while the No. 1 has a "D" shaped water passage as formed by the welded rings. At a point in the program, after several units were completed, it was realized that there was no corrosion protection in the No. 1 and No. 2 mirrors. The fact that units had been assembled severely limited the processes available. Most of the coating processes, such as electrolytic coatings and chemical conversion coatings, used relatively high temperatures and corrosive materials. It was decided to investigate coatings which were organic in nature. A study revealed that the successful application of these organic coatings depended on surface pretreatments similar in nature to the prior discarded electrolytic and chemical conversion coatings, or abrasive cleaning to prepare the surface. In some cases, a primer was also required. During the course of the investigations, a supplier suggested that an organic solvent be used, followed by air dry and a coating using a polyurethane paint. This method was tried, and tests were run on the unit which was a No. 2 mirror casting reject. The first attempt failed after 820 hours. The process

was modified and another No. 2 casting and a No. 1 casting were coated. These units were assembled into a collector box and water was circulated through the system for 1000 hours. The units were removed from the system and examined, and no evidence of paint failure was detected. The decision was then made to use this process on all No. 1 and No. 2 mirrors. Request for approval was submitted and approved, and the work was accomplished on all 60 units which were delivered. Prior to the delivery of the last 20 units, MSC discovered paint flakes in several of their systems and corrective action was requested.

EOS then began a study of removal techniques for the polyurethane paint. Normal organic solvents were of no use as their only effect was to loosen or soften the paint. This removal technique was not satisfactory since there was no adequate access to the interior of the castings. It was determined that it was necessary to have a method of dissolving the paint, rather than softening it. No commercial solvents were available; and, after a program of testing material compatibility, concentrated sulfuric acid was chosen. All castings that were painted were then stripped of paint using this material. The assembled collector boxes presented a slightly different problem because of the materials involved, (such as nylon, which is soluble in sulfuric acid). These problems were solved by using polyprophylene tubing in the system to bypass vulnerable materials during the sulfuric acid treatment. This method was used at MSC to remove the paint from the 40 assembled collectors.

Since the paint was removed, nothing has been done to protect the castings except for water control at MSC (a closed system using an organic inhibitor). It is evident, at this time, that corrosion of the aluminum castings is not a critical problem.

4.5 MIRROR REPLICA BONDING

Upon completion of the final machining, each casting was inspected by Quality Control/Receiving Inspection. Hydrostatic testing to 150 psig and water flow testing were conducted at the suppliers facility. No hydrostatic leakage was permitted and a water flow minimum was established for the type mirror casting.

After each casting was accepted, it was forwarded to the production areas. As the casting was received it was processed through a cleaning process, per EOS Directive 12-2. Upon completion of the cleaning process, the unit was inspected and approval was given for mirror replica bond.

The replica was set up on a locating and holding fixture and the casting was carefully located on the replica back side. After all locating fixtures were in place, the inside and outside diameters of the casting were marked. The casting was then removed and plastic tape applied to the back side of the replica area which would not be bonded.

After all masking was completed, the surfaces to be bonded on the casting and replica were scrubbed with 200^{o} alcohol. After the alcohol had dried, the mirror replica surface to be bonded was coated with Primer K and allowed to dry for 45 minutes.

The epoxy was then weighed and mixed and applied to both the replica and casting surfaces; then, the two surfaces were indexed jointly for bond. After assurance of centering and indexing, excess epoxy was applied to a previously cleaned area of the casting, and a torque button was positioned and guarded by means of a mechanical cover.

The bonded unit was then allowed to cure for a minimum of four hours and all excessive epoxy was trimmed and removed. After 24 hours, the breakaway torque of the test button was checked by Quality Control and DCAS personnel assigned to the bonding area. If successful torque results were achieved (10 ft/lb or more) the unit was acceptable and released for preliminary optical testing.

Torque values of less than 10 ft/lb were rejected; however, very few units were below this level of torque value.

The No. 1 mirror is bonded using a contoured bonding fixture; the No. 2 mirror uses a vacuum retention fixture; the No. 3 mirror is centered on the optical axis and bonded to the casting; and the No. 4 mirror is bonded to the replica while the replica is still retained on the No. 4 plating submaster tool.

During the bonding operations, there were a few problems encountered. Bad batches of epoxy were noted, the first of which had dark particles in the mixture. All of this epoxy was discarded, and no other problems occurred until the last batch of epoxy was used. Two mirror bonds were lost due to low torque results. When the mirror replicas were parted from the castings, the epoxy had localized areas which did not cure properly. These bonds were from a batch of frozen epoxy. Since no valid reason for poor cure could be found by EOS and the epoxy vendor, frozen mix was discontinued and hand-mixed epoxy was used during the remainder of the program.

4.6. PRELIMINARY OPTICAL TEST

After completion of the bonding operation, the mirror is tested to see if the optical figure is correct even though it may change after Elox cutting. The test serves two purposes: first it determines that the

unit is acceptable for elox cutting; second, if it is out of optical tolerance, a plating stress correction may be made. This test is the vernier adjustment of stress control since very small stress changes cause significant optical geometry changes.

Each unit is set up on an optical test bench and adjustments are made with the mechanical portions of the test equipment as referenced in the OT 1000 (Appendix A) test procedures. The Nos. 1, 2, and 4 mirrors are tested according to the test procedure in a test tower at points on the vertical (X axis) and horizontal (Y axis) of the mirror. Typical setups are shown in Figs. 14 through 16. Any areas which exhibit dark or light spots or deviations in screen grid patterns are also checked. The surface area is closely examined for digs, scratches, dimples, and general appearance. Any deformities are checked optically; and, if the required criteria are met, the unit is accepted for further processing. If the unit is not acceptable optically, it is rejected and reprocessed.

Any mass deviation areas noted are investigated, and this information is then transmitted back to the cognizant processing stations for corrective action.

The optical testing on the No. 3 mirror is performed using a glass checkplate on the mirror surface, and a fringe count is made. Many optical deviations can be noted by the experienced and trained eye and are closely checked with the glass checkplate. Fringe counts in excess of 16.7 fringes/inch, using a 2-inch dia checkplate, are cause for rejection. If the unit is optically out of tolerance, inspections and examinations are made and all information is forwarded to the various process sections as noted above.

All acceptable units are released to production for further processing.

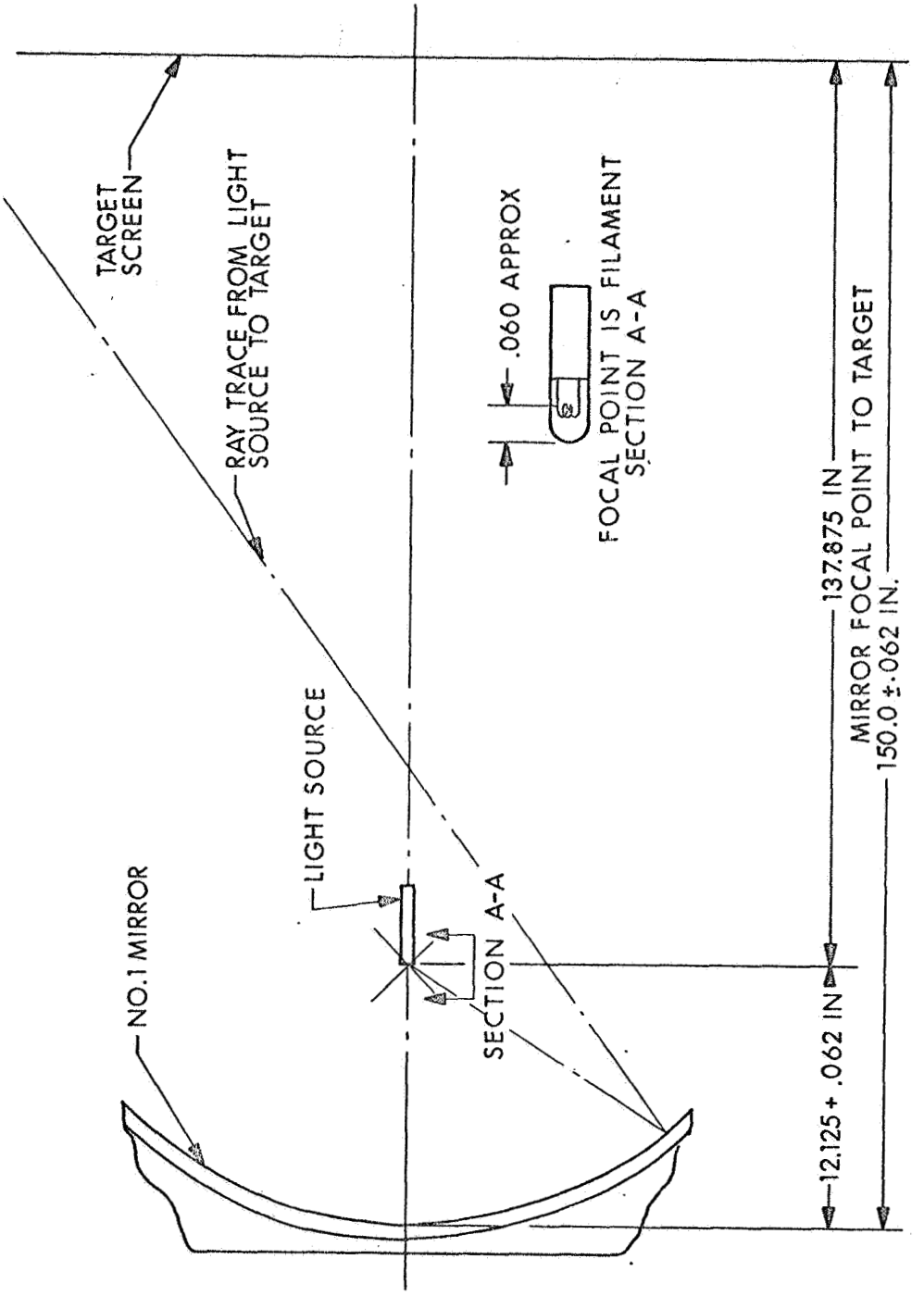


Figure 14. Schematic - No. 1 Mirror Test

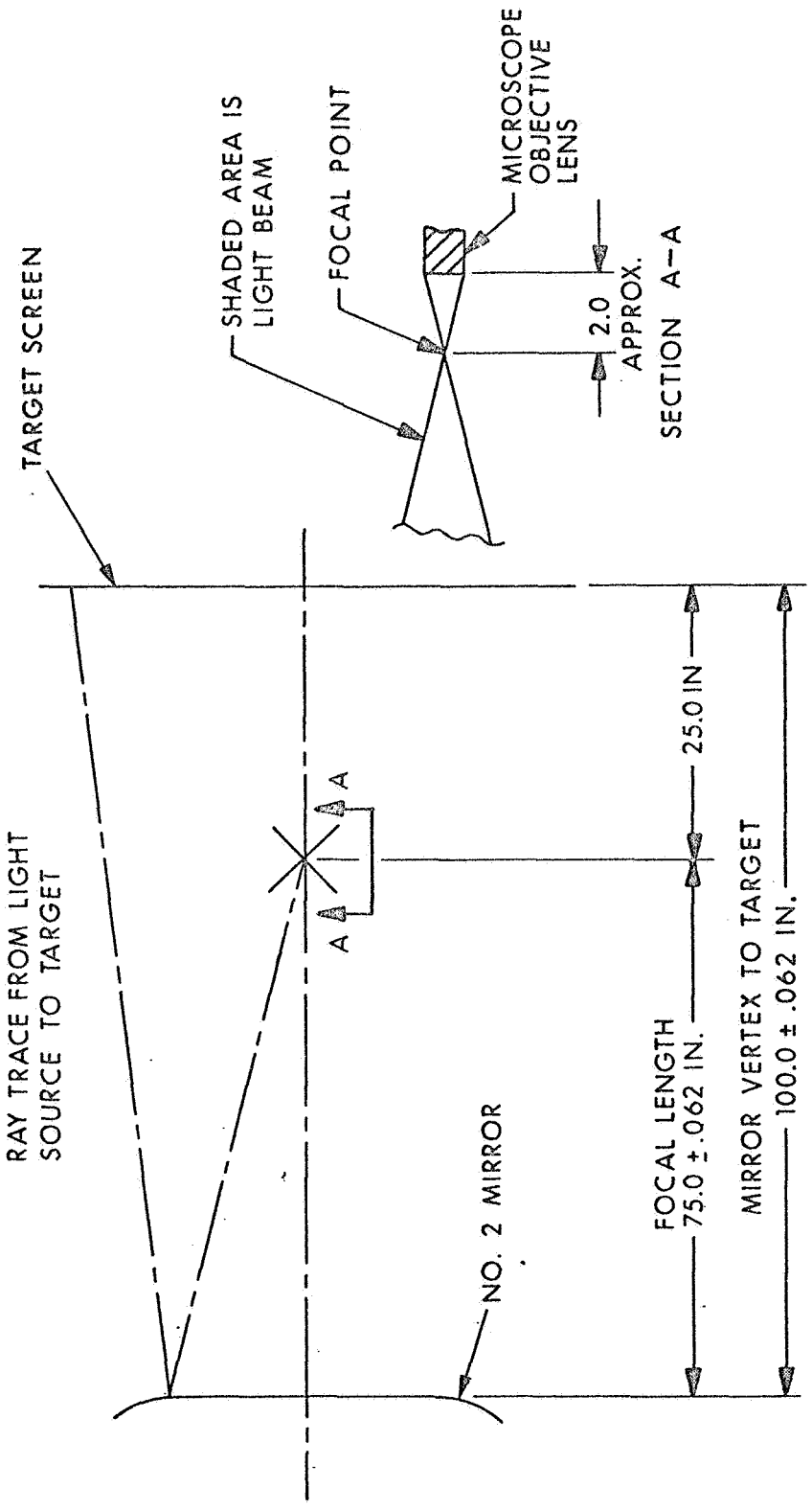


Figure 15. Schematic - No. 2 Mirror Test

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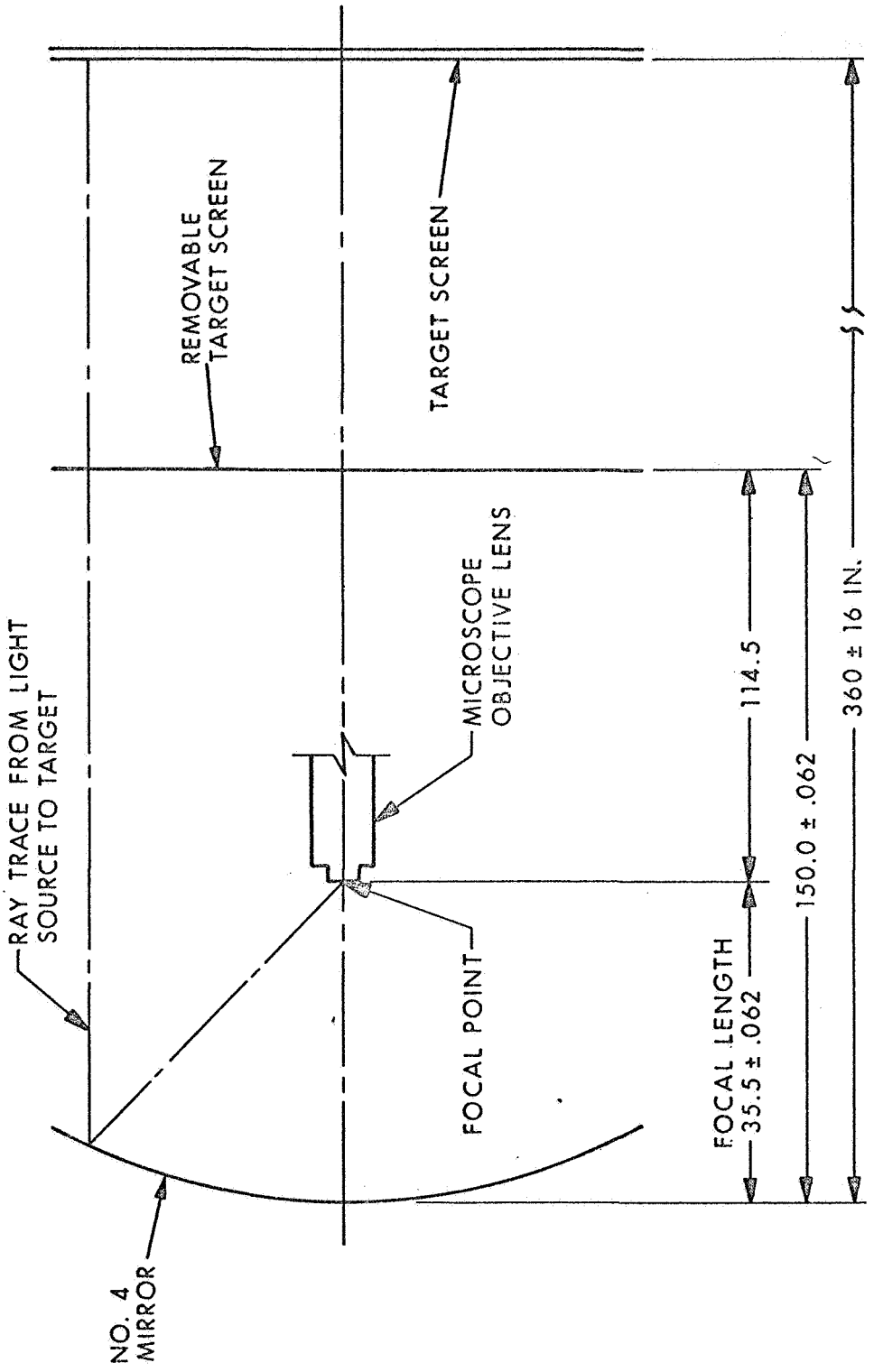


Figure 16. Schematic of No. 4 Mirror Test

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4.7 ELOX CUTTING

All mirrors were electric-spark-discharge machined on the inside and outside diameters after bonding and preliminary optical test operations.

The mirror assembly was cut to size as called out on the specified drawing. Each mirror assembly has a separate set of cutting tooling which attaches to the machine centering head. This tooling is designed for ease of replacement because it is consumed during the cutting action.

A casting location fixture is installed on the machine cutting table, and each casting is centered, and indexed prior to cutting. The No. 4 mirror is indexed to 3 positions because the Elox machine tool only cuts two sides of the hex and one of three slots during each pass. All electrical connections are made, the tub around the mirror assembly is filled with dielectric oil, and the cutting is accomplished.

After the mirror assembly is cut, it is removed from the machine, washed with detergent soap, water rinsed, and air dried. The inside and outside diameters are then deburred and the unit is water rinsed again. The mirror assemblies are then mechanically inspected to the applicable drawing, and the optical surface is visually examined for scratches, deburring marks, etc. Any mechanical discrepancies are cause for rejection or MRB action.

Periodically, units were rejected due to Elox arcing which causes small pits close to the edge of the cut surface which hinders coating applications. These rejections were rare.

4.8 FINAL OPTICAL TEST

The final optical test is the same test as the preliminary test (OT 1000, Appendix A), but it is witnessed by both DCAS and EOS inspectors. The No. 3 mirror is tested using a 2-in.-dia glass checkplate which has the correct radius of curvature. Monochromatic light is used for a conventional fringe count and the whole surface of the 12-in.-dia convex mirror is checked. Acceptance criteria are in the lens specification in Appendix A.

The Nos. 1, 2 and 4 mirrors were tested using a ray trace technique developed by EOS to test these specific mirrors. A point light source is placed at or near the focal point of the mirror to produce a return beam which does not diverge or converge to an extreme. A slotted mask is placed across the surface of the mirror which then projects on a target bar which shows the theoretical position of the image and the optical tolerance. This test only tests the finite area exposed, and a judgment factor must be used to determine how many test points are made. Initially, tests are made across the mirror in the form of a cross to align the unit in the X-Y plane and locate the axis. Once this is done, the relationship between the mirror and light source is not changed, only the slot mask is moved for additional test points. All test data taken are recorded and included in the mirror data package.

A problem with this test on the No. 4 mirror resulted in the return and subsequent rejection of 20 mirrors. The problem was due to the interpretation of areas to be checked and the mechanism for determining these errors. The test range is 150 in., and the image of the total projected beam at this point is not as distorted as it would be if the range is doubled. The increase in range would then double distances on the target bar, etc. This length range was not used because the

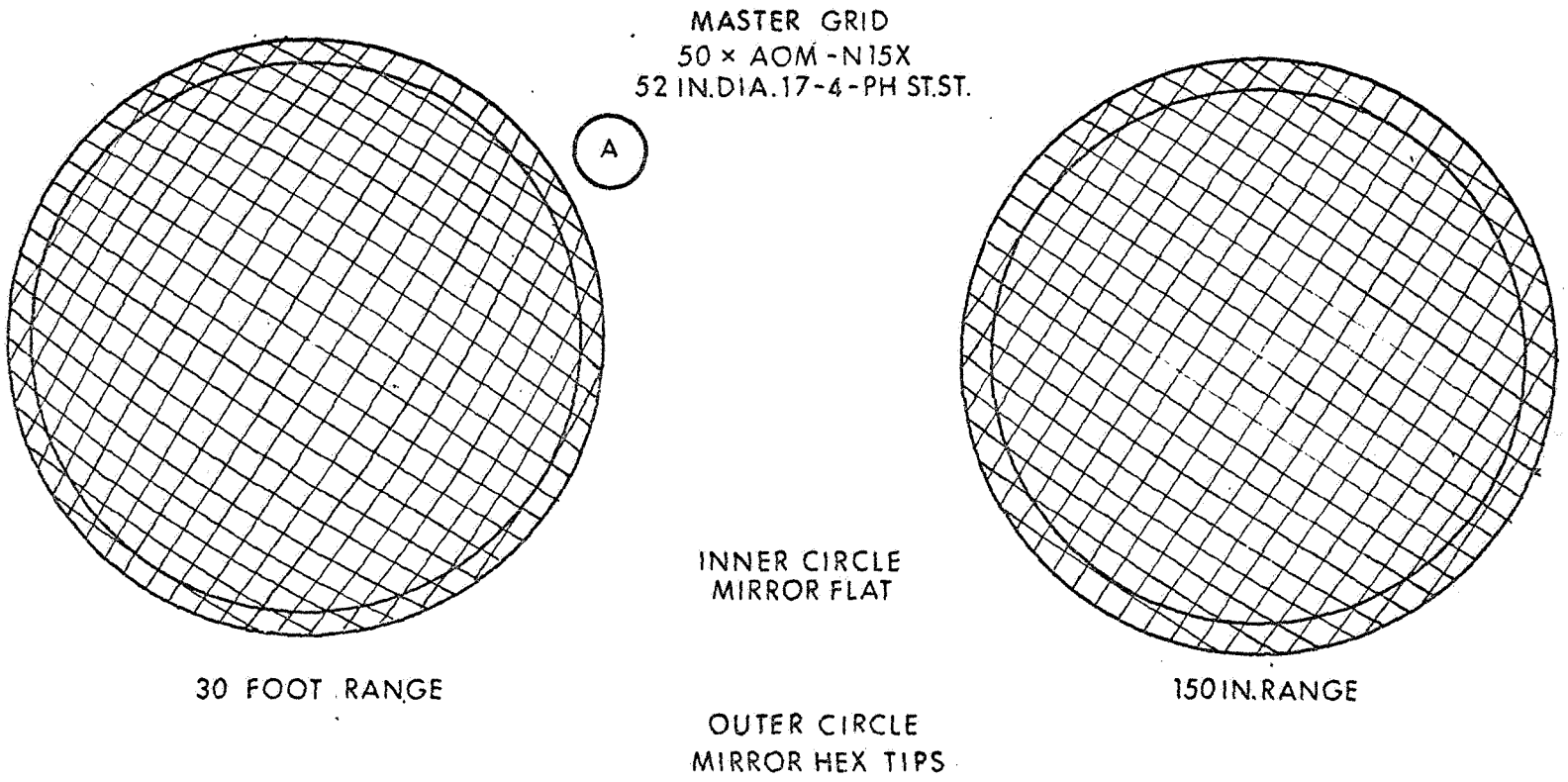
allowable tolerances would cause overlap of test zones on the target bar. This problem, plus the lower intensity and greater diffusion of the beam from the slot, resulted in the choice of the 150-in. range.

After the early rejections, EOS changed the test procedure to include looking at the projected image at 360 in. for zonal check locations, and checking with a 2-in.-sq grid. The actual measurements of angular error are still made using the 150-in. range; but, in addition, the 2-in.-sq grid is projected on the target screen. This device is made from 1/4-in. strips of steel spaced on 2-in. centers and mounted in a frame. Photos were made of the pattern produced by this grid at 150 and 360 in. using the stainless steel master. The photo was used to compare the projection of the mirror under test and the grid produced by the master at both ranges (Fig. 17). Although it is not required by the test procedure, all No. 4 mirrors are now checked by slot projection every 2 in. around the diameter, as shown in Fig. 18.

Changes can occur to the mirror figure after Elox cutting, since this relieves the stresses of the outside edge and center section. If changes occur to the extent of causing rejections, the data is fed into stress control for correction. Usually, the situation has been corrected prior to this operation; but in some cases, it does require correction.

There have been some instances of latent defects in optical geometry, apparently caused by continual flexing over epoxy bonding voids. Bond voids are difficult to locate and equally difficult to repair.

All rejected replicas were removed from the castings, and the castings were cleaned and reused.



A — MIRROR MASTER WORKING TOOL COMPARATIVE GRIND
TO BE USED FOR OPTICAL EVALUATION OF NO.4 MIRRORS
P/N 614320 & 614808 NASA CONTRACTS NAS-9-5805 & NAS-9-6659

Figure 17. No. 4 Grid Photo

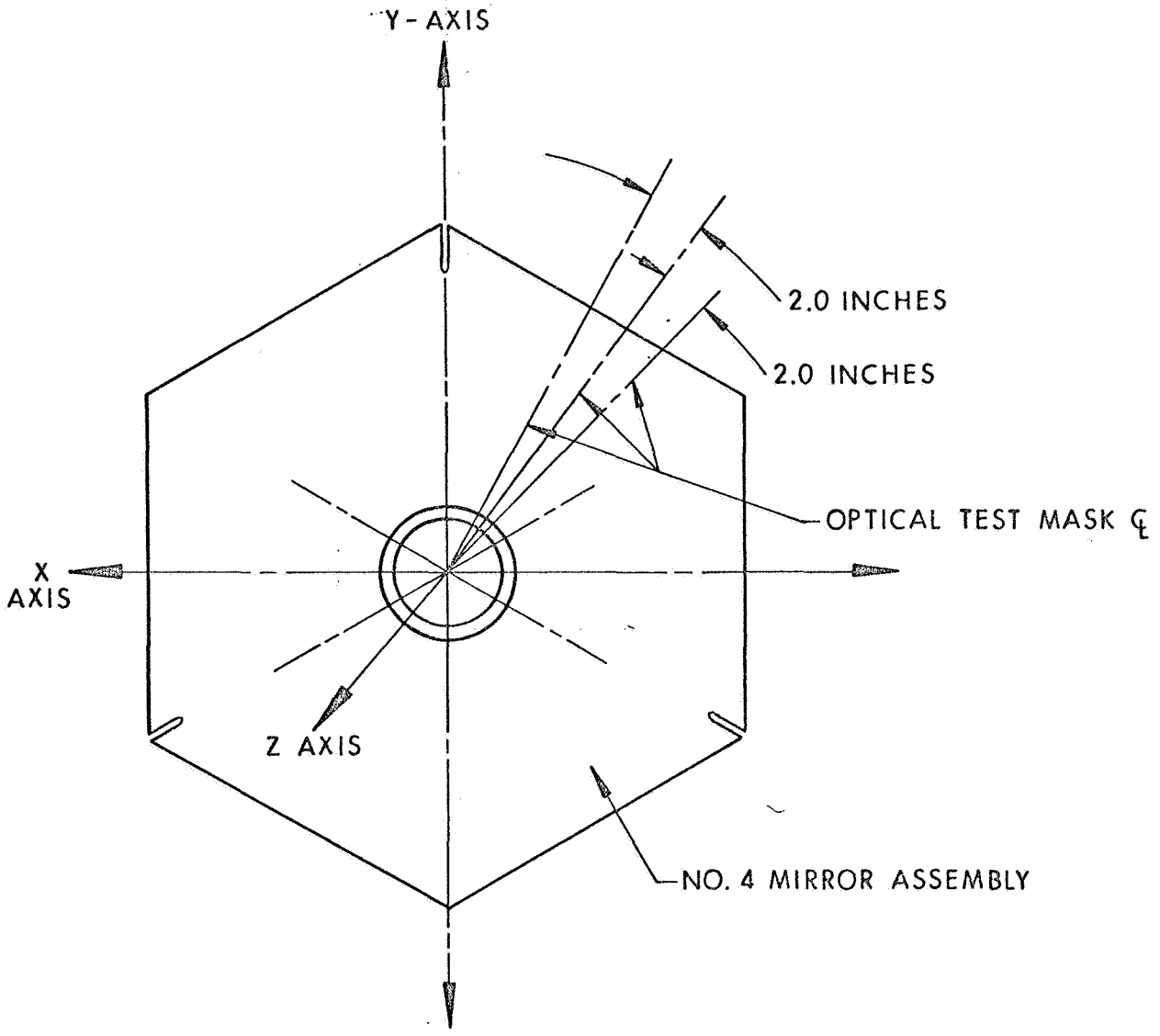


Figure 18. No. 4 Mirror Test Points

4.9 VACUUM COATING

Optical coatings to improve the spectral reflectance of the nickel mirrors were, in the original program, the same as specified in a previous contract with the Radio Corporation of America. The coatings consisted of an aluminum reflecting layer, overcoated with silicon monoxide, applied slowly so as to form a highly oxidized deposit. Prior to the aluminum deposit, it was necessary to apply a thin layer of chromium for enhanced adhesion, followed by a rapid layer of silicon monoxide to provide a diffusion barrier between the aluminum film and the substrate.

The overcoat of silicon monoxide was controlled to an effective optical thickness of one-half wavelength of visible light. This thickness was established as the minimum for acceptable mechanical protection of the aluminum layer but the thickest practical from an optical standpoint; i.e., solar reflectance and thermal emittance.

A characteristic of silicon oxide films of this type, as reported by Haas, et al (Applied Optics, Volume IV, 1965), is the removal of initially high UV absorption by exposure to intense ultraviolet radiation in an oxygen-bearing environment. During the prior program it was anticipated that this would be accomplished by normal usage in the simulation chamber, since the carbon arc is a rich source of ultraviolet radiation.

As a service history was developed on those units produced in the prior contract, two significant problems with the coatings arose. The primary difficulty was development of a corrosion of the coating, leading to spots or dendritic trails of low reflection. After much investigation and attempts to trace the exact history of specific surfaces, it was generally established that this corrosion was

electrochemical destruction of the aluminum film. The presence of ultraviolet radiation, moisture, and surface blemishes were all definite contributors, but not necessarily prerequisites, to this failure.

It appears that the mechanism of failure is a penetration of the overcoat (especially where flaws such as scratches exist) by some sort of electrolyte (such as water) which begins a galvanic type of corrosion of the aluminum layer. This process progresses from the point of origin between the layers until a path between poles is long enough or the by-products of the corrosion inhibit further growth.

Investigations of this problem and the relationship of ultraviolet irradiation to it revealed a second significant problem. It was found that the anticipated service exposure was not accomplishing the intended conversion of the overcoat to a lower ultraviolet absorptance layer of silicon oxide.

Contacts were made with numerous industrial firms and federal agencies in the investigation of these problems. Some general information was established on ultraviolet irradiation. The corrosion problem, it was learned, had been encountered in many instances, but no specific studies were concluded.

Subsequently, tests were conducted which led to establishment of equipment and a procedure for exposure of all mirrors to intense (more than 2500 microwatts per square centimeter) of shortwave ultraviolet (wavelengths 2600 angstroms or shorter) irradiation. This irradiation practice substantially improved the reflectance, as expected, but did not appreciably affect the corrosion problem.

The corrosion problem was the basis for a separate investigation conducted under Contract NAS9-6708, the aim of which was to investigate films of increased durability while maintaining the maximum of solar reflectance. The conclusion reached as a result of this program was that, of the films investigated, the best overall performance could be obtained from the same film stack as originally planned, except that silicon dioxide (quartz) should be employed in lieu of the former silicon monoxide films.

The final assemblies of this program were coated with this stack, employing silicon dioxide. Based upon the limited service results to date, there has been a definite, substantial reduction in the corrosion problem.

More recently, however, a new problem has emerged, principally on mirrors from a refurbishment contract (NAS9-6659) but also, to some extent, on units of this program. This difficulty centers around a failure of adhesion of the vacuum-deposited films to the nickel substrate. This failure, which is not apparent at the time of manufacture when a MIL-M-13508 adherence test is performed, develops at a later date. While the problem is not resolved at this time, enough data have been obtained to indicate rather strongly that the problem is one of integral cleanliness of the substrate prior to deposition and/or an effusion of included contaminants from within the nickel matrix itself.

Some tentative process modifications have been instituted which have resulted in mirrors without failure after three months of daily tape testing. Currently, efforts are under way to modify the equipment employed in this coating operation and to incorporate the new procedures. The results will be the basis of a separate report at the appropriate time under the refurbishment contract. Figure 19 shows a typical vacuum coating setup used in the coating operation.

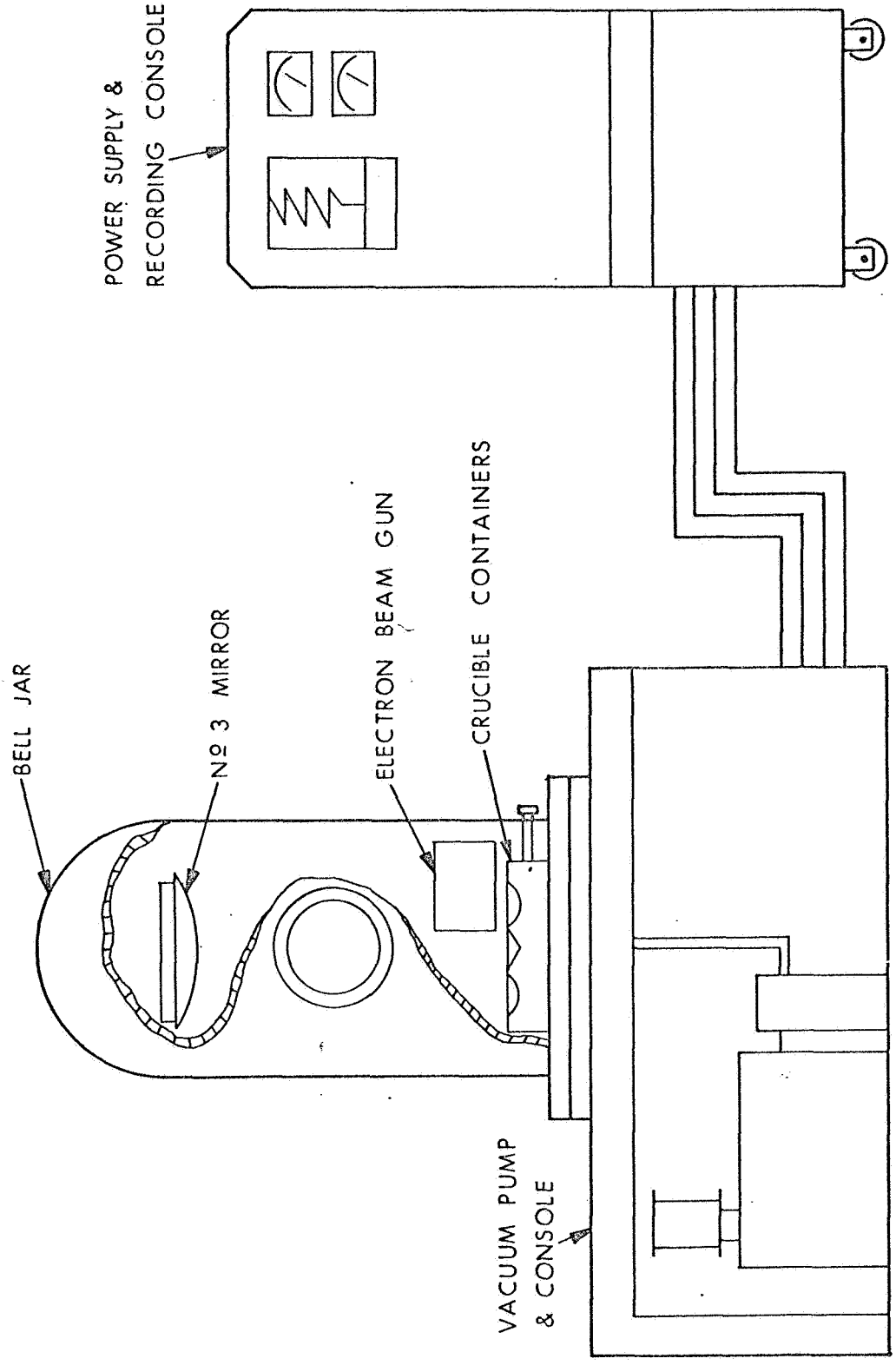


Figure 19. Typical Vacuum Coating Setup

4.10 FINAL INSPECTION AND SHIPPING

Upon completion of the mirror assembly processing, the manufacturing operations booklet was reviewed by the project engineer, quality control inspector, and the DCAS representative. All paperwork was reviewed, and each operation was checked for conformance and completion. When all paperwork was in order and stamped off, it was then duplicated and prepared for packaging with each representative mirror assembly.

Shipments of hardware from the processing area to the assembly area periodically caused damage to mirror surfaces and outside diameters. In order to prevent damage, a procedure inspection list for packaging and shipping was initiated. This became the final shipping and acceptance criterion for all optical train mirror assemblies transported to the assembly area.

Each mirror assembly was packaged in the appropriate mirror wooden container. Cap plugs were installed in the cooling passage inlet and outlet ports, and bolts are placed through the bottom of the wooden container to secure the mirror in place.

The cleanliness of mirror and container were inspected prior to closing and securing the container lid. When these requirements were satisfied, an acceptance tag was secured to the side of the container and all paperwork was completed and stamped off.

The master manufacturing order booklet was attached to the container and the packaged assembly was transported to the optical train assembly and alignment area. Duplicate data was then placed in the Production Department file for reference and historical record.

SECTION 5

ASSEMBLY AND TEST

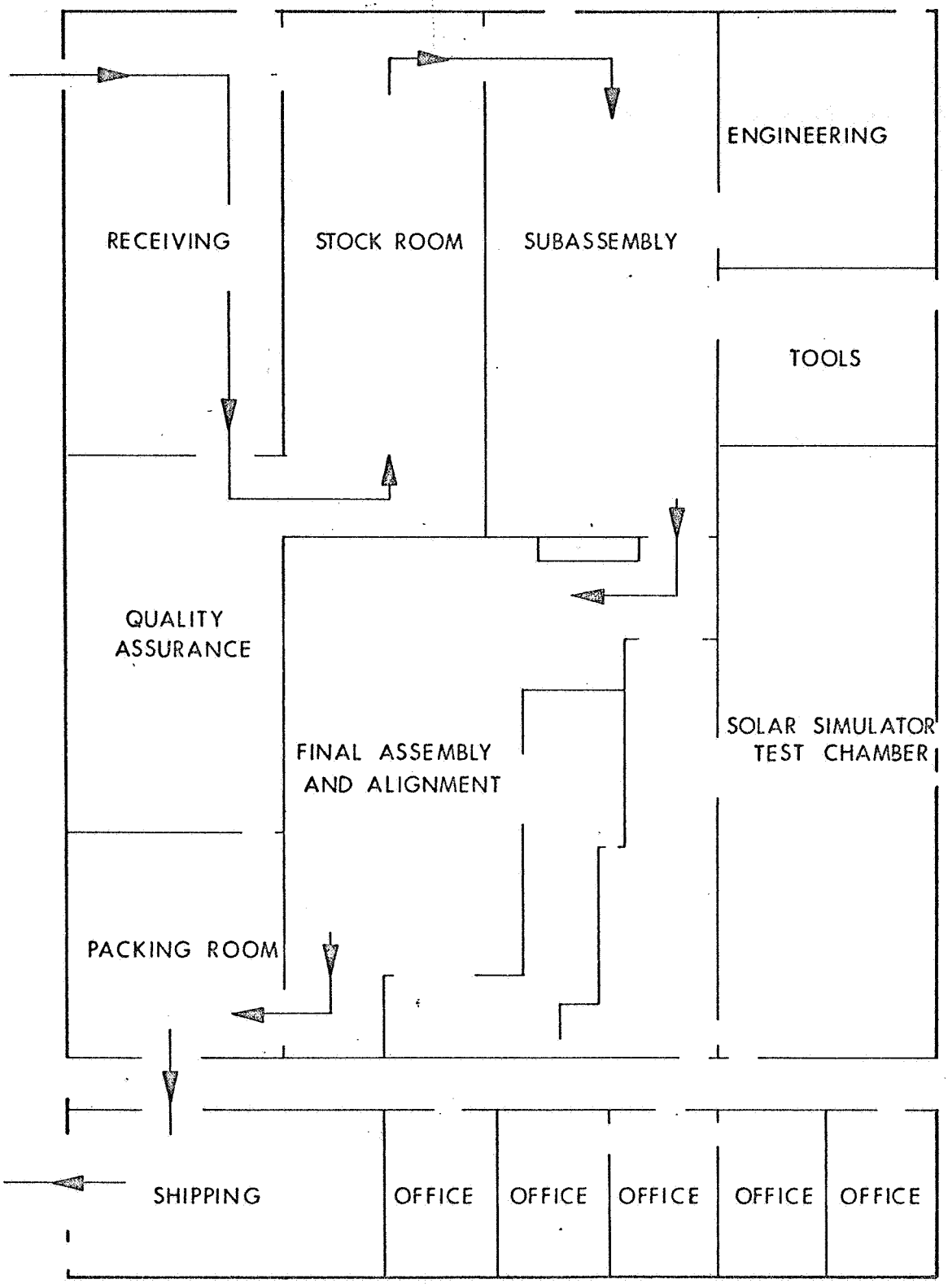
Assembly, optical alignment, and acceptance testing at EOS and MSC are discussed in this section. Several documents were used to control and record the operation. The NASA approved Production and Acceptance Test Plan (P&ATP), the MSC Acceptance Test Procedure (MSC ATP), and the Inspection Plan all were used as controlling documents. Inspection sheets, manufacturing orders, and kit lists which are included in these documents were used to monitor all process steps. (See Appendices A and B).

5.1 PLANT LAYOUT

Plant requirements were determined on the basis of a 37-week program which dictated production rates and floor space based on very rapid assembly and alignment of three major subassemblies. It was determined that four alignment ranges must be available, two for the collector assembly and two for the collimator assembly. The scheme also required hydraulic test capabilities for both units for flow and pressure testing. Areas were established for the various other functions, such as helium leak detection, inspection, bonded stores, collector assembly, etc. Flow charts were made, and the facility was constructed at the 125 Vinedo Street building (Fig. 20). Service was provided for air-operated tools in order to speed assembly operations.

All planning was based on the assembly line concept with the assemblies being dolly mounted or palletized to facilitate rapid movement through the assembly steps. Small subassemblies were planned for bench assembly to feed the mobile line. An area was also assigned to the carbon arc burner and optical bench for any test work required during the program.

ASSEMBLY AND TEST AREA



(This facility was used for ultraviolet radiation of mirror coatings during the program prior to the acquisition of an ultraviolet light bank.)

5.2 ASSEMBLY PROCEDURES

Procedures for acceptance testing on Contract NAS9-5482 were examined, and a refinement of the techniques was developed on this contract. This resulted in a scheme to monitor the alignment condition rather than actually test, quantitatively, the individual collector and collimator assemblies. The resulting test involved the comparison of two alignment photos, one taken at the completion of assembly and a second taken at MSC. The comparison of these photos then completed the acceptance of either collector or collimator.

The basic requirement was then met for the prealigned assemblies which could be rapidly assembled at MSC. The detailed procedures for the actual piece-by-piece assembly were written prior to any assembly of the actual hardware. The GFE optical train was used as a model; but due to the many changes made to the EOS units, it was difficult to visualize the assembly when working from the blueprints only. This resulted in several changes to the P&ATP (Appendix A) during actual assembly, which required contractual approval. It also became evident, at a later date, that these assembly procedures would be invaluable to EOS due to the scrambled sequence of assembly required by the delivery schedule versus the receipt of hardware schedule. After the program was completed, the collector, collimator assembly and alignment procedure, and the throat assembly procedure were a really useful part of the program.

5.3 ASSEMBLY TOOLING

EOS developed laser operated ray trace equipment for mirror master contour checking during the RCA mirror manufacture program (RCA Contract NAS9-1047. This led RCA to the use of laser beams as a visible centering mechanism for the optical elements in the collimator assemblies. EOS then further extended this application to include autocollimation of optical flats and lens elements for accurate component alignment in both the collector and collimator.

Perkin-Elmer Model 5200 helium neon continuous-wave lasers were used. These units produce a red beam (6328 Å) with a power output of over 0.5 milliwatt, and a collimating lens system was used to produce a reduced beam diameter 25 ft from the laser. The autocollimation accuracy of this system was within 1 minute of arc, and it also provided reference points which were easily reestablished, if relocated, and easy to check.

Laser support stands were built with the capability of X, Y, and rotational movement to align the laser with the assembly and alignment stand.

There were two basic types of stands, one for the collimator and one for the collector. The collimator stand is a heavy weldment bolted to the floor. The top section of the stand simulates a throat with field lens and lens retainer. Another type was built for the MSC acceptance test. It has a simulated throat welded to a plate for bolting to the existing optical bench. The collector stand was also a heavy-weldment bolted to the floor. The mounting surface simulated the front surface of the burner. The quick-change alignment tooling locater is located on the back side of the mounting surface, in the center. This system was originally manufactured for milling machines,

drill presses, lathes, or other machines where precision rapid tool changes are needed. The system was very effective for locating and quickly changing the alignment tooling for the collector. A similar stand was constructed to bolt to the optical bench at MSC.

Each assembly and alignment station is equipped with a Graflex camera with a 4- x 5-ft Polaroid back, target screen, and projection screen. Small hand tools, torque wrenches, and a stop watch were also standard in each station.

Small alignment and assembly tooling was designed and built to make alignment easier. A common-point source rod with a B & L 2.5V light was used for both collimator and collector alignment. Similar light sources were designed and built with tripod mount to align the No. 4 mirror.

An optical flat was built which was used to autocollimate and align the collector stand. Also produced was a vane alignment fixture to position and align the cooling vanes in the collector box. A fixture to align the collector box hard points was designed and built. This fixture positioned the hard points in relation to each other, set the Z dimension, positioned the hard point in relation to the optical axis, and a level to set the X, Y plane around the optical axis.

A reticle alignment fixture was built and was placed on the front of the collector box to align the box on its optical axis. Reticle plates were also built which fit in the inside diameter of the Nos. 1 and 2 mirrors. Held in place by spring pins, these plates were used to put the mirror on its optical axis. To measure the No. 4 mirror Z axis position, a locator was built which rested on the mirror and used a built-in micrometer.

All alignment tooling was thoroughly inspected and calibrated.

5.4 ASSEMBLY OPERATIONS

Assembly of collector components began early in the third month of the program, as did work on the throat wiring. The philosophy of this operation was at this time clear. A series of assembly operations was started, based on the hardware available, and production control was initiated through stores inventory. Assembly tooling was scheduled into the operation as was the hydraulic test equipment, and other equipment required to complete the program. The inventory-delivery-schedule-type assembly programming worked successfully, but it required a higher quality assembler than would have been used in large volume production. This was due primarily to the short learning curve required coupled with the ability to shift from one job to another.

Work continued on the piece-part basis for the duration of the program. (The first shipment, early delivery of 15 field lenses, was made in July, 1966.) Fortunately, the P&ATP assembly section allowed breakouts of small assemblies so that production could be monitored by inspection, and records of assembly were meaningful.

The throats were the first major units assembled, and the work involved was not complex. A wiring harness was installed, along with the three alignment sockets. The field lens retainer was shipped as a kit, as was the iris support assembly. Work on these units, including packing and shipping, was of a routine nature with no major problems.

The collectors were the second major assembly to be completed. They were much more complex, involving more parts than any other unit. Six kits consisting of over 370 parts and four major optical elements were used.

Two problems occurred during assembly and testing. The first involved aligning the collector lens; the second was due to failure of flexible water hoses under hydrostatic test. Both of these problems were resolved, the first by changing the alignment procedure, and the second by replacing the faulty material.

When complete sets of mirrors became available, collimator final assembly and testing began. Prior assembly included the collimator central optics and other small parts. The assembly of these units presented some minor problems which were corrected as they occurred. Changes in the P&ATP were made contractually. Many other changes were made, although most of them were not major. After assembly of the first few collimators a technique was developed to align the units which came from practice only.

The first completely assembled units were helium leak checked and passed specifications. However, failures began to occur on the 5-minute 150-psi hydrostatic test. Pin holes appeared in the 0.010-in.-wall tubing on the support arm subassemblies which caused changes in the order of tests. It was decided to pressure test first instead of helium check, and this solved the majority of problems. All of these tubing assemblies had to be prechecked by helium leak detection, so later units were all pre-hydro-checked prior to assembly. The pre-hydro-check was done primarily to prevent removal of support arm subassemblies after alignment.

Final acceptance tests were performed at MSC on each lot of collectors and collimators. All shipments were made by air-ride van. After receipt at MSC, each unit had a final acceptance test performed. This test consisted of rechecking the alignment of the unit and a general inspection for damage by EOS and MSC inspectors. During the first acceptance testing, MSC questioned the optical figure of the collimators and performed burn testing. Optical test equipment was then flown in

and EOS performed optical tests on one unit at MSC, which resulted in its rejection. Thirteen units were returned to EOS, disassembled, retested, and rejected. Finally, the remaining seven of the first 20 units were also returned, retested, and rejected. Changes were then incorporated in the test procedure to eliminate the problem. Forty collectors and collimators were assembled prior to the coating change which resulted from the coating study (NAS9-6708).

Four packing crate designs were required: one for collectors, one for collimators, and two for throats. The throats required two crates because the iris support subassembly was shipped two to a box in a separate crate. All of the crates were satisfactory, and 20 collimator crates were reused for a second round trip to MSC. No shipping damage was incurred. Household air-ride vans, with loading and unloading a one-time operation, reduce shipping damage to a minimum.

5.5 TEST EQUIPMENT AND PROCEDURES

There are two basic test stations, hydro testing and helium leak check. Hydro testing was performed on both the collimator and collector boxes. A helium leak check was performed only on collimators.

Hydro testing has two functions, to measure flow and maintain pressure. These tests were performed on an EOS-constructed hydro testing station. The testing station has a 10-gpm high-flow system for collectors and a 2-gpm low-flow system for collimators. The two systems have a common pressure pump and air blow down. Each flow system has a Fisher and Portor ±2% inline flow meter. Calibration of both flow meters was accomplished by timing and weighing the water from the flow systems. Two pressure gages for each flow system measured pressure drop and static pressure. Air was used to remove water after the test. (See test procedures for collector in P&ATP, page 45, 2.3.123, Appendix A; for collimator, see P&ATP, page 62, 2.4.33, Appendix A.)

Collimators were helium leak checked with a C.E.C. helium mass spectrometer Model No. 24-120A having a sensitivity of 1×10^{-10} STD cc/sec. he. (See P&ATP, page 61, 2.4.32, Appendix A, for test procedures.)

5.6 HANDLING EQUIPMENT

Special equipment was designed to transport and lift the collector and collimator assemblies. The throat was lifted by a cable sling or fork-lift, and it was supplied to EOS with four steel legs for ease in handling.

Two types of mobile devices were used to handle the collectors, which were the most complex assemblies. One device, a simple cart with pneumatic tires, carried the collector during the final assembly and hydraulic tests. Prior to this, it was assembled in a modified, three-wheel engine stand, which permitted turnover of the whole box during assembly. This unit permitted one man to easily, and with little fear of damage, install the heavy No. 1 mirror. The collector was also provided with a special scissors-type lifting tool which was inserted inside the collector box frame. On lifting the tool wedges itself into position so that there is no danger of falling. This tool is used with a hydraulic floor crane, but it can be used with any vertical lifting device.

SECTION 6

QUALITY ASSURANCE PROGRAM

EOS, as the contractor, implemented and maintained a Quality Assurance Program which satisfied the requirements of NASA Quality Publication NPC 200-2 and NPC 200-3 inspection systems.

6.1 QUALITY ASSURANCE VENDOR SURVEILLANCE

Suppliers (vendor) surveillance is a prime function of the EOS Product Assurance Department, and was an important phase of the Optical Train Program.

Suppliers surveillance serves a three-fold purpose:

a. Survey desired vendors to ascertain their ability to produce products to a desired level of quality and maintain that desired level of quality.

b. Notify vendors when their quality level drops to a questionable or non-acceptable level. These data are maintained at EOS Receiving Inspection as vendor history.

c. Perform physical inspection or test surveillance, as required, at the vendor's facilities. This activity is also documented and entered in the respective vendor history records.

6.2 EOS SOURCE INSPECTION

Several conditions are considered before a source inspection requirement is assigned to a specific purchase order. Most of the optical train purchase orders were related to the conditions listed below:

a. Is proper equipment available at EOS to adequately perform the inspection and/or test to completion?

b. Will it expedite the project to perform an in-process test or inspection prior to shipment from the vendor's facility?

c. Are there items to be shipped from one supplier to a second supplier for processing or tests?

d. Is there an economical or practical need to implement source inspection?

e. Does the material, or do the products, require Government source surveillance at an EOS vendor?

When the need for EOS source inspection is determined and indicated appropriately on the procurement documents, the vendor must call the EOS Vendor Surveillance Department for source inspection according to the requirements stipulated in the purchase order in the vendor's possession.

An EOS Source Inspector is assigned the "call" and responds to the vendor for the tasks as defined in the vendor's copy of the purchase order. Upon completion of his visit, the source inspector documents pertinent data in accordance with EOS Product Assurance Manual, Volume 1, Section Q-3-A.

All reports and/or test data collected by the source inspector are then hand-carried or mailed to the EOS Vendor Surveillance Department office for processing.

6.3 RECEIVING INSPECTION

Receiving inspection, which was required on the Optical Train Program, is for the purpose of determining the quality of the parts or material before movement into the stock room or stores area. Two general conditions control the receiving inspection operations:

a. Material or parts to be inspected for identification and damage only.

b. Material or parts which require inspection to the requirements of specifications and/or drawings as shown in the purchase order. (Note: These requirements are determined and established in the purchase order before the purchase order is released to the vendor.)

The product assurance copy of the purchase order is forwarded to and filed by the Receiving Inspection Department clerk. This copy of the purchase order is reviewed by the Receiving Inspector to ascertain the proper requirements for inspection, e.g., correct part and drawing number, correct revision letter, certification requirements, etc. The purchase order copy along with the copy of the receiving invoice or traveler will indicate whether the parts have been source inspected. If parts bear a source inspection tag, they are inspected for damage and counted and processed for stock.

When parts are received for inspection for identity and damage (Inspection Code 2), they are checked visually for damage and for conformity to identification requirements only. Dimensional inspection is accomplished on this level only in case of damage. When parts are received which require inspection to specification and drawing (Inspection Code 3), the Receiving Inspector reviews the purchase order for any instructions included therein. The vendor history record is taken from the file and reviewed for sampling instructions and acceptance quality level (AQL), if applicable, to determine if the inspection is to be performed to single or double, normal, tightened, or reduced sample. The inspection is then performed. After the inspection is completed, the results are compiled and recorded on the history record card. Records of discrepancies are made on the discrepant material report (DMR) with the discrepant material being placed in a secure bonded area (bond room or bond cage) until material review action is made and material review disposition is completed. Acceptable material is split off of invoice and forwarded to

the stock room. Movement of the material from the bond area is made under rigid supervision to make certain that unapproved material is not used in systems assembly.

6.4 IN-PROCESS INSPECTION

At EOS, in-process inspection is in two categories:

a. In-process inspection by an EOS Source Inspector at a vendor's facility, which is handled as a normal source inspection assignment.

b. In-process inspection at EOS facility in the areas where assembly and tests are accomplished.

The requirements for in-process inspection are established by project requirements as defined in a statement of work and shown on a flow chart which indicates at what time and point of assembly an inspection is required.

In-process inspection on the Optical Train Program was constant throughout the life of the program. Starting with the first mechanical assemblies, inspection was accomplished and verified by a check list showing each inspection sequence and buy-off for each major subassembly by serial number. Each operation was controlled by a manufacturing operations sheet, with spaces for inspection stamps to be affixed at the completion of each assembly operation or test.

6.5 DISCREPANT MATERIAL REPORTING AND CONTROL

During the term of the solar simulator program at EOS, the withdrawal, reporting, and dispositioning control of discrepant parts and material was accomplished by using three forms: receiving discrepancy report, inspection squawk report, and material review report.

Material withheld at the Receiving Inspection area was withdrawn by documenting findings on the receiving discrepancy report (RDR); parts and/or material withheld during in-process inspection were withdrawn by documenting on the inspection squawk report (ISR); material review, from the two previous documents, was accomplished by the transfer of information and data to a third form, the material review report (MRR).

Material withdrawn on the RDR and/or ISR was placed in bond for preliminary review of those data. When formal material review was required, data were transferred to the material review report for action. The material and MRR were then submitted to the quality agency (DCASR) which represented NASA-MSC at the EOS facility. At the completion of the material review, the parts and/or material were moved or disposed of in compliance with the MRR form.

6.6 FINAL INSPECTION (EOS)

Final inspection at EOS was comprised of the verification of documentation to assure that all operations and tests were completed per the acceptance test plan and the manufacturing operations sheets. A final visual inspection was accomplished at which time a final inspection tag, showing the unit serial number and bearing the final inspector's identifying stamp, was attached to the unit.

After the unit was placed in the shipping container and secured for shipment, another final visual inspection was accomplished to verify that no damage was incurred during this operation, and a second final inspection stamp was affixed to the inspection tag.

To assure that damage would not occur to the units, final documentation was packed and shipped separately in an identified container.

6.7 FINAL INSPECTION (MSC-HOUSTON)

Final inspection at the Manned Spacecraft Center consisted of witnessing the condition of the shipping containers to assure that no damage had been incurred during transit, and witnessing and verifying the tests of the various units per the acceptance test procedures for testing at MSC.

6.8 REVIEW

In looking back over the quality control phase of the Optical Train Program, certain points should be discussed for two purposes: (a) to eliminate those areas which created the greatest problems, and (b) to define those changes in operational procedures which have been implemented since the peak of the program.

The procurement and quality activities have been strengthened by the full-time assignment of a quality analyst to the procurement group to review purchase requests and purchase orders. This will assure that correct quality requirements are assigned to the purchase orders as released to the vendors. This review is in addition to the review required by the quality engineer assigned to the program. This level of review will also minimize the use of unapproved vendors. (Reference: EOS Product Assurance Department Vendor Rating List.) Better use of the vendor surveillance source inspection activity could have been made. There were certain specific problems with the No. 4 mirror casting and the collimator support casting which could have been minimized with a tighter on-site surveillance.

A greater use of source inspectors is being made for surveillance of critical-design items and difficult-to-manufacture items with the anticipation of minimizing, if not eliminating, future problem areas. The

fabrication of castings, casting molds, and form tooling are areas which receive close surveillance by Quality Control at EOS and at the vendor.

In the category of document control, the EOS Product Assurance Department has replaced three obsolete forms which are noted in this report, the receiving discrepancy report (RDR), the inspection squawk report (ISR), and the material review report (MRR). These forms have been replaced by EOS Form No. 813, discrepant material report (DMR). This is a general purpose inspection reporting document and is currently being used at all phases of quality control inspection. This form has the accommodation for, and is used in, material review activity, including preliminary and formal material review. The back page of this form is a hard copy rework order with spaces for complete rework instructions which may be required and assigned to the discrepant material listed on the face of the form. The use of this DMR form is proving very helpful in the control of lost or misplaced documents as well as reducing the document workload of inspection.

Some of these Quality Assurance Department procedure changes have materialized because of the Optical Train contract. As a result, the quality assurance of future contracts will be more efficient.

SECTION 7

PROCUREMENT

The following materiel policies, principles, and practices are used as a guide for procurement personnel, personnel of other divisions initiating procurement requirements, and the company's suppliers.

7.1 RESPONSIBILITY

Responsibility for the procurement of all purchased materials, supplies, and services required for the conduct of the business of the Company is vested in the Materiel Manager.

Procurement functions are delegated by the Materiel Manager to the Procurement Manager and staff of buyers as in the case of the optical train contract.

The major activities of the Procurement Department in the fulfillment of its responsibilities are as follows:

a. Supplier development and selection
b. Purchase inquiry (proposal support)
c. Bids and awards
d. Value analysis
e. Government/customer purchase order approvals
f. Purchase order negotiations, issuance and administration
g. Follow-up/expediting
h. Supplier relations

7.2 SUPPLIER EVALUATION AND SELECTION

Evaluations of prospective suppliers (subcontractors) are based primarily on past performance, current capabilities, and planned advancements in the industry. Potential sources are surveyed by the EOS evaluation team headed by a Procurement representative and including personnel from the Quality Assurance, Engineering, Manufacturing, and Finance Departments. A report of each survey is prepared and distributed to all interested departments.

Final decision on selection of suppliers is made by the Procurement Department after coordination with concerned functions of EOS. Recommendations of competent and qualified personnel are duly considered. For example, Quality Assurance must be satisfied that the supplier's quality control methods and procedures are sufficient and proper to meet requirements, Engineering must assess the technical capabilities of the supplier in a similar manner, and Manufacturing and Finance inputs are evaluated.

Procurement's only authority to purchase is a properly executed purchase request. It is the responsibility of the buyer to negotiate and issue a purchase order to a supplier consistent with the quality, service, and delivery required, and to justify and substantiate the purchase.

Prior to purchase order placement, the buyer shall obtain written approval, if required, from the customer. He must also determine that all applicable government regulations and prime contract requirements have been met and that all necessary procedures have been followed for the type of orders being issued.

7.3 SUPPLIER PERFORMANCE

Reliability of the end product is greatly determined by the supplier's performance and the quality which he manufactures into the parts, components, or assemblies. It is, therefore, an EOS policy to emphasize selection of suppliers with proven performance records. In the development of new sources of supply for the optical train components, careful attention was given to program requirements and vendors were selected based on performance reputation.

During surveys by EOS teams, the ability of a supplier to control and report performance was determined. This analysis included the ability to use the PERT or Modified PERT systems and to provide cost information adequate to the type of procurement which might result. Where competitively bid fixed-price fabrication orders were contemplated, suppliers were to provide copies of their internal operation sheets and schedules covering the proposed procurement. These were then used to determine progress and performance against projections.

Performance of suppliers on procurement of standard items or off-the-shelf parts was monitored by an assigned expeditor.

Suppliers (subcontractors) for complex procurements were required to submit, at a minimum, the following reports:

a. Initial PERT or Modified PERT network system.
b. Periodic (usually monthly) PERT system reports.
c. Periodic reports in bar-chart form showing actual progress in relation to scheduling of the activities in the cycle from go-ahead to delivery.
d. Periodic narrative reports explaining and projected or actual deviations from schedule, reasons for such conditions, and the projected recovery plan.

e. If required (cost-reimbursement orders), a periodic report of actual and estimated expenditures and projected cost to completion.

f. Periodic reports containing information as required to support quality assurance, reliability, and configuration control prime contract requirements.

An EOS resident buyer was assigned to monitor performance on some procurements. On others, the buyer coordinated inter-company matters and frequently visited the supplier's plant to determine progress and performance status and to provide assistance in problem areas. Engineering, Manufacturing, and Quality Assurance personnel accompanied the buyer.

Day-by-day monitoring of this major program at the supplier's plant indicates the level of performance. Close monitoring permits immediate remedial action where indicated. The periodic reports, buyer's frequent visitations, and expediting actions provide performance criteria.

7.4 COST ANALYSIS AND CONTROL

The Procurement Department has the prime responsibility for cost and price analysis and evaluation of suppliers' quotations and cost structures, as well as evaluation of cost feedback during purchase order performance. EOS Accounting or Estimating Department personnel may be called on for assistance where product competition and price cannot be readily established or when a following audit is requested.

The assigned buyer is responsible for the following functions during negotiations, issuance, and administration of all significant procurement transactions.

a. Review of cost data secured from suppliers during negotiations.

b. Determination that reasonable prices are obtained consistent with sound business principles.

c. Evaluation of potential or selected supplier's ability to perform and maintain pricing structures if awarded a subcontract.

d. Preparation of purchase orders or subcontracts which clearly define pricing criteria, payment schedules, and other terms and conditions which might be of assistance in adequate cost performance monitoring.

e. Summation of cost breakdown and supporting documentation, for retention in the Procurement case file, which fully justifies supplier selection and order award.

f. Visitations to suppliers' facilities during performance to secure on-site knowledge of cost and performance history.

g. The review of all cost information, value analysis, performance history, and application of this information in continuing efforts to effect cost reduction which might be applied to current or future procurement transactions.

7.5 TIME SCHEDULE

Support of the Optical Train Program continued as required to the contract fulfillment. While buying activity peaked with the release of the majority of purchase requests and slacked as purchase orders were placed, the performance evaluation of suppliers continues throughout the life of the program.

SECTION 8

CONCLUSIONS AND RECOMMENDATIONS

The No. 4 mirror master had a minor defect which caused high rejection rates during the manufacture of the first 40 units. The surface contour of the master was improved during the interim period between delivery of the first 40 units and the last 20 units. New submasters were then electroformed until a satisfactory working tool was produced. Nineteen submasters were made to produce 83 No. 4 mirrors, which is not a high tooling life in comparison to the life of the Nos. 1, 2, and 3 tools.

In retrospect, should it be required to replace the No. 4 master, a cost evaluation will be made to determine the practicality of using the master directly as a working tool. At this time, it appears to be the most desirable procedure.

The problem of orange peel surface conditions and the potential problem of material porosity and impurity inclusions indicate the advisability of using double vacuum-melt stainless steel for all future manufacture of metal masters rather than the more readily available air-melt stainless.

The current optical train assemblies are interchangeable with the units of RCA manufacture, but the mirrors are only usable in their respective assemblies. Since the mirrors often require maintenance, it is recommended that the appropriate steps be taken to design adapter kits to facilitate mirror interchangeability.

Almost three years from the starting date of this contract, it is evident that many costs associated with this program could be reduced by redesign;

but the redesign costs must be amortized over the future life of the system. The EOS-designed No. 4 mirror casting included cast integral water cooling coils to solve the potential problem of water leakage (as was experienced in the grooved casting) minimize corrosion, and maintain a vacuum-tight system. The early casting design used an epoxy-bonded water channel which was difficult to seal and would easily rupture. The MSC used an emergency solution to this problem by not using the No. 4 water cooling channels and merely bonded a copper cooling coil to the back of the casting. This cooling system functioned adequately. This makes the expense of the cast integral tube unit questionable.

It may also be possible to use a heavy nickel unbacked mirror with cooling coils directly bonded to the nickel replica. This method of mirror manufacture would result in significant material and labor cost reductions. It also presents a major step toward vacuum coatings having superior qualities to those in current manufacture. This method of fabrication would allow a higher glow discharge temperature which is now limited by the organic bond of the nickel replica to the aluminum casting.

EOS recommends that these design suggestions be carefully reviewed prior to any new No. 4 mirror casting procurement.

In addition to designs to facilitate mirror interchangeability, a cost reduction design review should be undertaken to reduce component part cost by relieving tolerances where possible. During the receiving inspection of parts, it became apparent that the suppliers made errors in manufacture. In reviewing these errors during Material Review Board actions, a very low percentage of the parts were unusable, some were reworkable, and many could be dispositioned "use as is, will not affect form, fit, or function."

The water used to cool the collector mirrors flows through the carbon arc burner and then into the collector where it splits into parallel circuits through the No. 1 and No. 2 mirrors. This makes it possible to restrict or block the flow in either of the two circuits. EOS recommended modifications of the circuit to a series flow to prevent possible damage to the mirrors.

Corrosion-resistant coatings of water cooling channels were required on those mirrors with exposed aluminum surfaces; however, in order to expedite the program, at NASA request, some mirrors were delivered without coatings on the various water channels in the castings. The castings still in service at the present time indicate that water-channel corrosion is not a severe problem. The MSC water cooling system has been modified from an open to a closed system in which the water pH is controlled and corrosion inhibitors are added.

EOS recommends that the castings which are high-silicon-type 356 aluminum, and rated as having very good corrosion resistance, be allowed to remain in the as-cast condition.

APPENDIX A

PRODUCTION AND ACCEPTANCE TEST PLAN

Original 13 May 1966	Approved 11 October 1966
Revised 18 October 1966	Approved 15 November 1966
Revised 14 December 1966	Approved 30 December 1966
Revised 15 December 1966	Approved 30 December 1966
Revised 5 January 1967	Approved 23 January 1967
Revised 23 January 1967	Approved 23 January 1967
Revised 25 April 1967	Approved 9 May 1967
Revised 8 September 1967	Approved 1 December 1967
Revised 3 June 1968	Approved 16 July 1968

ELECTRO-OPTICAL SYSTEMS, INC.

PRODUCTION AND ACCEPTANCE TEST PLAN FOR OPTICAL TRAIN SUBASSEMBLIES

Contract NAS9-5805

THIS DOCUMENT CONTAINS THE PRODUCTION AND TEST SCHEDULE (CONTRACT ITEM 1), THE PRODUCTION AND ACCEPTANCE TEST PLAN (CONTRACT ITEM 1), AND THE MSC ACCEPTANCE TEST PROCEDURE (CONTRACT ITEM 3).

Prepared by: W. McCarty

Reviewed & Approved by: E. A. [illegible]

Reviewed & Approved by: [illegible]
Q.A. Engineering

Date: 3 June 1968

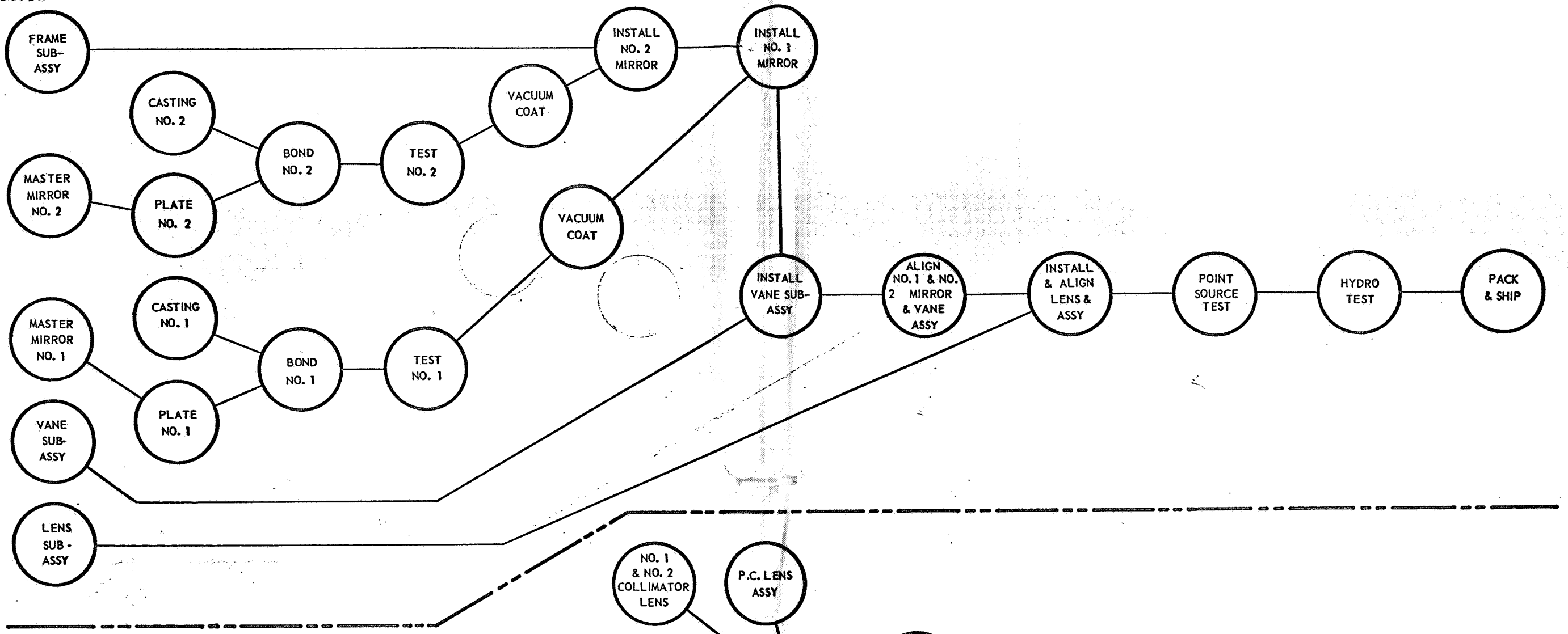
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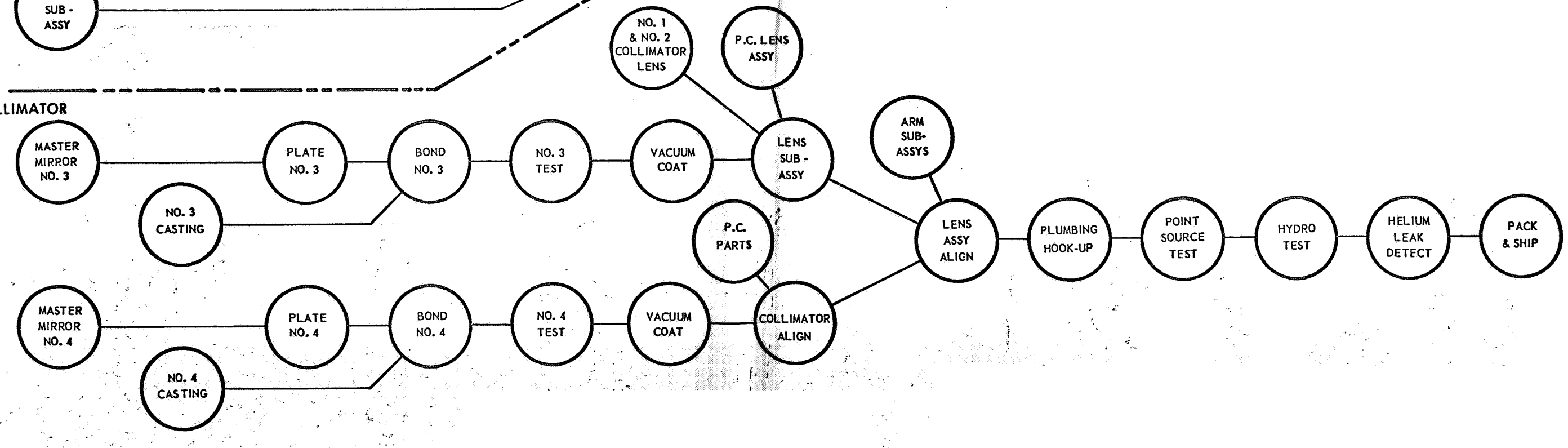
Contractor's Production and

Acceptance Test Plan Contract NAS 9-5805

COLLECTOR



COLLIMATOR



2.0 **Process Specifications and Acceptance Tests.** The following paragraphs will describe the assembly component tests, inspections, and the process description. All applicable documents, other than proprietary information are included.

Directive No.	:	12-2
Prepared by	:	E. L. Oslin
Approved by	:	
Revision No.	:	2
Date	:	10 Jan. 1967

PRETREATMENT OF 356 ALLOY ALUMINUM PRIOR TO ADHESIVE BOND NAS9-5805

SCOPE:

This specification describes the procedure for pretreatment of 356 Alloy Aluminum castings, prior to bonding of nickel replicas.

RESPONSIBILITIES:

The Bonding Group, under the Component Production Section is responsible. Process Control will monitor the operation.

GENERAL:

This is a critical process and must be rigorously controlled. It is required that this procedure be strictly followed. Suggestions for changes and improvements are solicited, but no changes will be made without approval of Program Management.

1.0	Pre-clean	Turco 4215	5 - 7 oz./gal
		Temperature	150° - 160°F

1.1 Immerse part into cleaner solution and turn up air agitation.
1.2 Allow part to soak clean for at least fifteen (15) minutes.
1.3 Remove and spray rinse over cleaner tank using hot tap water (140° - 180°F)

2.0	Etch	Turco Aluminetch No. 3	5 - 7 oz./gal.
		Temperature	140° - 160°F

2.1 Immerse part into etch solution and wait until etching action is uniform over entire surface.
2.2 Allow to etch for 5 - 10 seconds.
2.3 Remove and spray rinse over etch tank using hot tap water (140° - 180°F)

3.0	De-oxidize	Turco Nitradd	12 - 20% by Vol.
		Nitric Acid (42°Be)	60 - 80% by Vol.
		Temperature	Ambient

3.1 Immerse part into de-oxidizer solution for fifteen seconds.
3.2 Transfer part to rinse tank. DO NOT RINSE OVER DE-OXIDIZER TANK. WATER MUST NEVER BE ALLOWED TO ENTER TANK. IN TRANSFERRING PART, DO NOT ALLOW DE-OXIDIZER SOLUTION TO CONTAMINATE IRIDITE SOLUTION.
3.3 Spray rinse <u>thoroughly</u> with deionized water. All traces of deoxidizer solution must be removed. "Optional - part may be rinsed by immersing in a tank of continuously running deionized water for one minute followed by a spray rinse of deionized water."
3.4 Visually inspect part for dark smut. If traces are present, repeat steps 3.1 - 3.4.

4.0	Conversion Coating	Iridite 14 - 2	1.0 - 1.5 oz./gal.
		pH (Electrometric)	1.4 - 1.6
		Temperature	Ambient

4.1 Immerse part in conversion coating solution <u>while still wet</u>. If part has been allowed to dry, repeat de-oxidation.
4.2 Allow to react for 3 - 5 minutes.
4.3 Transfer part to rinse tank. Spray rinse <u>thoroughly</u> with deionized water.
4.4 Allow part to dry before bonding (part may be oven dried at 120° - 150°F if desired).
4.5 DO NOT TOUCH SURFACE TO BE BONDED. IF PART IS NOT TO BE BONDED IMMEDIATELY WRAP IN CLEAN UNWAXED PAPER AND STORE IN DRY PLACE.

Directive No.: 15-2
Prepared by: W. D. McCrary
Approved by:
Revision No.: Two
Date: 10 January 67

BONDING NICKEL REPLICAS TO ALUMINUM CASTINGS

1. PURPOSE:

This specification describes the procedure for bonding nickel replicas to aluminum castings. It also establishs techniques for the measurement and control of adhesive bond strength.

2. GENERAL

2.1 This is a critical process and must be rigorously controlled. If changes or deviations are required they must be approved by the governing agency.

2.2 The torque shear adhesion test consists of a 3/4" diameter button which is bonded to the back of the aluminum casting. A torque is applied to the button using a calibrated torque wrench until a shear failure occurs in the adhesive bond. The maximum shear stress (outer edge of bond) can then be calculated from the measured torque by means of the following equation.

$$S_{max.} = \frac{16T}{\pi d^3}$$

Where: S max = maximum shear stress

T = measured torque

d = diameter of button

For a 3/4" diameter button and a measured torque in ft.-lbs., the above equation reduces to: S max. (psi) = 145 T

3. RESPONSIBILITIES:

The bonding group, under the Component Production Section is responsible. Process Control will monitor the operation.

4. EQUIPMENT/MATERIAL

1. Bonding Fixtures.
2. Center Locating Plate for Castings.
3. Air Injection Gun and Plastic Spreader.
4. Furane Epibond 1210/9615 Epoxy
   100 parts 1210 - 100 parts 9615 frozen mix (12 oz.)
   100 parts 1210 - 100 parts 9615 hand mix

5. Mirror Support Fixture.
6. Epocast "K" Primer.
7. Test button (reusable) Part Number 81-12050.

NOTE: The bonding area must be clean. All dust and dirt produced from other operations, (grinding, etc.) must be removed from bonding fixtures, tools and tables prior to the bonding process.

The following procedure must be performed in the sequence indicated without interruption.

OPERATIONAL PROCEDURE

1.0 Replica Preparation

1.1 Strip protective film from reflective surface. (All except No. 3).
1.2 Place replica face down on support fixture in wash tank.
1.3 Moisten back of replica with deionized water. Sprinkle cleanser, (Institutional Formula White King or equivalent) over back of replica and scrub surface using clean bristle brush. DO NOT USE CLEANSERS CONTAINING CHLORINE OR BROMINE BLEACH.
1.4 Turn replica over carefully, positioned face up on support fixture in wash tank.
1.5 Wet down surface of replica with deionized water. Using "Amway" Solvent Detergent (or equivalent), swab surface gently to remove impurities and oil stains. (All except No. 3) "Do not apply pressure." Extreme care should be used, so you don't scratch the reflective surface.
1.6 Rinse thoroughly with deionized water. Blow dry with air. (Air line must have adequate oil and water trap which must be checked at least once per week).
1.7 Clean the test button bonding surface using the materials and techniques of paragraph 1.3 to 1.6 above.

2.0 Casting Preparation (No. 3 Casting Only)

2.1 Remove conversion coating from face of casting. Use cleanser (Institutional Formula White King or equivalent), clean bristle brush or grade 00 steel wool. Blow dry with clean air.

3.0 Mask and Prep Components

3.1 Place replica on bonding fixture and position casting in place with centering plate. (Bonding fixture surface to be clean from dust, dirt and epoxy).
3.2 Place casting on the back of the replica and draw outline of casting on the replica using a lead pencil.
3.3 Completely mask edges of casting (I. D. and O. D.) and replica outline (I. D. and O. D.) with vinyl masking tape.
3.4 Rinse back of replica with 200° absolute ethyl alcohol (from squeeze bottle) and let dry. Apply a coating of "Epocast K Primer" over bonding area, preferably with brush or spray gun. "K" primer must

have cure time of ½ hour at room temperature before applying epoxy. Care must be taken not to damage or scratch reflective surface in handling.

3.5 Prepare the test button as in 3.4 above and mask the O. D.

4.0 Preparation of Adhesive and Application

4.1 Preparation for adhesive. Hand mix.

4.1.1 Weigh out epoxy (Ratio 100 parts 1210 to 100 parts 9615).

HAND MIX

Mirror No. 1	1210 500 grams
	9615 500 grams
Mirror No. 2	1210 200 grams
	9615 200 grams
Mirror No. 3	1210 200 grams
	9615 200 grams
Mirror No. 4	1210 800 grams
	9615 800 grams

4.1.2 Mix 1210/9615 thoroughly (combined).
4.1.3 Epoxy to be used within ½ hour after mixing.

4.2 Preparation for adhesive. Frozen Pre Mix.

4.2.1 Immerse tubes in hot water 120° to 150°F. Care must be taken not to get water into back of cartridge as this will contaminate the epoxy.

FROZEN PRE MIX

Mirror No. 1	3 tubes
Mirror No. 2	1 tube
Mirror No. 3	1 tube
Mirror No. 4	5 to 6 tubes

4.2.2 Thaw tubes for 5 - 12 minutes.
4.2.3 Epoxy to be used within ½ hour after thaw.

4.3 Apply epoxy to back of replica and front of casting with air injection gun or equivalent.
4.4 Spread epoxy out evenly with plastic spreader. (Serrated type preferred).
4.5 Carefully position and center the casting on to back of replica by installing centering plate.
4.6 Allow excess epoxy to flow out from between the parts. "Do not apply pressure to the assembly."
4.7 A torque shear test button (EOS Print No. 81-12050) shall be bonded on each casting simultaneous with the bonding of each nickel reflector, using exactly the same materials and processing techniques. The

weight of the test button (87.5 g ±0.5 g) shall provide the proper bonding pressure.

4.8 After the epoxy has set to a tack free state (4 to 6 hours), use an X-acto knife to remove the excess epoxy by trimming around the O. D., I. D. of casting and test button. DO NOT CUT INTO REPLICA WHILE TRIMMING. (No. 3 assembly has to be removed to perform this operation. After the operation is complete, the assembly should be placed back on the bonding fixture and allowed to cure).

4.9 Allow the assembly to cure at room temperature 12 hours before removing from bonding fixture.

5.0 Test Procedure

5.1 Remove masking tape from O. D. of test button.

5.2 Using a calibrated torque wrench (either torque limiting or torque recording) apply a torque to the test button. Use care to prevent application of a bending force. The torque should be gradually increased until a failure of the bond occurs.

5.3 Record the measured torque required to cause failure or the last torque limit prior to failure, on the M. O.

5.4 A measured torque of less than ten (10) foot pounds shall be cause for rejection of the assembly.

Directive No.: 15-5
Prepared by :
Approved by :
Date : 11-16-66

NASA MIRROR ASSEMBLY
STRIPPING REWORK PROCEDURE

Equipment and Materials

1. Acetylene torch (use safety precautions and equipment)
2. Pittsburgh Paint and Varnish Remover
3. Screwdriver, hammer, paint brush and putty knife

Operational Procedure Removal of Nickel Skin (#1 and #4 Mirror Assemblies)

1. Position mirror face up on welding table.
2. Apply heat to reflective surface with acetylene torch, until the epoxy bond is broken. Peel the nickel skin from the casting. Use extreme care not to damage casting face and contour. (Do not pry the nickel skin off.)

#2 and #3 Mirror Assemblies

1. Position mirror face down on a table.
2. Using a screwdriver and hammer position the screwdriver on the nickel O.D. overhang of the assembly and pound until the bond joint is broken. Do this around the entire O.D. Peel the nickel skin from the casting. Use extreme care not to damage the casting face and contour. (Do not pry the nickel skin off.)

Removal of Excess Epoxy from Castings (#1, 2, 3 and 4 Mirror Assemblies)

1. Apply varnish remover to epoxy with a paint brush and let set for 15 minutes. Highly corrosive material. May cause severe burns. Avoid contact with skin and eyes.
2. Scrape off softened epoxy with a putty knife. Repeat this step until all epoxy is removed from the casting. Wipe excess varnish remover from casting with a paper towel.
3. Spray rinse the casting with water.
4. Scrub the casting (especially the face) with White King Institutional Cleanser or equivalent and a bristle brush.
5. Spray rinse with deionized water.
6. After re-inspection of the casting prepare the casting for bonding per Directive 12-2.

Directive No.:	12-7
Prepared by:	D. L. Ruffner
Approved by:	[illegible]
Revision No.:	2
Date:	10 November 66

APPLICATION OF PROTECTIVE FILMS PEEL TYPE NAS9-5805

SCOPE:

This specification describes the material and process to be used for application of protective films to reflective nickel surfaces.

APPLICABILITY:

This procedure applies to all reflective surfaces as specified by the Manufacturing Order (MO).

MATERIAL:

Protective coating compound designated as "Spraylat" No. SC-1070T is to be used as received. DO NOT THIN. An equivalent protective coating may be used.

PROCESS:

4.1 Apply a thin uniform coating using a pressure type spray gun or brush.

4.2 Allow to air dry a minimum of two (2) hours or until tack-free before handling.

4.3 Spray gun and equipment must be cleaned before and after use.

Directive No.: 35-1
Date : 25 October 1966
Revision No. : 1
Prepared by : L.T. Cipriano
Approved by : B.C. Lukes

Analytical Control Manual

Purpose

The purpose of this manual is to provide analytical procedures for the analysis of all chemical processing solutions and their control within optimum concentration ranges.

General

The procedures have been written with the intention that anyone with a basic knowledge of chemical terminology and analytical laboratory technique would be able to perform the required analyses. They have been kept as simple as possible, for maximum efficiency, within the limitations imposed by the required accuracy. Most are proven methods which are standard throughout the industry. The required techniques can be easily learned and should be committed to memory within a short period of time.

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* 10. Calculation of Additions

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* Not Included in this specification

1. Laboratory Procedure

1.1 Laboratory Chemicals

Chemicals are manufactured in several grades of different purity. It is important that an analyst recognize these and their suitability for laboratory use. The six most common grades are as follows (in order of increasing purity):

Commercial or Technical Grade - This grade is produced largely for industrial use and is not sufficiently pure for general laboratory use. Do not use unless specifically called out.

U.S.P. Grade - These chemicals are tested by the manufacturer for certain types of impurities but may contain appreciable amounts of impurities not tested for. Do not use unless specifically called out.

Chemically Pure (C.P.) Grade - These chemicals are purified according to standards set up by the individual manufacturer and since these standards vary, the chemicals are of indefinite purity. However, they are generally of high purity and may be used for most applications, except where a higher purity grade is specifically called out.

Reagent or ACS Grade - These are high purity chemicals manufactured and purified according to standards set by the American Chemical Society. This grade is suitable for all laboratory uses except the preparation of some primary standard solutions.

Primary Standard Grade - These chemicals meet all the above requirements and in addition are certified to contain close to 100% of the principal substance. They are used for preparation of primary standard solutions.

Electronic or Semiconductor Grade	- A grade of chemicals of extremely high purity used for specialized applications. These chemicals are desirable for some laboratory applications (such as analysis for trace impurities). However, their general use is not justified due to high cost.

1.2 Recording of Data

All analytical data (titration volumes, weights, etc.) should be recorded in ink directly on the forms provided (Chemical Analysis Worksheet). If an error is made, the incorrect figure should be crossed out and the correct one inserted. Each analysis worksheet must be signed and dated by the analyst and filed for future reference. Duplicate analyses will not be required unless the results are questionable. Titration volumes should be recorded to the nearest 0.05 ml, weights to the nearest 0.1 mg.

1.3 Calculations

Slide rule accuracy is sufficient for all calculations if the rule is 10 inches or greater. Care must be used not to express the result in a way that implies far more precision than was used in obtaining the result. In most cases, calculation of results to more than two (2) decimal places is neither justified nor desirable. The result cannot be more accurate than the data from which it is obtained.

2. Sampling

2.1 Whenever possible, assure that the solution has been thoroughly mixed before sampling. Samples should not be taken too soon after addition of chemicals or water. Sufficient time must be allowed for solution to become homogeneous.

2.2 Sampling is best performed with a glass or plastic tube approximately ½" in diameter. Flush the tube thoroughly with solution, then insert vertically into tank and allow to fill with sample. Place thumb over top of tube and withdraw. Release solution into a sampling bottle which has been previously rinsed with sample. Continue to transfer solution to bottle until sufficient liquid is collected for analysis. Solution should be taken from several sections of tank.

2.3 Allow sample to cool to room temperature before analysis, except in cases where solids may precipitate out. In this case, keep sample just warm enough to retain solids in solution.

2.4 After the analysis is complete, the sample bottle should be capped and the sample retained until a new sample of the same solution is taken. This is to allow a recheck of the analytical results if the need should arise.

4. Analysis of Alkaline Cleaner Solutions

4.1 Turco 4215 (Preclean)

4.1.1 Pipet 10 ml of sample into a 250 ml flask. Add 100 ml of deionized water.

4.1.2 Add 5 - 10 drops of Methyl Orange Indicator and titrate with 1N Sulfuric Acid (H_2SO_4) to reddish orange end-point.

4.1.3 Reactions:

$$2OH^- + H_2SO_4 \rightarrow SO_4^{-2} + 2H_2O$$

4.1.4 Calculations:

ml x 2.40 = oz/gal of Turco 4215

4.2 MacDermids Metalex W Special

4.2.1 Pipet 10 ml of sample into a 250 ml flask. Add 50 ml of deionized water.

4.2.2 Add 3 - 5 drops of Phenolphthalein Indicator and titrate with 1N Sulfuric Acid (H_2SO_4) to disappearance of pink color.

4.2.3 Reactions:

$$2OH^- + H_2SO_4 \rightarrow SO_4^{-2} + 2H_2O$$

4.2.4 Calculations:

ml x 1.35 = oz/gal of MacDermids Metalex W Special

5. Analysis of Deoxidizer and Etch Solutions

5.1 Turco Nitradd/Nitric Acid Deoxidizer

5.1.1 Nitric Acid

5.1.1.1 Pipet 2 ml of sample into a 400 ml beaker containing 100 ml of deionized water.

5.1.1.2 Titrate with 0.5N Sodium Hydroxide (NaOH) to a pH of 4.0 using a pH meter.

5.1.1.3 Reactions:

$$HNO_3 + NaOH \rightarrow NaNO_3 + H_2O$$

5.1.1.4 Calculations:

ml x 1.624 = % by Vol. of Nitric Acid (69%)

5.1.2 Nitradd

5.1.2.1 Pipet 2 ml of sample into a 250 ml flask containing 50 ml of deionized water. Pipet in 1 ml of Indicator B.

5.1.2.2 Slowly add 1N Sodium Hydroxide (NaOH) dropwise until color just changes to yellow-orange.

5.1.2.3 Pipet in 0.5 ml of Indicator A and add 20 ml of Nitradd Buffer Solution.

5.1.2.4 Titrate with 0.1N Thorium Nitrate ($Th(NO_3)_4$) to first definite pink color.

5.1.2.5 Reactions:

$$4F^- + Th(NO_3)_4 \rightarrow ThF_4 + 4NO_3^-$$

5.1.2.6 Calculations:

ml x 2.00 = % by Vol. of Nitradd

5.2 Turco Aluminetch #3

5.2.1 Pipet 10 ml of sample into a 250 ml flask. Add 30 ml of deionized water.

5.2.2 Add 5-10 drops of Phenolphthalein Indicator and titrate with 1N Sulfuric Acid (H_2SO_4) to disappearance of pink color. Record as titration A.

5.2.3 Add approximately 2g of Sodium Fluoride (NaF) and swirl to dissolve (pink color should return). Continue titration to disappearance of pink color. Record total ml used as titration B.

5.2.4 Reactions:

$$2AlO_2^- + H_2SO_4 + 2H_2O \rightarrow 2Al(OH)_3\downarrow + SO_4^{-2}$$

$$Al(OH)_3 + 6NaF \rightarrow Na_3AlF_6 + 3NaOH$$

$$2NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O$$

5.2.5 Calculations:

$$(A - 1/3\ (B-A)) \times 1.25 = \text{oz/gal of Aluminetch \#3}$$

$$(B-A) \times 0.012 = \text{oz/gal of Aluminum (Al)}$$

5.3 Sulfuric Acid Etch

5.3.1 Pipet 5 ml of sample into a 250 ml volumetric flask. Dilute to volume with deionized water.

5.3.2 Pipet 10 ml of diluted sample into a 250 ml flask. Add 50 ml of deionized water.

5.3.3 Add 5-10 drops of Methyl Orange Indicator and titrate with 0.1N Sodium Hydroxide (NaOH) to yellow end-point.

5.3.4 Reactions:

$$H_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2H_2O$$

5.3.5 Calculations:

ml x 1.39 = % by Vol. of Sulfuric Acid (96% H_2SO_4)

6. Analysis of Conversion Coating Solutions

6.1 Turco Alumigold

6.1.1 Alumigold

6.1.1.1 Pipet 10 ml of sample into a 250 ml flask. Add 10 ml of 1:1 Sulfuric Acid (H_2SO_4) and dilute to 100 ml with deionized water.

6.1.1.2 Add 1-2g of Potassium Iodide (KI) and swirl to dissolve. Stopper flask and allow to stand five (5) minutes.

6.1.1.3 Titrate with 0.1N Sodium Thiosulfate ($Na_2S_2O_3$) until endpoint is near (greenish-yellow). Add 1-3 ml of Starch Indicator and continue titration to disappearance of dark coloration.

6.1.1.4 Reactions:

$$Cr_2O_7^{-2} + 9KI + 14H^+ \rightarrow 2Cr^{+3} + 3I_3^- + 9K^+ + 7H_2O$$

$$I_3^- + 2Na_2S_2O_3 \rightarrow 3I^- + S_4O_6^{-2} + 4Na^+$$

6.1.1.5 Calculations:

ml x 0.110 = oz./gal. of Alumigold

6.1.2 pH

6.1.2.1 Measure pH of sample at room temperature using an electrometric pH meter.

6.2 Iridite 14-2

6.2.1 Iridite

6.2.1.1 Pipet 10 ml of sample into a 250 ml flask. Add 10 ml of 1:1 Sulfuric Acid (H_2SO_4) and dilute to 100 ml with deionized water.

6.2.1.2 Add 1-2g of Potassium Iodide (KI) and swirl to dissolve. Stopper flask and allow to stand five (5) minutes.

6.2.1.3 Titrate with 0.1N Sodium Thiosulfate ($Na_2S_2O_3$) until endpoint is near (greenish-yellow). Add 1-3 ml of Starch Indicator and continue titration to disappearance of dark coloration.

6.2.1.4 Reactions:

$$Cr_2O_7^{-2} + 9KI + 14H^+ \rightarrow 2Cr^{+3} + 3I_3^- + 9K^+ + 7H_2O$$

$$I_3^- + 2Na_2S_2O_3 \rightarrow 3I^- + S_4O_6^{-2} + 4Na^+$$

6.2.1.5 Calculations

ml x 0.081 = oz./gal. of Iridite 14-2

6.2.2 pH

6.2.2.1 Measure pH of sample at room temperature using an electrometric pH meter.

7. Water Analysis

7.1 Total Hardness

7.1.1 Pipet 100 ml of sample into a clean 250 ml flask which has been rinsed with distilled water (not deionized).

7.1.2 Add 5 ml of concentrated Ammonium Hydroxide (NH_4OH) and approximately 0.2g of Eriochrome Black T Indicator Mixture (EBT). Swirl to dissolve.

7.1.3 Titrate with 0.02N EDTA to blue end-point.

7.1.4 Reactions:

$$Ca^{+2} + EBT \rightarrow Ca - EBT^{+2} \text{ (red)}$$

$$Ca - EBT^{+2} + EDTA^{-2} \rightarrow Ca - EDTA + EBT \text{ (blue)}$$

7.1.5 Calculations:

ml x 10.0 = ppm of Calcium Carbonate ($CaCO_3$)

7.2 Chloride

7.2.1 Place approximately 100 ml of sample into a 250 ml flask that has been rinsed with distilled water (not deionized).

7.2.2 Add 10 ml of 1:1 Nitric Acid (HNO_3) and approximately 5 ml of 0.1N Silver Nitrate ($AgNO_3$).

7.2.3 Mix solution thoroughly and examine against a strong light. A white turbidity indicates the presence of chloride.

7.3 pH

7.3.1 Measure pH of sample using an electrometric pH meter.

Directive No.: 15-3
Prepared By : T. Pagano
Approved By : [illegible]
Revision No. : Original
Date : 12/30/66

VOID REPAIR PROCEDURE, # 7056-1

SCOPE:

This specification describes the procedure for repairing voids in the bond lines on NASA Solar Simulator Mirrors.

RESPONSIBILITIES:

The Bonding Group, under Component Production Section is responsible. Process Control will monitor the operation.

GENERAL:

This is a critical process and must be rigorously controlled. is required that this procedure be strictly followed.

VOID REPAIR

EXTERNAL VOIDS

EQUIPMENT/MATERIAL

1. Woodcarving tools and dental tools
2. 1 inch masking tape
3. Eye dropper or air injection gun
4. Tongue depressor and unwaxed 16 oz. Dixie cup
5. Shell 828/DTA (Diethylentriamine) mixture:
   50 grams Shell 828 to 7 grams D.T.A.

Note: All equipment must be free from epoxy, dust and grease.

OPERATIONAL PROCEDURE:

1. Cover the mirror surface with Polyethelene film to keep any foreign matter from scratching or staining it, (except No. 2 and 3 mirrors turn reflective face down in min 1 inch bed of clean absorbent cotton).
2. Locate void, then with a small file gently file the epoxy surrounding the void to attain a good bonding surface.
3. With an air hose blow all of the filings and dust from the void and void area.
4. Take a cotton swab moistened with 200 proof alcohol and swab out the void to further remove any dust or grease.
5. Take a clean paper towel moistened with 200 proof alcohol and gently rub the void area to remove dust and grease.
6. Mask off the void area to keep the excess epoxy off of the casting and nickel replica.
7. After the part has been masked off take a clean paper towel and moisten with 200 proof alcohol and gently rub the void area to remove any dust or grease left by finger prints when the part was being masked.
8. With an air hose blow out the void to dry excess alcohol.
9. With a calibrated scale measure out the specified mixture of Shell 828/DTA. Stir the mixture slowly until it is thoroughly mixed.
10. Using an eye dropper or air injection gun shoot the mixture into the void.

EXTERNAL VOIDS (CONTINUED)

11. With a small pointed tool tamp the mixture into the void making sure there are no air bubbles.

12. After the mixture has set up for two hours remove the masking tape.

13. After the mixture has cured for six to eight hours remove all excess epoxy with wood carving tools or dental tools.

PROCESS SPECIFICATION NO. OT 1000

Detail Test Procedure for NASA Optical Train Reflectors

25 April 1967

PURPOSE

This document is to prescribe the procedure to be used in the Optical Test and Acceptance of the NASA Optical Train Reflectors.

RESPONSIBILITIES

Optical Test will be performed by the Production Group of the Components Production Section. Process Control will monitor the test.

GENERAL

This document will be used in the Optical Test and Acceptance of the following reflectors:

PART NUMBER	DESCRIPTION	IDENTIFICATION
614331	Primary Reflector Collector	Reflector No. 1 (See Appendix 1)
614577	Secondary Reflector Collector	Reflector No. 2 (See Appendix 2)
614576	Secondary Reflector Collimator	Reflector No. 3 (See Appendix 3)
614320	Primary Reflector Collimator	Reflector No. 4 (See Appendix 4)

OPERATIONAL PROCEDURE

Prescribed in Appendix.

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APPENDIX 1

OPTICAL TEST PROCEDURE REFLECTOR NO. 1

TEST EQUIPMENT REQUIRED

1. Reflector Holding Fixture and Support Assembly having horizontal, vertical, focus, azimuth, and elevation adjustments. HDS Print No. 91-11855.

2. Light Source - Bausch and Lomb 71-71-44 Lamp (2.5 Volts). For focal length adjustment, lamp should be measured under magnification to establish dimension from center of filament to outside of glass envelope. DC Power Supply 0-12 V.

3. Light Source Support - Micro Manipulator Model MP1, Catalog No. 30-51-10, having horizontal, vertical and focus adjustments, and photographic tripod.

4. Theoretical displacements target bars, showing nominal theoretical displacements and ± displacements allowed. Mount on to flash target with concentric rings for alignment purposes.

5. Slotted Mirror Face Masks.

6. Reticle Plate for locating mirror face masks.

7. Mirror Mounting Standoffs.

8. Focal Length Fixture and set of inside micrometers.

9. Graphic box camera and polaroid film pack.

NOTE: Preparation for the test requires a target flat within ± .125" plus perpendicularity to the floor within ± .125" plus a floor center line perpendicular to target within ± .0625.

1.0 DETAIL TEST TECHNIQUES

1.1 Mount standoffs 120° apart on back of assembled mirror casting.

1.2 Bolt mirror assembly to support assembly spider.

1.3 Install reticle plate (to locate on casting I. D. and reticles in reticle plate to match reticles in mirror). This establishes center of mirror. Match of reticles to be as accurate as possible.

1.4 Place slotted face masks on center locating stud of reticle plate and lay on reflecting surface of mirror in x and y axis. Reticle marks determine axis. Masks should be on a flat plane from stud to first test diameter of mask. The mask should lay flat along the contour of the mirror.

1.5 Center the support assembly on the floor center line.

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1.6 Mount mirror theoretical target bar on flash target centering pin.

1.7 Place mirror theoretical vertex 150" ± 1/16" from the theoretical target bar, on the optical axis (center of target to mirror theoretical vertex). Mount focal length fixture on mirror and measure with tape measurer from target bar to focal length fixture.

1.8 Place light source on the optical axis, using focal length fixture approximately 12.125" from mirror theoretical vertex. Focal length tolerance 12.125 ± 1/16". Darken room.

1.9 Concentrically align projected flash to a concentric ring on flash target (using x, y, z, azimuth and elevation controls of mirror support and light source). Check for flash abnormalities: i. e., distortion, tweaks, bonding void, etc.

1.10 By focusing, adjusting azimuth and elevation on mirror support assembly and light source, gain the best average reflected mask slot image (at all test diameters) in comparison to theoretical target bar.

NOTE: Mirror theoretical vertex to target and focal length dimensions must be remeasured and/or re-established following any azimuth or elevation of focus adjustments.

1.11 Examine reflected images, draw pencil line through center of image of all diameters on target bar. Check to see that all images are within specifications. Measure minute deviation of mirror on target bar (pencil line to nominal theoretical location ± deviations), and record on corresponding data sheet.

1.12 Take a photograph of entire projected flash and staple to data sheet. On final optical test, two (2) pictures are required.

MIRROR NO. 1

OPTICAL TEST SPECIFICATIONS

A. Test to specification: Contract NAS 9-5805 - Statement of Work Exhibit "C"

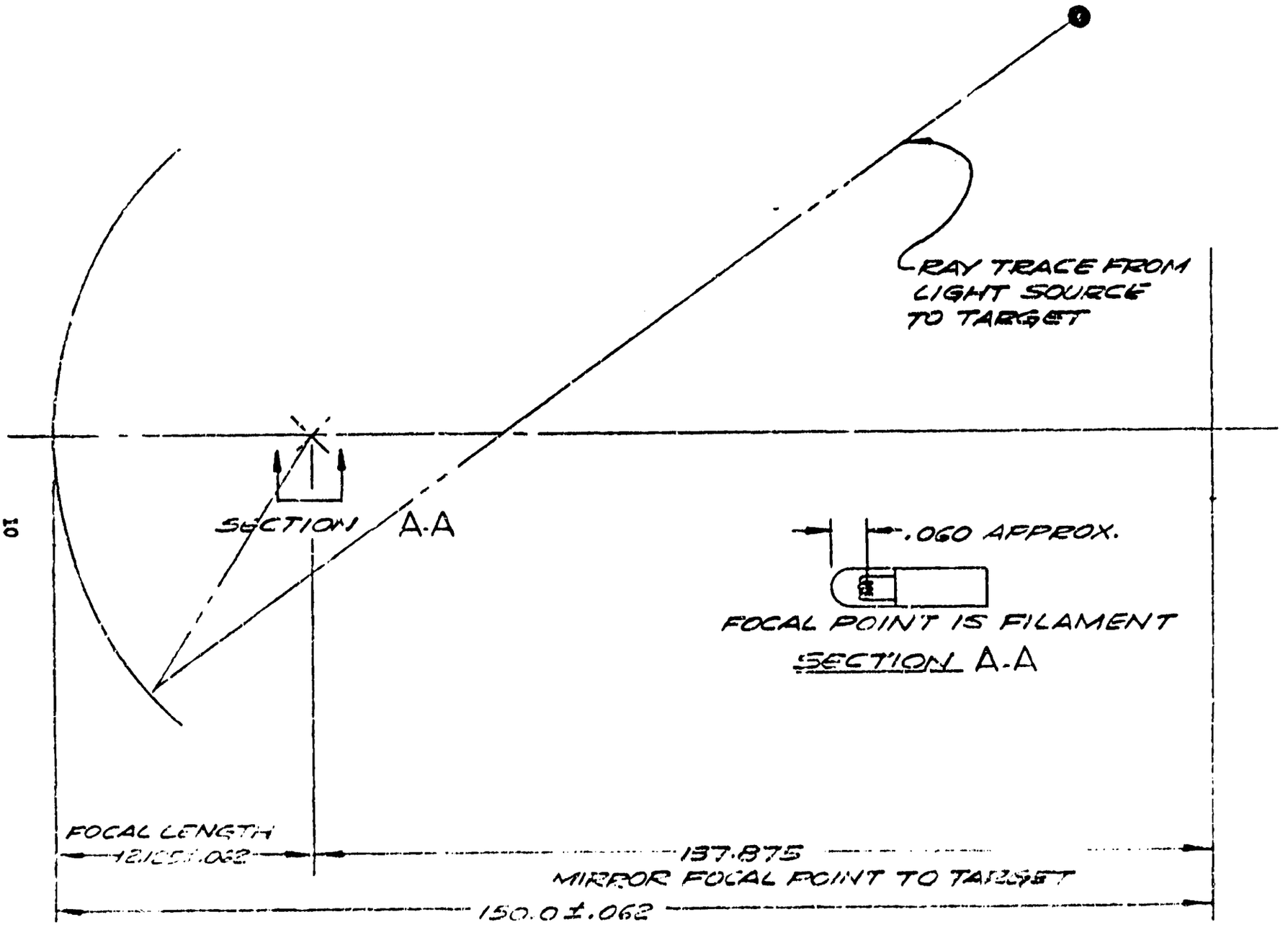
B. Acceptance of mirror will be within the following:

Focal Length	-	12.125" ± 1/16"
Minute Deviation	-	± 4 minutes of theoretical slope

C. Optical test method accuracy is ± 1.0 min. of slope.

Final Optical Tests are to be witnessed by Quality Assurance Inspection.

Revised 18 October 1966



NASA #1 SET-UP

5-13-

APPENDIX 2

OPTICAL TEST PROCEDURE REFLECTOR NO. 2

TEST EQUIPMENT REQUIRED

1. Reflector Holding Fixture and Support Assembly having horizontal, vertical, focus, azimuth, and elevation adjustments. EOS Print No. 91-11855.

2. Projection Light Source. Sylvania ASA Code FAV 100 Watts (11.0 Volts). Microscope Objective Lens 2.5; 1 x N.A. 0.10 DC Power Supply 0-12 Volts.

3. Light Source Support - Micro Manipulator Model MPI, Catalog No. 30-31-10, having horizontal, verticle, and focus adjustments.

4. Theoretical displacements target bars, showing nominal theoretical displacements and ± displacements allowed. Mount on to flash target with concentric rings for alignment purposes.

5. Slotted Mirror Face Masks.

6. Reticle Plate for locating mirror face masks.

7. Mirror Mounting Standoffs.

NOTE: Preparation for the test requires a target flat within ± .125" plus perpendicularity to the floor within ± .125" plus a floor center line perpendicular to target within ± .0625.

1.0 DETAIL TEST TECHNIQUES

1.1 Mount standoffs on back of assembled mirror casting.

1.2 Bolt mirror assembly to support assembly spider.

1.3 Install reticle plate (to locate on casting I. D. and reticles in reticle plate to match reticles in mirror). This establishes center of mirror. The match of reticles to be as accurate as possible.

1.4 Place slotted face masks on center locating stud of reticle plate and lay on reflective surface of mirror in x and y axis. Reticle marks determine axis. Masks should be a straight line from stud to first test diameter of mask. The mask should lay flat along the contour of the mirror.

1.5 Center the support assembly on the floor center line.

1.6 Mount mirror theoretical target centering pin.

1.7 Place mirror theoretical vertex 100" ± 1/16" from the theoretical target bar, on the optical axis (center of target to mirror theoretical vertex).

1.8 Place light source on the optical axis, using focal length fixture approximately 75.0" from mirror theoretical vertex. Focal length tolerance 75.0" ± 1/16". Darken room.

1.9 Concentrically align projected flash to a concentric ring on flash target (using x, y, z, azimuth, and elevation controls of mirror support and light source). Check for flash abnormalities; i. e., distortion, tweaks, etc.

1.10 By focusing, adjusting azimuth and elevation on mirror support assembly and light source, gain the best average reflected mask slot image (at all test diameters) in comparison to theoretical target bar.

1.11 Examine reflected images, draw pencil line through center of image of all diameters. Check to see that all images are within specs. Measure minute deviation of mirror on target bar (pencil line to nominal theoretical locations) and record on corresponding data sheet.

MIRROR NO. 2

OPTICAL TEST SPECIFICATIONS

A. Test to specifications Contract NAS 9-5805 - Statement of Work Exhibit "C"

B. Acceptance of mirror will be within the following:

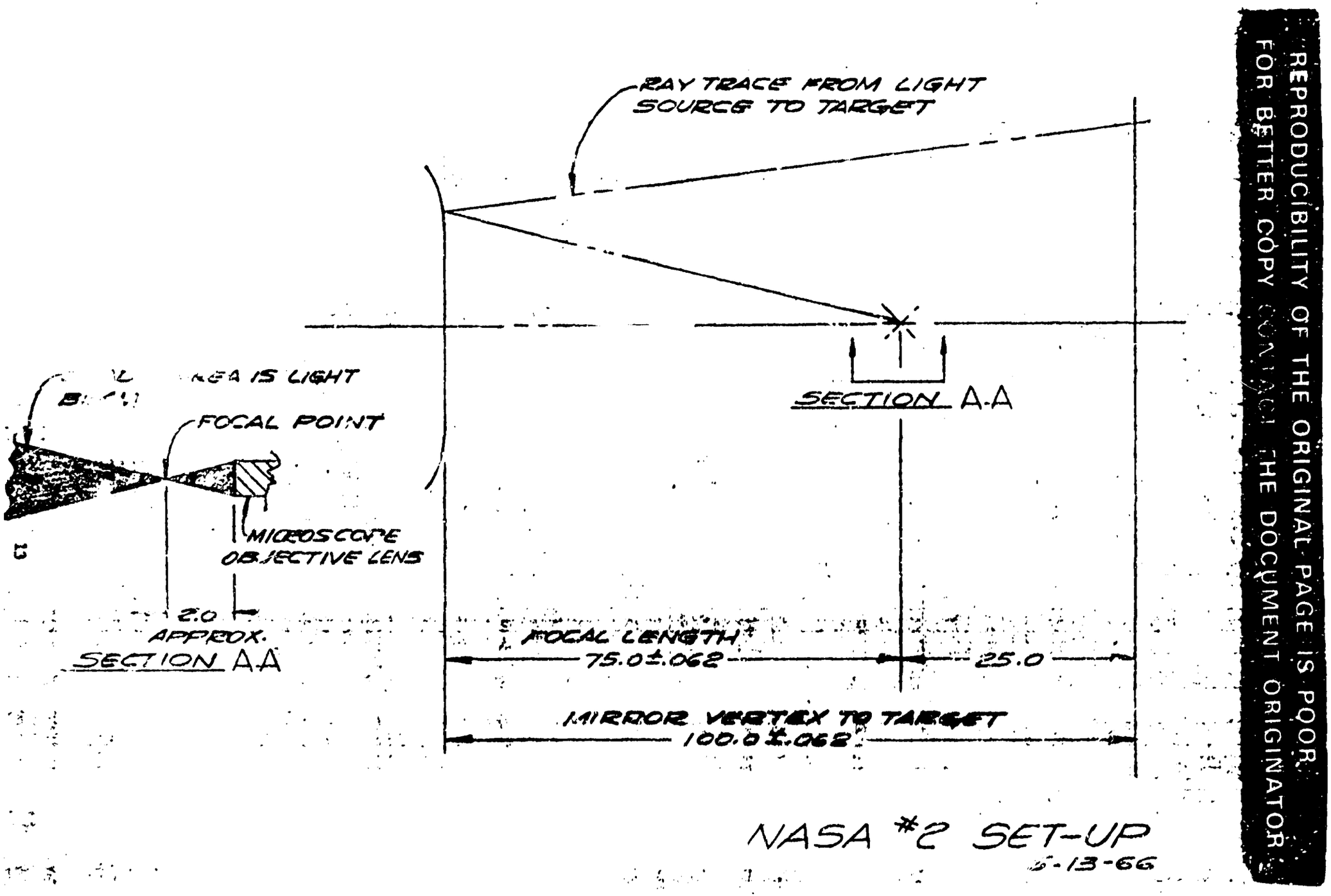
Focal Length	-	-75.0" + 1/16"
Minute Deviations	-	± 3-1/2 minutes of theoretical slope

C. Optical Test method accuracy is ± 1.0 min. of slope.

Final Optical Tests are to be witnessed by Quality Assurance Inspection.

Revised 18 October 1966

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NASA #2 SET-UP

5-13-66

APPENDIX 3

OPTICAL TEST PROCEDURE MIRROR NO. 3

TEST EQUIPMENT REQUIRED

1. Test bench.
2. Clear Safety Glasses (personnel eye protection).
3. Test light source using Sylvania F15T8BL tubes and having a light diffuser.
4. Two-inch optical check plate with x, y grid markings (nominal spherical radius of the replica).

1.0 TEST TECHNIQUES

1.1 Place the mirror on the test bench under the test light source.

1.2 Check plate and mirror must be clean.

1.3 Apply the check plate on an x band and y band and at overlapping intervals being certain that none of the area representing a cross 2" wide will go unchecked.

1.4 Use the check plate as follows to calculate uniformity of curve.

1.4.1 Turn the check plate carefully to align the diameter of the check plate with the fringe lines causing a fringe line to begin and end at the extremes of the diameter.

1.4.2 If the fringe line is bent count the number of lines crossing the diameter line from the extreme to center. This is the number of fringes.

1.4.3 Maximum deviation of ± 30 seconds equals 16.6 fringes, when tested with the optical check plate having the same radius of curvature as the replica. (NOTE: The use of additional check plates of varying radii within the allowable radii tolerance for the replica may be required.)

1.5 Record the fringe count number in the pattern area described in 1.4.2.

Revised 18 October 19[illegible]

MIRROR #3

A. Test to specification - Contract NAS 9-5805 Statement of Work Exhibit "C"

B. Acceptance will be within the following:

Focal Length - Not Applicable R = 24.867

Minute deviation $\pm$ ½ minutes of theoretical slope.

C. Optical test method accuracy approximately 4 fringes.

Revised 18 October 1966

APPENDIX 4

OPTICAL TEST PROCEDURE REFLECTOR NO. 4

TEST EQUIPMENT REQUIRED

1. Reflector Holding Fixture and Support Assembly, having horizontal, vertical, focus, azimuth, and elevation adjustments. EOS Drawing No. 91-11855.

2. Projection Light Source, Sylvania ASA Code FAV 100 Watts (11.0 Volts). Microscope Objective Lens 40X N. A. 0.65. DC Power Supply 0-12 Volts.

3. Light Source Support - Micro Manipulator Model MP1, Catalog No. 30-51-10, having horizontal, vertical, and focus adjustments.

4. Theoretical displacements target bars, showing nominal theoretical displacements and ± displacements allowed. Mount to flash target screen.

5. Slotted Mirror Face Masks.

6. Reticle plate for locating mirror face masks.

7. Mirror mounting standoffs.

8. Focal length fixture and set of inside micrometers.

9. Graphic camera and poloroid film pack.

10. Grid Mask (2 inch square pattern).

NOTE: Preparation for the test requires a target flat within ± .125" plus perpendicularity to the floor within ± .125" plus a floor center line perpendicular to target within ± .0625. Target should have concentric rings for alignment purposes.

1.0 DETAIL TEST PROCEDURE

1.1 Mount standoffs on back of assembled mirror casting.

1.2 Bolt mirror assembly to support assembly.

NOTE: Orient the top of the mirror (slot has mounting holes in flange) at the top.

1.3 Install reticle plate (to locate on casting I. D. and reticle in reticle plate to match reticles in mirror). This establishes center of mirror. Match of reticles to be as accurate as possible.

1.4 Place light source on the optical axis using focal length fixture approximately 35.5" from mirror theoretical vertex. Focal length tolerance 35.5" ± 1/16". Operate the light source and darken room.

1.5 Concentrically align projected flash to a concentric ring on the 150" flash target (using x, y, z, azimuth, and elevation controls of mirror support and light source).

1.6 Install the 2 inch square grid at the theoretical focal length. Take three (3) photographs at the 150" range and two (2) photographs at the 360" range.

NOTE: Clear sharp photos are necessary in the following steps.

1.7 Place slotted face masks on center locating stud of reticle plate and lay on reflective surface of mirror in x and y axis. Reticle marks determine axis. Mask should be a straight line from stud to first test diameter of mask. The mask should lay flat along the contour of the mirror.

1.8 Mount mirror theoretical target bar on 150" flash target centering pin.

1.9 By focusing, adjusting azimuth and elevation on mirror support assembly and light source, gain the best average reflected mask slot image (at all test diameters) in comparison to theoretical target bar. Use the 360" flash photo as a guide to determine abnormalities. Look for curves or wavy grid lines, bright spots, dark spots, which will be tested in addition to the x and y axis. All additional test locations will be noted on one of the 150" flash photos. All additional test locations will be numbered clockwise looking at the face of the mirror and marked counterclockwise on one of the 150" flash photos. Move the slot mask to the selected positions to prove these areas are within specification.

1.10 If the examination shows the unit is acceptable record data for the x-y axis and all additional test diameters by orienting the target bar to coincide with the slot mask locations. Mark the center of the reflected image on the target bar and record the data on the data sheet.

1.11 Complete the data package by making two (2) complete sets of data consisting of one (1) 150" flash photo, one (1) 360" flash photo, one (1) 150" flash photo showing additional test location notes, and all test data sheets.

NOTE: Second marked 150" flash photo may be a Xerox copy.

MIRROR NO. 4

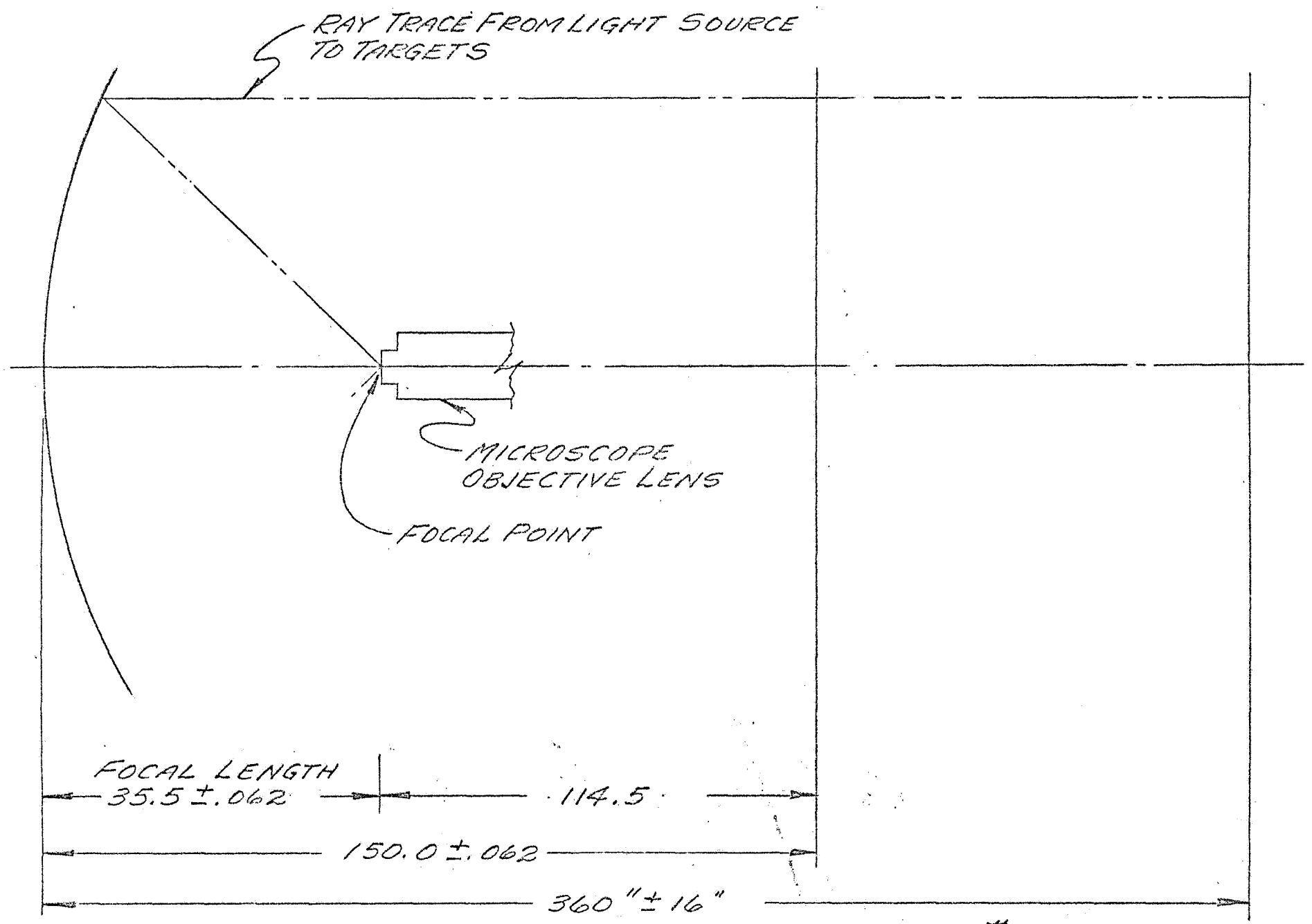
OPTICAL TEST SPECIFICATIONS

A. Test to specification Contract NAS9-5805 Statement of Work Exhibit "C".

B. Acceptance of mirror will be within the following:

Focal Length	35.5" $\pm$ 1/16"
Minute Deviation	$\pm$ 5 minute of theoretical slope

C. Optical test method accuracy is $\pm$ 1.5 minute of slope.



NASA #4 SET-UP

4-25-67

Directive No.: 110-1
Revision No.: Original
Date: 12 December 1966
Prepared by: W. McCrary
Approved by: J. Cinchett

CORROSION RETARDENT COATING FOR ALUMINUM CASTINGS

Purpose: This directive provides the material specification, use and application of materials used to minimize or retard corrosion of aluminum on internal water coolant channels.

Use: NASA Solar Simulator Mirror Nos. 1 and 2

Responsibility: Solar Simulator Program Office

Description: CS 2602 is a two component polyurethane coating which cures at normal temperatures to a tough, long wearing, and abrasion resistant coating. CS 2602 is a glass-like coating which is resistant to chemicals, weathering, and extremes in temperatures. Properly applied CS 2602 is highly resistant to staining, chalking, cracking, oxidizing, crazing, and peeling. CS 2602 is a non-toxic, germ-free, inert coating which will not sustain fungus growth.

1.0 Data

Application Properties

Color	White
Mixing Ratio	Base Compound: Curing Agent 3: 1 by volume
Shelf Life	One Year (Unopened Container)
Flash Point	Above 90°F
Application Life	12 Hours
Tack-free Time	2 Hours
Time for Full Cure	3 - 5 Days
Coverage per gallon (1½ mils)	650 square feet

Cured Properties

Hardness	68 Sward Rocker
Chemical Resistance	Excellent
Weather Resistance	Excellent

Abrasion Resistance Compared to Other Materials

CS 2602	36.6
Vinyl	90
Epoxy	185
Chlorinated Rubber	210

NOTE: Determinations were based on Average Taber Abrasion Index. The numbers indicate the milligrams of weight loss per 1000 revolutions using the CS 17 wheel and a 1000 gram load.

2.0 Surface Preparation

1. Flush the casting using commerical grade acetone. Changes of solution will be made until casting flows freely and effluent solvent is free of metal chips, discoloration, etc.

NOTE: Casting water flow rate must meet drawing specifications.

2. Air dry the casting until it is free of solvent.

3.0 Mixing Instructions

Thorough mixing is essential to obtain a cured coating. If prevailing temperatures exceed 90°F, storage and mixing should be in a cool area since elevated temperatures will reduce the application life. If prevailing temperatures are below 65°F, CS 9936 Speed Cure must be used.

The following procedure should be followed:

1. Transfer all of the curing agent into the base compound container and mix until a thorough blend is obtained.

2. Allow to stand 15 minutes before using.

3. For lesser amounts, mix three (3) parts of base compound to one (1) part of curing agent by volume. Caution: Keep all containers tightly sealed.

4.0 Application Instructions

1. Introduce mixed CS 2602 into casting with pumping station until material flows freely with no evidence of entrapped air.

2. Remove excess paint from casting.

5.0 Cure

The rate of cure is affected by temperature and humidity. The rate of cure may be accelerated by heating. CS 2602 will achieve full cure under conditions in 3 to 5 days.

If a faster tack-free and cure time is desired, CS 9936 Speed Cure is recommended. The use of CS 9936 Speed Cure is not detrimental to the properties of CS 2602.

6.0 Moisture Contamination

CS 2602 is extremely moisture sensitive. Adequate precautions must be taken to prevent moisture contamination from improperly cleaned surface and equipment.

7.0 Cleaning

CS 2602 should be removed from equipment and tools with CS 9900 Cleaner before the coating cures. Cured coating may be removed from equipment by soaking in CS 9900 Cleaner and scrubbing.

8.0 Storage Life

CS 2602 may be stored for one year below 80°F in the original unopened containers without deterioration of the usefulness of performance properties of the cured materials.

TITLE Mirrors, Front Surface Coating PROCESS SPECIFICATION OT 45-1

ORIGINATOR R. Frank REVISION

CHECKED DATE 12 May 1966

APPROVED PROCESS CONTROL

APPROVED ENGINEERING R Frank

1.0 SCOPE

This specification covers the vacuum deposition of high reflectance films on electroformed optical elements.

2.0 EFFECTIVITY

2.1 This specification becomes effective on the date of issuance. No deviations or changes shall be permitted without the written authorization of the Optical Train Program Office.

3.0 APPLICATION

3.1 The requirements of this specification shall apply to all vacuum deposition of films on Optical Train electroformed optical elements assigned by the Production Section.

4.0 DOCUMENTATION

Each class of element for which a manufacturing order is issued shall have a Vacuum Deposition Production Outline prepared and maintained in the file of the Vacuum Deposition Laboratory. The Vacuum Deposition Production Outline shall be considered a part of this specification as applied to the specific class of element involved and it will be treated as EOS Private Data.

5.0 CLEANING AND STRIPPING

5.1 General cleaning will be performed on all replicas prior to coating. Special cleaning techniques may also be required as indicated by the Production Outline. General cleaning will consist of spray rinsing to remove loose particles, then gentle washing with absorbent cotton and a non-ionic detergent, followed by a thorough rinsing with distilled water. All surfaces, not just the areas to be coated, will be cleaned if practical.

5.2 Replicas received with the silver sensitizing film intact will be stripped immediately following general cleaning. Stripping will be accomplished with one of Electro-Optical Systems proprietary solutions for dissolving silver. These solutions vary in composition according to the type and nature of the surface to be stripped. The Production Outline will indicate the formula to be used.

5.3 Silver stripping with the appropriate solution, may be accomplished by immersion, flushing, spray or wiping as indicated by the production outline. This operation shall be followed by a wiping rinse using distilled water and absorbent cotton, then flooding with distilled water.

5.4 After the cleaning and stripping operations have been completed, the replica shall be flushed with 200 proof ethyl alcohol, drained slightly and gently wiped with absorbent paper towels.

5.5 The replicas shall be placed in the vacuum system as quickly as possible after the completion of the cleaning, stripping, and drying operations. In no case, shall this waiting period exceed one (1) hour and the replicas must be protected from atmospheric contamination during the waiting period.

6.0 VACUUM DEPOSITION

6.1 Prepared replicas shall be placed in the system in the arrangement indicated in the Production Outline. Remove all dust particles from the optical surface using a gentle stream of dry nitrogen.

6.2 Maintain the nitrogen stream across the surface as long as possible while closing the system. Exhaust the plant as rapidly as possible.

6.3 Once pumping has begun, it will be necessary to refer to the specific instructions of the Production Outline for glow, discharge, cleaning and evaporation procedures. Such procedures are extremely critical and very specific for each case and are beyond the scope of the general processes specified in this document.

6.4 Upon completion of the deposition, a period shall be allowed for cooling the sources before therepressurization of the vacuum system. This cooling period shall be a minimum of one half the deposition time of the last film condensed on the replica. Following the cooling period, slowly admit air to the system, open the chamber and remove the replica.

6.5 Allow coated replicas to cool to room temperature and visually inspect prior to submission for process inspection.

7.0 FINAL ACCEPTANCE

7.1 All coated replicas must be submitted to the Process Control Group for coating acceptance.

7.2 Replicas failing to meet acceptance requirements shall have rejection documents issued against them. They shall be removed to a holding area by the process control group until written disposition is furnished by the Optical Train Program Office.

EXHIBIT C

SPECIFICATION FOR MSC SOLAR SIMULATOR MIRRORS

1. SCOPE

This specification covers the requirements for the design fabrication, testing, acceptance, and shipment of four (4) electroformed reflectors used for each solar simulator module. The acceptance test may be made after the reflector is assembled into the final collector or collimator assembly.

2. APPLICABLE DOCUMENTS

The following drawings with this specification will be the sole documents for acceptance of each electroformed solar reflector.

Drawings	Reflector No.	
EOS P/N 91-11927	1	Primary Collector
EOS P/N 91-11880	2	Secondary Collector
EOS P/N 91-11856	3	Secondary Collimator
EOS P/N 614320	4	Collimator Mirror

3. REQUIREMENTS

The four (4) solar simulator reflectors shall be in accordance with Drawings 91-11927, 91-11880, 91-11856, 614320 as currently modified and specified herein Reflectors No. 1 and No. 4 shall be fabricated for positive cooling water sealant without use of bonding techniques. The contractor shall minimize corrosion in all reflector coolant water channels.

3.1 Coatings

3.1.1 Coating Reflectivity

Each electroformed nickel mirror will be coated with a barrier coat of Chromium and SiO, aluminized, and then overcoated with highly oxidized SiO. The reflectivity will be measured as follows: The contractor will supply MSC twelve (12) representative sample coatings on glass slides. MSC will test all twelve (12) samples and return six (6) of these samples to the contractor as standards. Six samples will be retained by MSC as standards.

During the actual coating operations, two (2) glass slides positioned at the O. D. and I. D. of each mirror, will be included with each production mirror so that the coating applied to the reflector will also be applied to the slides and be representative of the uniformity of coating throughout the mirror.

These slides will then be compared to the returned standard slides. The comparison will be accomplished by the vendor using a Beckman Model DU spectrophotometer or equal. A specular reflectivity reading will be made at approximately 380, 550, and 850 millimicrons. The measured reflectivity of the production sample shall not be more than 2% below the reflectivity of the "standard" (average for the six samples) slide for the wavelength tested. (± 2% is the nominal inherent accuracy of the instrument-operator measurement system.

3.1.2 Coating Adhesion

Coatings shall be firmly adherent and shall not be removed when subjected to cleaning procedures as set forth in Section 6.2.1 of this Specification.

3.2 Reflector Figure

The contractor shall supply or arrange for the supply of all masters and submasters from which the replica mirrors will be made. The following deviations or figure tolerances for the final replica mirrors will be allowed from the theoretical optical figures as shown in Chart II of Exhibit B.

a. Primary Collector, Drawing No. 91-11927 slope error ± 4 min. of arc from the theoretical figure.
b. Secondary Collector, Drawing No. 91-11880 slope error ± 3-1/2 min of arc from the theoretical figure.
c. Secondary Collimator, Drawing No. 91-11856 ± 30 sec. of arc from the theoretical figure.
d. Primary Collimator, Drawing No. 614320 ± 5 min. of arc from the theoretical figure.

Masters shall be oversized minimum of final mirror dimensions + 2 in. radius outside, -2 in. radius inside. A slight distortion exceeding the above noted tolerances may be present at inner and/or outer edges. These areas shall not be included when inspecting for optical figure.

3.2.1 Tooling

A specific test technique will be used for testing each of the 4 configurations of production mirrors. Two (2) identical sets of test equipment will be fabricated by the contractor and compared for accuracy and reproducibility. MSC will inspect test equipment, select and transport one (1) set to NASA, MSC facility for comparative test purposes. The 2nd set will be retained by the contractor for production and acceptance testing. Where applicable, the contractor

shall utilize equipment already developed for NASA Contract NAS 9-1097.

3.2.2 Test Method

Each mirror shall be tested before shipment to MSC for proof of compliance with the requirements for reflector figure (Section 3.2). Tests will be performed by EOS personnel. The test techniques will be similar in nature, but, because of the difference in configuration and optical characteristics of the four (4) mirrors in question, each test will differ in detail for mirrors #1, #2 and #4. The tests will consist of mounting the mirror to be tested on a holding fixture which has the capability of linear movement in the x and y planes as well as azimuth and elevation movement. A point light source shall be located on a device which is capable of adjustment in the x, y, and z planes and positioned in front of and on the optical axis of the mirror being tested. The system shall be adjusted such that the energy from the source shall be reflected by the mirror onto a target plane. The target plane shall be suitably marked and positioned in conjunction with the aforementioned adjustments of the mirror support and light source so that an illuminated pattern of axial symmetry can be achieved. A grid or mask will be interposed in the light beam between the sources and the mirror or against the surface of the mirror, as the particular mirror configuration requires, in such a manner that the pattern of the grid or mask will be projected on the target area.

The test shall consist of a comparison between the projected patterns (as observed on the target) of the replica production mirror and the theoretical data points from which the replica mirror was made. Allowable angular slope errors shall be mathemetically calculated by determining the deviation in beam position at the target plane and the distance between grid or mask and target plane. The grid or mask shall provide for comparison of the replica, with the theoretical data points across at least two (2) full diameters, 90^{o} to each other (x and y axis). Mask hole spacings or grid spacing shall allow for diametrical examination of the usable mirror surface at intervals not exceeding 1/2" for mirrors Nos. 1, 2 and 3 and 1" intervals for mirror No. 4.

In application, the target pattern, based on the theoretical data will be permanently recorded on the respective target areas and the allowable beam deviations associated with each of the individual

slope error tolerances as noted in Section 3.2 a, b, c, and d, will be marked on the targets. The tests for the No. 3 mirror shall be by conventional optical test plate techniques using a two (2) inch diameter test plate.

3.2.3 Tolerances and Surface Defects

3.2.3.1 Additionally, 1% of the usable surface area of each mirror may exceed the tolerances listed above provided that no single defect shall have an area greater than 1/10 of 1% for Mirrors No. 1, 2, and 3 and 1/20 of 1% for Mirror No. 4. Areas effected by edge sealing of coatings and/or non-usable inside diameters and outside diameters, as previously defined during the course of the contract, shall not be included in the 1% allowance.

3.2.3.2 Additionally, for Mirrors No. 1, 2 and 4, a photograph of the projected "flash" will be made where feasible. If apparent abnormalties are noticed, the mirrors will be repositioned and the prescribed tests will be performed to include the questionable areas. Mirrors will be acceptable if the measured deviations do not exceed conditions of Par. 3.2, a, b, c, and d and Par. 3.2.3.1.

3.2.3.3 Mirrors No. 1, 2, and 3 shall have no more than 1% of the surface area which is less than the allowable reflectivity level with further limitations to area as defined in 3.2.3.1 above. Mirror No. four(4) shall have no more than ¼ of 1% of total area allowable reflectivity degradation except for an allowable ¼ inch wide band at inner and outer edges. In addition, no single surface defect shall be more than 1/ 50 of 1% of the usable surface area.

Optical Tolerance and Surface Defects, Attachment 1 to Exhibit C, dated 20 June 1967, is included herein and attached hereto and made a part hereof for inspection purposes."

3.2.3.4 The 1% area allowable for optical slope defects and the above defined or coating defect areas shall not be considered additive. No more than one percent shall be allowed for the total of both types of defects.

3.2.3.5 The presence of mirror surface defects which are normal to the replicated mirror processes and which are not obviously the result of poor workmanship shall not be cause

for rejection. Pits and digs replicated from the master shall not exceed the allowable areas above.

3.3 Operating Characteristics

The reflectors shall not be damaged when subjected to an operational temperature environment of -280°F to +150°F, and P/N 91-11856 and 614320 shall be capable of sustained exposure to a vacuum not to exceed 1×10^{-7} torr, to a temperature environment ranging from -280°F to +150°F, and shall withstand shock loads up to those associated with normal truck and air transportation, without mechanical failure or loss of optical figures, provided that neither the water cooling nor the illumination portion of the overall Solar Simulator Module System malfunctions.

4. QUALITY ASSURANCE PROVISIONS

The contractor is responsible for the performance of all inspections and test requirements specified herein. Inspections and test of end items may also be performed at the contractor's plant by MSC designated personnel.

4.1 Mechanical Inspection

Each reflector shall be in accordance with Drawings P/N 91-11927, 91-11880, 91-11856, 614320 as currently modified.

4.2 Tests

Each reflector shall have the following tests performed by Production Control Personnel

a. Coating reflectivity in accordance with Paragraph 3.1.

b. Reflector figure in accordance with Paragraph 3.2.

c. Leak and pressure tests - each reflector cooling system shall be tested in accordance with the applicable drawing requirements and the following: All mirrors shall be checked at a hydrostatic test pressure of 150 PSIG for five (5) minutes or more.

5. PREPARATION FOR DELIVERY

5.1 Packaging

Reflectors shall be packaged adequately to assure no damage in shipment via commercial air or surface carriers.

5.2 Accompanying Data

The following data will accompany each reflector:

5.2.1 Inspection Traveler - certifying the compliance of Items 4.2 Item a, b, and c.

6. WARRANTY

In lieu of any other warranty, expressed or implied, the contractor shall

warrant the reflector figure and optical coating in accordance with this specification for a period of one (1) year after acceptance provided that proper handling methods and cleaning procedures have been utilized and the mirrors have not been exposed to temperature or other conditions that exceed those defined in Section 3.3, Operating Characteristics.

6.1 Reflector Figure Warranty

Justification for warranty replacement for reflector figure deviation will be evidenced by comparison of the photo or test of the questionable reflector with the photo or test made for acceptance.

6.2 Optical Coatings Warranty

Coating failure clearly attributable to faulty workmanship by the contractor (i. e. after exposure to normal operation or storage conditions the coating peels or seriously degrades) shall be cause for replacement. Pinpoint or other replicated defects are normal in electroformed replicas, and will not be cause for replacement. Additionally, arc sputtering, tail flame impingement shall not be cause for warranty replacement.

6.2.1 Cleaning of the Reflective Coatings

Improper cleaning of the vacuum deposited reflective coating can seriously affect the lifetime of the coatings. Minute scratching from abrasive particles can penetrate the protective SiO overcoat, exposing the reflective aluminum layer to humidity and other atmospheric attack. Excessive pressure or abrasion during cleaning can also penetrate one or more of the vacuum deposited layers and contribute to local loosening of the films. Vacuum deposited films are inherently stressed and any substantial scratching or penetration can minimize both reflectivity and lifetime.

For these reasons the following optical coating cleaning procedures are mandatory.

Cleaning Procedure

Optical coatings as applied to each of the four mirrors under this contract shall be cleaned using a soft cloth which has been adequately laundered to remove any abrasive agents and a 1 to 3 percent aqueous solution of a non-ionic detergent such as Kyro E. O. (Proctor & Gamble). No abrasives of any kind should be used. Before physical cleaning of the surface, any particles which may exist on the surface should be flushed away before wiping is begun. The cleaning solution and the surface to be cleaned should be at a temperature range between $+60^{\circ}$ and $+80^{\circ}$F. The mirror should be rinsed only with distilled or deionized water and dried using a clean soft laundered cloth or surgical grade absorbent cotton. Only mild pressures should be used as

even surgical cotton is abrasive under sufficient pressure. Evaporative drying can also be accomplished following the distilled water rinse with the use of absolute ethyl alcohol or triple distilled acetone. A flushing wash of either of these materials may be applied and the mirror blown dry with filtered dry air, dry nitrogen or a filtered warm air gun.

During and after the cleaning operation, the surface should be carefully scrutinized to determine if scratching or sleeking is being induced by the cleaning process. The highly oxidized SiO overcoat will withstand repeated cleaning if care, as noted above is exercised to prevent the inclusion of any abrasive particles during the operation. Conventional paper toweling, Kimwipes and other paper products should be avoided as they almost always contain some abrasive materials. Wiping should be accomplished from the reflective surface to the inner or outer edge in a circular motion. Care must be exercised not to drag any foreign particles or materials from the edges or back of the mirror into the mirror reflective surface during the cleaning operation.

6.2.2 Storage

Mirrors will be packed in boxes for transit with protective covering for dust protection. Mirrors in storage shall be protected from normal atmospheric fallout on the reflective surface at all times. If high humidity or situations promoting condensation are likely to occur during storage, the boxed or stored mirrors must be maintained in a position such that condensate will not collect on the mirror surface. A desiccant should be stored with the mirrors if prolonged storage in high humidity area is undertaken. Condensate shall not be allowed to stand on the mirror surface.

INSPECTION CLARIFICATION OF EXHIBIT C PARAGRAPH 3.2.3
OPTICAL TOLERANCE AND SURFACE DEFECTS

Table I
CLASSIFICATION OF SURFACE AREA DEFECTS

Mirror No.	Type Defect	Single Defect %	Single Defect Dia-Max	Total Defects %	Total Defects Area
1	SE/NR	1/10	0.77 in	1	4.61 sq in
2	SE/NR	1/10	0.38 in	1	1.15 sq in
3	SE/NR	1/10	0.37 in	1	1.10 sq in
4	SE	1/20	0.90 in	-	-
	NR	1/50	0.57 in		
	SE/NR	-	-	¼ of 1	3.19 sq in

SE in table I above stands for slope errors in excess of that stated in Par. 3.2a,b,c, and d. Slope errors are measured by ray deviations determined during the tests defined in par. 3.2.2. NR stands for reflective areas which are below the accepted level as defined in section 3.1 of Exhibit "C" and shall include the following types of defects:

1. All plating defects whether they originate in the master or result from workmanship. Includes pinholes, protrusions, scratches (replicated and unique to the replica) and surface gray (due to slow master degradation).
2. All vacuum coating defects where a significant reduction in the coating reflectivity is visible. This shall include discoloration, blistering, electrolitic spotting, etc.

Area determinations are based on the following:

#1 Mirror - Total projected area = 530 sq. in. The edge seal permits loss of .080 in around the I.D. and O.D.

#2 Mirror - Total projected area = 148 sq. in. in less area covered by mask = 115 sq. in. The edge seal permits loss of .080 in around the I.D. Also excluded are the areas covered by the pupil masks when the mirror is installed and aligned in the collector assembly.

#3 Mirror - Total projected area = 110 sq. in. The edge seal permits loss of .080 in around the I.D. and O.D.

#4 Mirror - Total projected area = 1,277 sq.in. Not included is a ¼ in wide band around the outside edges including the support arm slots and area covered by the bezel.

NOTE: Defect areas may be determined based on projected area only for the determination of conformance to the specification.

SPLIT ORDER RECORD			
DATE	NO.	QTY	BAL.

ENG. CHANGES		DATE
LET.	E.C.I.	

ELECTRO-OPTICAL SYSTEMS, INC.
A Subsidiary of Xerox Corporation

MANUFACTURING ORDER

M.O. NO.	100
W.A. NO.	7056
P.W.O. NO.	
QTY	S.N.
NEXT ASSY	QTY

PART NAME Assembly No. 1 Mirror PART NO. 614331
DATE 1-11-67 PAGE 1 OF 2 EDITION NO. 5 UNIT Optical Train
PLANNER J. Bibeau EXT. 298 REQUESTOR W. McCrary

SCHEDULE DATES		INSPECTION
ISSUE		COMPLETION STAMP
IN WORK		
DUE		

WORK CENTER NO.	OPER. NO.	TOOL NO.	OPERATION DESCRIPTION	EST. HRS	COMP.	ACCEPT.
	10		Prepare master and equipment to plate in accordance with EOS			
			Proprietary Process Specification No. N102-1.			
			Start Cycle Complete Cycle			
			Master No. Replication No.			
			At completion of plating, part and clean replica, and identify.			
	15		Process Control Inspect.			
	20		Optical Test Replica (optional)			
	30		Clean casting for bonding in accordance with EOS Directive 12-2			
			Record S/N			
	31		Q.C. Inspection per II #7056-17.			
	36		Government Inspection			
	40		Bond nickel replica to aluminum casting in accordance with EOS			
			Directive 15-2.			
	41		Q.C. Inspection per II #7056-18			
	46		Government Inspection			
	50		Perform torque shear test in accordance with EOS Directive No. 15-2			
			para. 5.0			
			Record Torque Value			
	51		Q.C. Inspection per II #7056-18a.			
	56		Government Inspection			
	60		Preliminary Optical Test			
	65		Process Control Visual Inspection			
	70		Elox Cut			
	71		Q.C. Mechanical Inspection per II #7056-14A.			
	76		Government Inspection			

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APPROVAL | MFG. | Q.A. | RECEIVED BY | DATE | TOTAL HOURS

MO 100

SPLIT ORDER RECORD			
DATE	NO.	QTY	BAL.

ELECTRO-OPTICAL SYSTEMS, INC.
A Subsidiary of Xerox Corporation

MANUFACTURING ORDER

M.O. NO. 100
W.A. NO. 7056
P.W.O. NO.
QTY | S.N.
NEXT ASSY | QTY

ENG. CHANGES		DATE
LET.	E.C.I.	

PART NAME Assembly No. 1 Mirror — PART NO. 614331
DATE 1-11-67 — PAGE 2 OF 2 — EDITION NO. 5 — UNIT Optical Train
PLANNER J. Bibeau — EXT. 298 — REQUESTOR W. McCrary

SCHEDULE DATES		INSPECTION
ISSUE		COMPLETION STAMP
IN WORK		
DUE		

WORK ENTER NO.	OPER. NO.	TOOL NO.	OPERATION DESCRIPTION	EST. HRS	COMP.	ACCEPT.
	80		Final Optical Test in Accordance with Proc.Spec.No. 0T1000, Appendix 1			
	81		Q.C. Witness Operation No. 80 per II #7056-14			
	86		Government Inspection			
	90		Vacuum coat in accordance with Process Specification No. 0T45-1			
	91		Q.C. Inspection per II #7056-19			
	96		Government Inspection			
	100		Apply SR-82 Edge Seal.			
	115		Process Control - Check Reflectivity.			
	121		Q.C. Witness Operation No. 115 per II #7056-15			
	126		Government Inspection			
	131		Q.C. Final Inspection per II #7056-16.			
	136		Government Inspection			

Page 2 of 2

APPROVAL | MFG. | Q.A. | RECEIVED BY | DATE | TOTAL HOURS

MO 100

SPLIT ORDER RECORD

DATE	NO.	QTY	BAL.

ENG. CHANGES		DATE
LET.	E.C.I.	

ELECTRO-OPTICAL SYSTEMS, INC.
A Subsidiary of Xerox Corporation

MANUFACTURING ORDER

M.O. NO. 200
W.A. NO. 7056
P.W.O. NO.
QTY | S.N.
NEXT ASSY | QTY

PART NAME Assembly No. 2 Mirror PART NO. 614577
DATE 1-11-67 PAGE 1 OF 2 | EDITION NO. 5 | UNIT Optical Train
PLANNER J. Bibeau | EXT 298 | REQUESTOR W. McCrary

SCHEDULE DATES		INSPECTION
ISSUE		COMPLETION STAMP
IN WORK		
DUE		

WORK ENTER NO.	OPER. NO.	TOOL NO.	OPERATION DESCRIPTION	EST. HRS	COMP.	ACCEPT.
	10		Prepare master and equipment to plate in accordance with EOS			
			Proprietary Process Specification No. N102-1.			
			Start Cycle Complete Cycle			
			Master No._____ Replication No._____			
			At completion of plating, part and clean replica, and identify.			
	15		Process Control Inspect.			
	20		Optical Test Replica (optional)			
	30		Clean casting for bonding in accordance with EOS Directive No. 12-2.			
			Record S/N_____			
	31		Q.C. Inspection per II #7056-17.			
	36		Government Inspection .			
	40		Bond nickel replica to aluminum casting in accordance with EOS			
			Directive 15-2.			
	41		Q.C. Inspection per II #7056-18.			
	46		Government Inspection .			
	50		Perform torque shear test in accordance with EOS Directive No.15-2			
			para. 5.0			
			Record Torque Value_____			
	51		Q.C. Inspection per II #7056-18a.			
	56		Government Inspection			
	60		Preliminary Optical Test			
	65		Process Control Visual Inspection			

APPROVAL | MFG. | Q.A. | RECEIVED BY | DATE | TOTAL HOURS _____

SPLIT ORDER RECORD			
DATE	NO.	QTY	BAL.

ELECTRO-OPTICAL SYSTEMS, INC.
A Subsidiary of Xerox Corporation

MANUFACTURING ORDER

M.O. NO. 200
W.A. NO. 7056
P.W.O. NO.

PART NAME Assembly No. 2 Mirror PART NO. 614577
DATE 1-11-67 PAGE 2 OF 2 EDITION NO. 5 UNIT Optical Train
PLANNER J. Bibeau EXT. 298 REQUESTOR W. McCrary

QTY S.N.
NEXT ASSY QTY

ENG. CHANGES		DATE
LET.	E.C.I.	

SCHEDULE DATES | INSPECTION
ISSUE
IN WORK
DUE
COMPLETION STAMP

WORK ENTER NO.	OPER. NO.	TOOL NO.	OPERATION DESCRIPTION	EST. HRS	COMP.	ACCEPT.
	70		Elox Cut.			
	71		Q.C. Mechanical Inspection per II #7056-14A.			
	76		Government Inspection			
	80		Final Optical Test in accordance with Proc.Spec.No. OT1000, Appendix 2.			
	81		Q.C. Witness Operation No. 80 per #7056-14.			
	86		Government Inspection			
	90		Vacuum coat in accordance with Process Spec. No. OT45-1.			
	91		Q.C. Inspection per II #7056-19.			
	96		Government Inspection			
	100		Apply SR-82 Edge Seal.			
	115		Process Control - Check Reflectivity.			
	121		Q.C. Witness Operation No. 115 per II #7056-15.			
	126		Government Inspection			
	131		Q.C. Final Inspection per II #7056-16.			
	136		Government Inspection			

APPROVAL | MFG. | Q.A. | RECEIVED BY | DATE | TOTAL HOURS

SPLIT ORDER RECORD

DATE	NO.	QTY	BAL.

ENG. CHANGES		DATE
LET.	E.C.I.	

ELECTRO-OPTICAL SYSTEMS, INC.
A Subsidiary of Xerox Corporation

MANUFACTURING ORDER

M.O. NO. 300
W.A. NO. 7056
P.W.O. NO.
QTY | S.N.
NEXT ASSY | QTY

PART NAME Assembly No. 3 Mirror PART NO. 614576
DATE 1-11-67 PAGE 1 OF 2 EDITION NO. 5 UNIT Optical Train
PLANNER J. Bibeau EXT. 298 REQUESTOR W. McCrary

SCHEDULE DATES: ISSUE, IN WORK, DUE
INSPECTION: COMPLETION STAMP

WORK CENTER NO.	OPER. NO.	TOOL NO.	OPERATION DESCRIPTION	EST. HRS	COMP.	ACCEPT.
	10		Prepare master and equipment to plate in accordance with EOS			
			Proprietary Process Specification No. N102-1.			
			Start Cycle_____ Complete Cycle_____			
			Master No._____ Replica No._____			
			At completion of plating, part replica, clean and identify.			
	15		Process Control Inspect.			
	20		Elox cut centering hole, clean, and de-burr.			
	25		Process Control Visual Inspection			
	30		Clean casting for bonding in accordance with EOS Directive No. 12-2			
			Record S/N_____			
	31		Q. C. Inspection per II #7056-17.			
	36		Government Inspection			
	40		Bond nickel replica to aluminum casting in accordance with EOS			
			Directive 15-2.			
	41		Q. C. Inspection per II #7056-18.			
	46		Government Inspection			
	50		Perform torque shear test in accordance with EOS Directive No. 15-2,			
			Paragraph 5.0. Record torque value_____			
	51		Q. C. Inspection per II #7056-18a.			
	56		Government Inspection			
	60		Elox Cut			
	65		Process Control - Visual Inspection			
	71		Q. C. Inspection to perform final Optical Test in accordance with Process			

APPROVAL | MFG. | Q.A. | RECEIVED BY | DATE | TOTAL HOURS

SPLIT ORDER RECORD

DATE	NO.	QTY	BAL.

ENG. CHANGES		DATE
LET.	E.C.I.	

ELECTRO-OPTICAL SYSTEMS, INC.
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MANUFACTURING ORDER

M.O. NO. 300
W.A. NO. 7056
P.W.O. NO.

PART NAME Assembly No. 3 Mirror — PART NO. 614576
DATE 1-11-67 — PAGE 2 OF 2 — EDITION NO. 5 — UNIT Optical Train
PLANNER J. Bibeau — EXT. 298 — REQUESTOR W. McCrary

QTY — S.N.
NEXT ASSY — QTY

SCHEDULE DATES	INSPECTION
ISSUE	COMPLETION STAMP
IN WORK	
DUE	

WORK ENTER NO.	OPER. NO.	TOOL NO.	OPERATION DESCRIPTION	EST. HRS	COMP.	ACCEPT.
	71 (Continued)		Specification No. OT1000 Appendix 3 and II #7056-14.			
	76		Government Inspection			
	81		Q. C. Inspection, Mechanical Inspection of Mirror per II #7056-14A			
	86		Government Inspection -			
	90		Vacuum coat in accordance with process specification No. OT45-1.			
	91		Q. C. Inspection per II #7056-19.			
	96		Government Inspection -			
	100		Apply SR-82 Edge Seal.			
	115		Process Control - Check Reflectivity.			
	121		Q. C. Witness Operation No. 110 per II #7056-15.			
	126		Government Inspection -			
	131		Q. C. Final Inspection per II #7056-16.			
	136		Government Inspection -			

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APPROVAL | MFG. | Q.A. | RECEIVED BY | DATE | TOTAL HOURS

SPLIT ORDER RECORD			
DATE	NO.	QTY	BAL.

ELECTRO-OPTICAL SYSTEMS, INC.
A Subsidiary of Xerox Corporation

MANUFACTURING ORDER

M.O. NO. 301
W.A. NO. 7056
P.W.O. NO.

ENG. CHANGES		DATE
LET.	E.C.I.	

PART NAME Casting - No. 3 Mirror PART NO. 614576
DATE 9-23-66 PAGE 1 OF 1 EDITION NO. 1 UNIT Optical Train
PLANNER T. Apodaca EXT. REQUESTOR W. McCrary

Effective Date 15 May 1967

QTY S.N.
NEXT ASSY 614570 QTY

SCHEDULE DATES	INSPECTION
ISSUE	COMPLETION STAMP
IN WORK	
DUE	

WORK CENTER NO.	OPER. NO.	TOOL NO.	OPERATION DESCRIPTION	Prod. Date	Insp. Date
	10		Clean casting in accordance with Process Spec. No. N301		
			Casting S/N_____		
	15		Process Control Inspect		
	16		Government Inspection		
	20		Impregnate - (Outside Supplier)		
	25		Receiving Inspection (E. O. S.)		
	30		Helium leak detection		
	35		Q. C. Inspection - Witness Helium Leak Check		
			Oper. No. 30 Per II #7056-30		
	36		Government Inspection		

APPROVAL
MFG. R.D. Hatherington
Q.A. Ross L. Gordon 9/27/66 RECEIVED BY
DATE
TOTAL HOURS _____

SPLIT ORDER RECORD			
DATE	NO.	QTY	BAL.

ENG. CHANGES		DATE
LET.	E.C.I.	

ELECTRO-OPTICAL SYSTEMS, INC.
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MANUFACTURING ORDER

M.O. NO. 400
W.A. NO. 7056
P.W.O. NO.
QTY | S.N.
NEXT ASSY | QTY

PART NAME Assembly No. 4 Mirror PART NO. 614320
DATE 1-11-67 PAGE 1 OF 2 | EDITION NO. 5 | UNIT Optical Train
PLANNER J. Bibeau | EXT 298 | REQUESTOR W. McCrary

SCHEDULE DATES		INSPECTION
ISSUE		COMPLETION STAMP
IN WORK		
DUE		

WORK NTER NO.	OPER. NO.	TOOL NO.	OPERATION DESCRIPTION	EST. HRS	COMP.	ACCEPT.
	10		Prepare master and equipment to plate in accordance with EOS			
			Proprietary Process Specification No. N102-1.			
			Start Cycle_____ Complete Cycle_____			
			Master No._____ Replica No._____			
			At completion of plating, part, clean and identify replica.			
	15		Process Control Inspection.			
	20		Optical Test Replica (optional)			
	30		Clean casting for bonding in accordance with EOS Directive No. 12-2			
			Record S/N_____			
	31		Q. C. Inspection per II #7056-17.			
	36		Government Inspection -			
	40		Bond nickel to aluminum casting in accordance with EOS Directive 15-2.			
	41		Q. C. Inspection per II #7056-18.			
	46		Government Inspection -			
	50		Perform torque shear test in accordance with EOS Directive No. 15-2,			
			paragraph 5.0 Record torque value_____			
	51		Q. C. Inspection per II #7056-18a.			
	56		Government Inspection -			
	60		Preliminary Optical Test			
	65		Process Control Visual Inspection			
	70		Elox Cut			
	71		Q. C. Mechanical, Inspection of mirror per II #7056-14A			

APPROVAL | MFG. | Q.A. | RECEIVED BY | DATE | TOTAL HOURS _____

SPLIT ORDER RECORD			
DATE	NO.	QTY	BAL.

ELECTRO-OPTICAL SYSTEMS, INC.
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MANUFACTURING ORDER

M.O. NO. 400
W.A. NO. 7056
P.W.O. NO.

ENG. CHANGES		DATE
LET.	E.C.I.	

PART NAME Assembly No. 4 Mirror — PART NO. 614320
DATE 1-11-67 — PAGE 2 OF 2 — EDITION NO. 5 — UNIT Optical Train
PLANNER J. Bibeau — EXT. 298 — REQUESTOR W. McCrary

QTY — S.N.
NEXT ASSY — QTY

SCHEDULE DATES		INSPECTION
ISSUE		COMPLETION STAMP
IN WORK		
DUE		

WORK CENTER NO.	OPER. NO.	TOOL NO.	OPERATION DESCRIPTION	EST. HRS	COMP.	ACCEPT.
	76		Government Inspection -			
	80		Final Optical Test in accordance with Process Specification No. OT1000, Appendix 4			
	81		Q. C. Witness Operation No. 80 II #7056-14.			
	86		Government Inspection -			
	90		Vacuum coat in accordance with Process Specification No. OT45-1			
	91		Q. C. Inspection per II #7056-19			
	96		Government Inspection -			
	100		Apply SR-82 Edge Seal.			
	115		Process Control - Check Reflectivity			
	121		Q. C. Witness Operation No. 115 per II #7056-15.			
	126		Government Inspection -			
	131		Q. C. Final Inspection per II #7056-16.			
	136		Government Inspection -			

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APPROVAL — MFG. — Q.A. — RECEIVED BY — DATE — TOTAL HOURS

SPLIT ORDER RECORD			
DATE	NO.	QTY	BAL.

ELECTRO-OPTICAL SYSTEMS, INC.
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MANUFACTURING ORDER

M.O. NO. 700
W.A. NO. 7056
P.W.O. NO.

PART NAME NASA Mirror Assemblies, Rework
PART NO. 614576, 614321, 614330, 614577

QTY | S.N.
NEXT ASSY | QTY

DATE 1-13-67 PAGE 1 OF 1 | EDITION NO. 1 | UNIT NASA Solar Simulators

PLANNER R. Kowatch | EXT. 311 | REQUESTOR W. D. McCrary

ENG. CHANGES		DATE
LET.	E.C.I.	

SCHEDULE DATES: ISSUE / IN WORK / DUE

INSPECTION COMPLETION STAMP

WORK CENTER NO.	OPER. NO.	TOOL NO.	OPERATION DESCRIPTION	EST. HRS	COMP.	ACCEPT.
	10		Remove Nickel Skin from Casting in accordance with EOS Directive 15-5.			
	20		Remove Excessive Epoxy from Casting in accordance with EOS Directive 15-5.			
	21		Q. A. Mechanical Inspection of casting. Inspect unit visually for damage, complete epoxy removal, and check the contour using the appropriate receiving inspection gage.			
	125		Government Inspection			

APPROVAL | MFG. | Q.A. | RECEIVED BY | DATE | TOTAL HOURS

SPLIT ORDER RECORD			
DATE	NO.	QTY	BAL.

ELECTRO-OPTICAL SYSTEMS, INC.
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MANUFACTURING ORDER

M.O. NO. 1200
W.A. NO. 7056
P.W.O. NO.

PART NAME Casting No. 1 and No. 2 — PART NO. 614577 / 614331

QTY | S.N.

DATE 1-11-67 | PAGE 1 OF 1 | EDITION NO. 2 | UNIT

NEXT ASSY | QTY

PLANNER R. Tellkamp | EXT. 241 | REQUESTOR W. McCrary

ENG. CHANGES		DATE
LET.	E.C.I.	

SCHEDULE DATES: ISSUE / IN WORK / DUE

INSPECTION: COMPLETION STAMP

WORK ENTER NO.	OPER. NO.	TOOL NO.	OPERATION DESCRIPTION	EST. HRS	COMP.	ACCEPT.
	10		Prepare Surface - (Department Directive 110-1, Paragraph 2.0, 2.1, 2.2)			
	15		Q. C. Inspection, verify that surface is prepared in accordance with Department Directive No. 110-1, Paragraph 2.0, 2.1, 2.2.			
	16		Government Inspection			
	20		Mix Coating - (Department Directive 110-1, Paragraph 3.0, 3.1, - 3.3).			
	25		Q. C. Inspection, verify that mixing is in accordance with Department Directive 110-1, Paragraph 3.0, 3.1 - 3.3.			
	26		Government Inspection			
	30		Apply Coating - (Department Directive 110-1, Paragraph 4.0, 4.1, 4.2)			
	35		Q. C. Inspection, verify that the material is applied in accordance with Department Directive 110-1, Paragraph 4.0, 4.1, 4.2			
	36		Government Inspection			

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APPROVAL
MFG. Wilbur D. McCrary | Q.A. H. Sullivan | RECEIVED BY | DATE

TOTAL HOURS _____

MO 1200

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2.2.0 Specification Lenses for Solar Simulator

2.2.0.1 General

This specification covers the manufacture, quality and acceptance inspection for the lenses used in the MSC Solar Simulator System.

2.2.0.2 Applicable Documents

The following drawings, charts and specifications form a part of this specification:

1.	Drawings	Revision & Drawing No.
	MSC, NASA	E 30-018 - Collector Lens
		D 31-111 - Field Lens
		D 31-034 - Collimator Lens #1
		D 31-035 - Collimator Lens #2
2.	Joint Army Navy Specification	
	JANC 174	
	Amendment 1	Glass Optical
	13 March	
3.	Military Specification	General Specification
	MIL-O-13830 (Ord)	
4.	Chart I 7 December 1964	Acceptable Transmission curve for 1/2 inch thickness of fused silica.
5.	Chart II	Basic Optical Layout (Applicable to Optical figures only)

2.2.0.3 Detailed Specification for Fused Silica Lens Blanks

1. Striae

The fused silica shall be graded according to striae content and shall not be poorer than the standard sample (par. H-3 Jan G174) representing that grade. In no case will material of a quality less than Dynasil Grade-Optical No. 4000 or equal be acceptable for drawings Rev. E 30-018 and Rev. D 31-111 or Dynasil Grade-Optical No. 3000 or equal for Rev. D 31-034 or Rev. D 31-035.

2. Transmission

The spectral transmission of light including surface reflections of the material supplied under this spec. shall equal or better that of the transmission curve represented by Chart I.

3. Bubble Content or Occlusion of Each Part

.01 Max. dia. seeds and bubbles

	Rev.	Drawing No.
.020 in.	E	30-018
	D	31-111
.035 in.	D	31-034
.050 in.	D	31-035

.02 Max. # seeds and bubbles/in^3

8	E	30-018
	D	31-111
15	D	31-034
	D	31-035

.03 Max. Percent projected area per inch light path

.008	E	30-018
	D	31-111
.025	D	31-034
	D	31-035

4. Optical Properties

Index of Refraction

The refractive index, N_D, shall be within $\pm$ .001 of a nominal value of 1.458 and a certificate of compliance is required for each batch or melt used in manufacture. Abbes Constringent Co-efficient shall be 67.6 plus or minus 0.5.

5. Inspection

Inspection and sampling procedures for lens blanks are cited below. Failure of sample shall cause rejection of the lot which it is representative unless 100% inspection of individual samples is accomplished, these individual samples meeting requirements will be acceptable.

5.1 Bubbles-Each lens blank shall be inspected for bubbles, seeds and stones and occlusions by immersion in a cell,

illuminated by monochromatic light and containing a liquid having a suitable index of refraction. The requirements set forth in 2.2.0.3.3 shall be met.

5.2 Strain-Selected lens blanks from batch or lot shall be examined at the completion of annealing process for amount and symmetry of strain by means of a standard polariscope test and found to be less than 10 millimicrons per centimeter path difference.

5.3 Transmission-Samples selected and tested for transmission requirements from each batch or melt of blanks shall be equal to or better than the transmission curve represented by Chart I as measured by an acceptable recording spectrophotometer.

5.4 Striae-100% inspection of lens blanks worked shall conform to 3-A as inspected by performing measurements in accordance with Para. F-3C Jan G174.

Index of Refraction and Abbes Constringent Co-efficient of selected samples s all be measured on a standard refractometer and certified to meet 2.2.0.3.4.

2.2.0.4 Detailed Specifications for Manufacture of Lenses

2.2.0.4.1 Scope

This portion of the specification covers the requirements for manufacture of the lenses from the fused silica lens blanks as specified above in accordance with Drawings Rev. E 30-018, Rev. D 31-111, Rev. D 31-034, and Rev. D 31-035.

2.2.0.4.2 Surface Quality

The surfaces of the lens should be polished to a quality where the maximum width of scratches is 60 microns and the maximum dig and bubble diameter is 500 microns. This corresponds to a scratch and dig code number as per MIL-O-13830 of 60-50.

2.2.0.4.3 Surface Shape Tolerance

The surface of the lenses shall be made to match

radii templates to .001/inch for Drawing Rev. D 31-034 and Rev. D 31-035 and .0001/inch for Rev. D 31-111. Drawing Rev. E 30-013 requires match of an aspheric template and radii template to .001/inch. Alternately the surface shape for lenses shown on Drawings Rev. D 31-034, Rev. D 31-035, and Rev. D 31-111 may be verified by optical check plates. Check plate diameter, allowable tolerance, acceptable fringe count and template tolerance will be determined by the contractor, but shall not exceed tolerances specified by use of radii templates.

2.2.0.4.4. Cementing

No cementing is allowable as each lens shall be a single element lens manufactured from a single lens blank.

2.2.0.4.5 Inspection

Inspection methods are described below, 100% inspection of the lenses shall be effected and inspection certification submitted for each lens. Those lenses not meeting requirements will be rejected and replaced at the expense of the vendor.

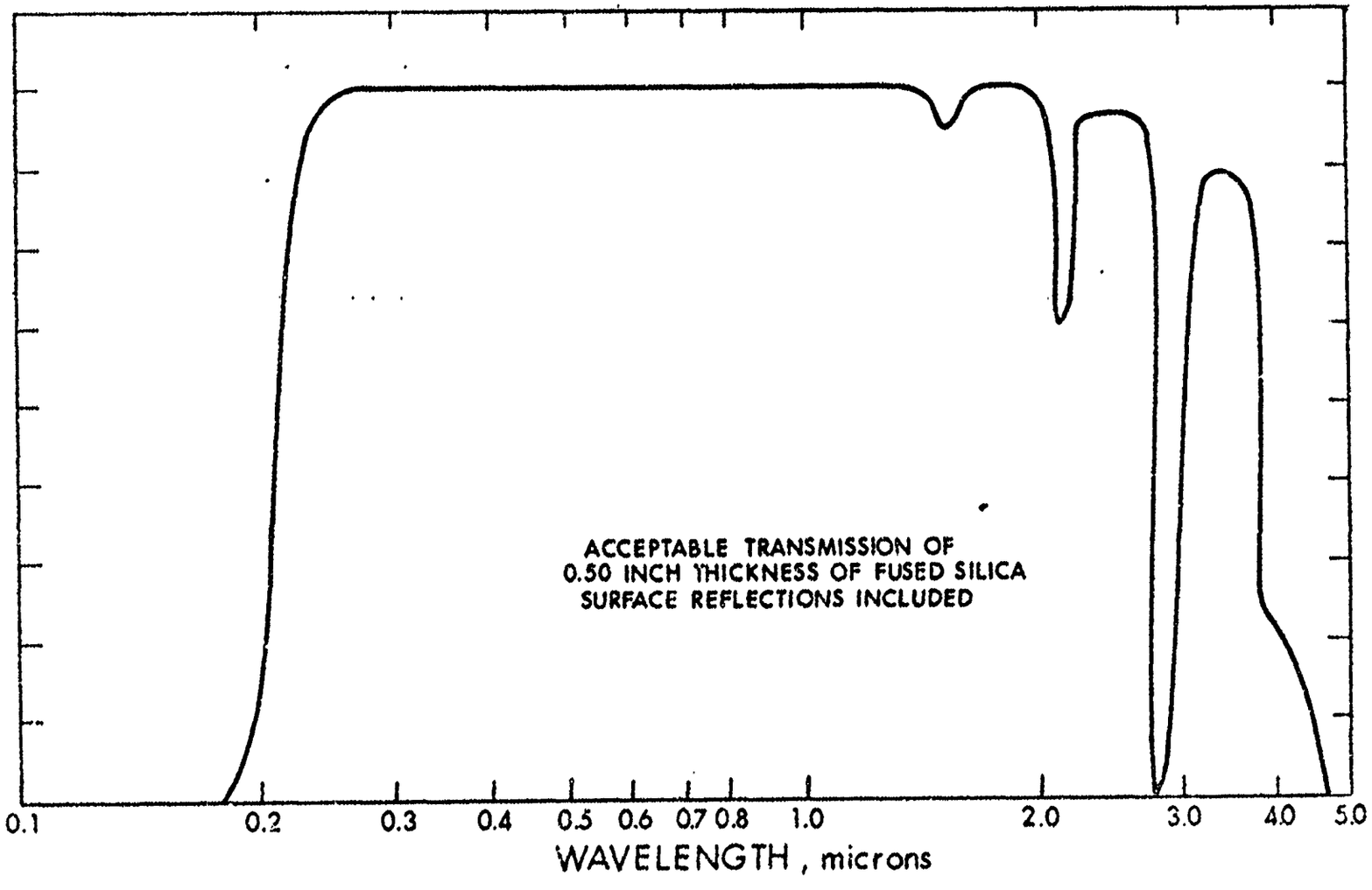
Surface Quality: The surface quality will be inspected for compliance with the scratch and dig code by comparison with a suitable test plate engraved with permissible digs and scratches. This plate to be supplied by vendor.

Surface shape will be inspected by wire feeler gage and optical check plates (where applicable) for specified fit to templates to be supplied by vendor for each specific surface generated.

Each lens will be certified for dimensions as per drawings.

Rev.	Drawing No.
E	30-013
D	31-111
D	31-034
D	31-035

CHART I


ACCEPTABLE TRANSMISSION OF
0.50 INCH THICKNESS OF FUSED SILICA
SURFACE REFLECTIONS INCLUDED
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
1.0
2.0
3.0
4.0
5.0
WAVELENGTH , microns

RETICLE SPECIFICATION

Grid patterns to be applied by marking into the surface of each lens as follows:

Dwg. 30-018	Collector Lens:	Mark Aspheric Surface
Dwg. 31-111	Field Lens:	Mark Plan Surface
Dwg. 31-034	Collimator I:	Mark Convex Surface
Dwg. 31-035	Collimator II:	Mark 65.622 Radius Surface

All line widths will be .002 +.003 - .000.

Optical centering of pattern .0025".

Length of Lines = .200 - .250"

Grid to consist of two (2) lines in a cross pattern.

$90^{\circ} \pm$ 15 min. perpendicularity.

2.3.0 Collector Alignment and Assembly (Drawing 614575)

The following procedure outlines the method by which the collector assembly of the NASA Solar Simulator System will be aligned and assembled at EOS before shipment to Houston.

Equipment Required:

1. Laser and collimating lens.
2. Projection screen.
3. Laser stand 614588.
4. Stand, burner simulator 614592.
5. Fixture, burner simulator 614593.
6. Target screen 5-000.
7. Post, Alignment, Burner Simulator 614594.
8. Handling Carts.
9. Optical Flat 614681.
10. Handling Hoist.
11. Point Source Rod 614682.
12. Reticle Plates 614597 - 614683.
13. Vane Assembly Locator Rod 614683.
14. Light Source and Power Supply.
15. Fixture, Reticle Alignment, Collector 614694.
16. Throat Simulator 614599.
17. Adapter, Burner Simulator 614695.
18. Assembly and transport stand 614585.
19. Vane alignment fixture 614684.

Test Set-Up

The equipment listed above will be installed at the EOS - 125 Vinedo facility in a manner similiar to the attached sketch. In addition the laser stand No. 614588 will have provision for rotation of the laser so it may be used on two (2) assembly and alignment ranges. The locations of the components critical to the alignment are shown on the sketch.

Inspection - Accountability and Orientation - This inspection will verify that the assembly operations have been performed according to the preceding process step, and show good workmanship.

2.3.1 Issue Kit No. 1 - Collector Frame Subassembly.

2.3.2 Accountability only. (Stores and Requestor).

2.3.3 Place frame, Item 1 (30-001), on assembly stand with side without gussets turned up, and burner end, with the 9½ diameter hole, facing to the right.

2.3.4 Install three (3) flanges, Item 4 (30-006), with flat face out, on burner end with nine (9) each screws and lockwashers, Items 14 and 15.

Tighten screws.

2.3.5 Install three (3) flanges, Item 47 (30-050), with flat face out, on throat end with nine (9) each screws, lockwashers and flatwashers, Item 17, Item 13 and 15. Leave screws loose, i. e. ½ to one (1) turn short of snug.

2.3.6 Install point, Item 21 (30-028), nut, Item 23 and ring, Item 48, in flange at approximately 9 o'clock position facing throat-end. Leave nut loose.

2.3.7 Install in the two (2) remaining flanges two (2) points, Item 22 (30-027), with nuts, Item 23. Leave nuts loose.

2.3.8 Install two (2) lower support tubes, Item 57 (30-059), and two (2) threaded plugs, Item 58 (30-058, using four (4) each screws and lockwashers, Items 55 and 56. Tighten screws holding plugs. Adjust tubes for close fit between end plates; do not deflect plates. Tighten screws in tubes.

2.3.9 On the inside of the throat end install four (4) spacers, Item 3 (30-005), using four (4) each screws and lockwashers, Items 15 and 16. Tighten screws.

2.3.10 Install fittings, Items 36 and 42 on cooling panel, Item 2. Apply varnish, Item 73 to pipe threads. Orient fittings per print.

2.3.11 Install one (1) cooling panel, using two (2) screws, Item 13, two (2) screws, Item 14, and four (4) lockwashers, Item 15. Mount at positions approximately 2 & 5 o'clock facing burner end. Tighten screws.

2.3.12 Q. C. Inspection and Accountability and Orientation only, per II #7056-0.

2.3.13 Issue Kit No. 2 - Mirror No. 2 Subassembly.

2.3.14 Accountability only between stores and lab.

2.3.15 Place mirror, Item 20 (614577), on assembly fixture #614751. Do not touch mirror face.

2.3.16 Install three (3) jam nuts, Item 53 on three (3) studs, Item 59 (614337-1) opposite slotted end..

2.3.17 Install three (3) alignment nuts, Item 64 (614332-7). Position end of each nut 5/8 inch from mirror back with hex toward slotted end of stud.

2.3.18 Install studs Item 59, jam nuts, Item 53 and alignment nuts, Item 64 at 3, 7 and 11 o'clock with water port at 12 o'clock. Turn stud until snug in bottom thread. Tighten jam nut.

2.3.19 Install three (3) flange nuts, Item 62 (614334-3), one (1) on each alignment nut and position flange 1¼ inches from mirror back.

2.3.20 Install reticle plate in mirror (614597-2, 614598-2).

2.3.25 Accountability and Orientation by assembler.

2.3.26 Move mirror No. 2 and nine (9) each screws and washers, Item 13 and 15, to frame subassembly area.

2.3.27 Issue Kit No. 3 - Mirror Mo. 1 Subassembly.

2.3.28 Accountability only, by lab personnel.

2.3.29 Place mirror, Item 19 (614331), on assembly fixture #614751. Do not touch mirror face.

2.3.20 Install three (3) nuts, Item 54, one (1) on each stud, opposite slotted end.

2.3.31 Install three (3) alignment nuts, Item 63 (614332-3). Position end of each nut 3/4 inch from mirror back with hex toward slotted end of stud.

2.3.32 Install alignment studs, Item 60 (614333-1). Bottom stud in casting and tighten jam nut, Item 54.

2.3.33 Install three (3) flange nuts, Item 61 (614334-1), one (1) on each alignment nut. Position flange 13/16 inch from mirror back.

2.3.34 Install a 7/8" piece of copper tubing, Item 12 on nipple Item 78, use solder Item 74.

2.3.35 Install a Union Swagelok elbow, Item 41, on 7/8" long copper tubing and tighten ½ turn only.

2.3.36 Place an O-ring gasket, Item 66, at the base of the straight threads of the nipple, Item 78.

2.3.37 Fit an eight (8) inch length of hose, Item 32, with the assembly of step 2.3.36 on one (1) end and a Swagelok union elbow on the other, Item 41. Do not tighten fittings on hose. Prepare a long hose assembly per operations 2.3.38 and 2.3.39.

NOTE: Paragraphs 2.3.21, 2.3.22, 2.3.23 and 2.3.24 deleted.

2.3.38 Assemble an O-Ring, Item 66, a nipple, Item 77 and a Swagelok elbow, Item 41.

2.3.29 Fit a 26 inch length of hose, Item 32, with the assembly of operation 2.3.38 on one (1) end, on other end assemble male elbow, Item 69. Do not tighten hose fittings.

2.3.40 Connect hose assemblies to mirror. Orient elbows by rotating on copper tubing. Do not tighten straight threads in mirror ports.

2.3.41 Install reticle plate in mirror (614597-1) (614598-1)

2.3.42 Accountability and Orientation check by assembler.

2.3.43 Move mirror No. 1, two (2) hose assemblies, and nine (9) each screws and lockwashers, Item 13 and 15 to frame subassembly. area.

2.3.44 Issue Kit No. 4 - Vane Subassembly.

2.3.45 Accountability only, by lab personnel.

2.3.46 Place vanes on bench elbows up, in this order: Item 5 (30-032), Item 6 (30-033) and Item 7 (30-034).

2.3.47 Assemble mounting plates on vanes, two (2) Item 24 (30-035) and one (1) Item 25 (30-036), using six (6) each screws, washers and lockwashers, Item 14, 15 and 17. Leave screws loose.

2.3.48 Assemble two (2) each stand-off, Item 26 (30-037) and three (3) each spacer, Item 27 (30-038) per stand-off on each mounting plate using two (2) each lockwashers and screws, Item 15 and 16. Leave screws loose.

2.3.49 Install metal hose assemblies, four (4) Item 8, using varnish Item 73 on NPT threads.

2.3.50 On the upper hose having a free end, assemble two (2) each, elbows, Item 37, one (1) nipple, Item 51, and one (1) hose coupling, Item 31. Use varnish, Item 73 on NPT threads.

2.3.51 On the lower hose free end, assemble one (1) elbow, Item 50. Use varnish, Item 73.

2.3.52 Accountability and Orientation by assembler.

2.3.53 Move vane subassembly and fixture with six (6) each screws and lockwashers, Items 15 and 16, one (1) support tube, Item 57 (30-059), one (1) threaded plug, Item 58 (30-058) and two (2) each screws and lockwashers, Items 55 and 56 to frame subassembly area.

2.3.54 Issue Kit No. 5 - Lens Subassembly.

2.3.55 Accountability, lab personnel.

2.3.56 Install three (3) retaining blocks, Item 44 (30-049), on the flat side of alignment flange, Item 29 (30-024). Use six (6) each screws and lockwashers, Items 45 and 46. Position blocks to cover the 3/8 diameter holes in the flange. Tighten the screws.

2.3.57 Install three (3) retaining blocks, Item 43 (30-048), on the same side of the flange, Item 29, using six (6) each screws and lockwashers, Items 45 and 46. Position the blocks with their 3/8 diameter hole toward the center of the flange. Tighten the screws.

2.3.58 Join the assembly to the alignment ring, Item 28 (30-025). Nest the pilot diameter of the flange into the ring. Orient the parts to align the 3/8 diameter holes in both. Use three (3) shoulder screws, Item 34. Screw in each screw three (3) turns.

2.3.59 Assemble the lens structure, Item 35 (30-043), without lens, with the above assembly. Mate the 1/8 radius edge of the structure ring with the bevel on the alignment flange. Join with three (3) each screws and lockwashers, Items 14 and 15. Do not tighten screws.

2.3.60 Screw three (3) set screws, Item 76, one (1) each into three (3) clamps, Item 30 (30-019). Screw head to be away from notched side.

2.3.61 Install Lens, 30-018, with safety wire, Item 77.

2.3.62 Accountability and Orientation by lab personnel.

2.3.63 Move lens subassembly to collector alignment fixture. Include the three (3) clamps, Item 30, six (6) each screws and lockwashers, Items 15 and 16 and three (3) springs, Item 33(30-042).

2.3.64 On frame subassembly install No. 2 mirror with screws and lockwashers provided, nine (9) each, items 13 and 15 from Kit 2. Leave screws loose.

2.3.65 Install hoses to mirror. Use varnish, Item 73 on NPT threads. Orient hose elbows by tightening tapered pipe threads with double wrenches. Do not tighten straight threads in mirror ports, just snug.

2.3.66 Connect lower hose to cooling panel coupling.

2.3.67 Accountability and orientation lab personnel.

2.3.68 Install No. 1 mirror with the nine (9) each screws, items 13 and 15 from Kit 3. Leave screws loose. Do not tighten straight thread hose connectors in mirror ports.

2.3.69 Accountability and orientation lab personnel

2.3.70 Install vane subassembly using screws and lockwashers provided six (6) each, item 15 and 16 from Kit 5. Tighten these six (6) screws only.

2.3.73 Connect upper hose assemblies of mirror and vane using fittings provided on vane hose assembly.

2.3.74 Install 3rd support tube and threaded plug with screws and lockwashers provided. Items 57, 58, 55 and 56 from Kit 4.

2.3.75 Accountability and orientation by lab personnel.

2.3.76 Move partially assembled collector with its assembly and transport stand to the alignment area.

2.3.77 Remove collector from transport stand.

2.3.78 Return stand to collector frame subassembly area.

2.3.79 Mount pre-assembled collector assembly on Burner Simulator Stand No. 614592.

2.3.80 Check to see that the laser beam is autocollimated from the alignment rod autocollimating mirror fixture No. 614681. Remove autocollimating rod #614681. Install x, y reticles on the front of collector assembly and center the assembly on laser beam with alignment stand locating nuts. Set the z axis dimension of 19.546" ±.020 from face of collector box to face of alignment stand center hub.

N : Paragraphs 2.3.71 and 2.3.72 deleted.

- Install reticle plate in mirror No. 2 (614597-2)(614598-2)
- Install reticle plates in mirror No. 1(614597-1)(614598-1)

2.3.81 Center No. 1 mirror reticle on laser beam by adjusting the nut flange mounts, Item 61 (614575) and torque the nine (9) cap screws, Item 13 (614575) to 75 inch pounds.

2.3.82 Center No. 2 mirror reticle on laser beam by adjusting the nut flange mounts, Item 62 (614575) and torque all nine (9) cap screws, Item 16 (614575) to 75 inch pounds. Remove reticle plates, adjust the mirror, tilt alignment nuts, Item 64 (614575) to locate z axis position of 0.377" $\pm$.005" plus alignment stand jaw simulator ref. dimension 4.460", to No. 2 mirror surface I.D.

2.3.83 Install the point source rod fixture No. 614682. Adjust the rod projection from the simulated jaw to be 0.794 $\pm$ .005" to the B & L lamp filament.

2.3.84 Adjust the tilt of the No. 1 mirror to symmetrically illuminate the I.D. of the No. 2 mirror using three (3) alignment nuts, Item 63, then by identical rotation of all three (3) alignment nuts position the No. 1 mirror axially as required to focus the mirror's projected image on the projection screen (projection screen is located 46.128 $\pm$ .100" from the simulated jaw of alignment stand No. 614592).

2.3.85 Center the focused image on the laser beam at the projection screen by adjusting the alignment nuts, Item 64 on the No. 2 mirror.

2.3.87 Remove point source rod No. 614682 and install vane assembly alignment No. 614684 on alignment rod and slide on the rod to almost touch the No. mirror.

NOTE: Paragraph 2.3.86 deleted





2.3.88 Slide vane subassemblies, Items No. 5, 6 and 7 of Drawing 614575 into contact with vane alignment fixture and then tighten twelve (12) each cap screws, Items 14 and 16.

2.3.89 Remove vane assembly alignment fixture No. 614684 and vane alignment rod No. 614683, then install point source rod No. 614682.

2.3.91 Install two (2) lower clamps, Item 30 using four (4) screws and lockwashers, Items 15 and 16. Install three (3) springs, Item 33 in 3/8 diameter holes of alignment ring, Item 28 and alignment plate, Item 29. Install lens assembly using the remaining clamps and screws and lockwashers. With screws loose, rotate so that one (1) vane is verticle below the horizontal centerline on the front of the collector assembly. Snug the three (3) mounting clamps, Item 30.

2.3.92 Center the lens reticle in the laser beam, using set screws, Item 76 in each of three (3) assembly mounting clamps, Item 30. Then torque mounting clip retainer screws, Item 16 to 75 inch pounds.

2.3.93 Adjust the tilt of the collector lens until the projected laser image from the front surface is autocollimated back on a target screen and centered. This adjustment is made using the three (3) adjusting screws, Item 16 in retainer block, Item 43 (614575.

2.3.94 Set the dimension between the vertex of the collector lens and the simulated jaw reference to be 8.141 $\pm$ .005" using adjustment screws, Item 34 in retainer blocks No. 44. Move all three (3) screws equally and check autocollimation of the lens, adjust as required.

2.3.95 Install Throat Simulator Fixture No. 614599 on front of collector assembly. Move fixture up or down until the reticle of the fixture optical flat is centered on the laser and the level on the fixture indicates level within one line, then torque all collector flange screws, Item 14 to 75 inch pounds.

2.3.96 Adjust the projection of the point alignment pins, Item 21 and Item 22 until the spacing between the vertex of the collector lens and the fixture center rod is 5.442" $\pm$ .005.

NOTE: 2.3.90 deleted

Check to see that the laser beam is still centered on the optical flat reticle of the fixture and then adjust the alignment points until autocollimation is obtained on the target screen. Recheck the dimension of 5.442" ± .005.

2.3.97 Remove the throat simulator fixture No. 614599 from the collector assembly.

2.3.98 Operate the point source light and observe the flash on the target screen. When the collector assembly is properly aligned, all of the light flash from the system will be located symmetrically about the marked zones on the target screen 12' from the face of the collector assembly. If the flash from the reflective and refractive portions are not symmetrical, adjust the tilt of the lens to obtain symmetry. Repeat Paragraphs 2.3.92 and 2.3.94. Document the alignment with two (2) each 4 x 5 polaroid photos of the aligned projected image on the target (5-000). Record on the photos the exposure time, f number, date and assembly serial number. Locate camera lens, laser beam high, and center the lens 8" left of the laser, at the focal point of the collector box.

NOTE: Due to lens tolerances, autocollimation from the reticle may not produce optimum alignment.

2.3.99 Issue Kit No. 6

2.3.100 Accountability by stores and lab personnel.

2.3.101 Measure and record length between frame ends adjacent to upper support tube. Remove support tube.

2.3.102 Install upper cooling panel, Item 2 (30-002), using two (2) screws, Item 16, eight (8) screws, Item 14, and ten (10) lockwashers, Item 15, six (6) nuts, Item 18, twelve (12) washers, Item 17. Tighten screws.

2.3.103 Install elbow, Item 69 on throat side of upper cooling panel. Use varnish, Item 73. Connect hose assembly from No. 1 mirror to Item 69.

2.3.104 Install elbow, Item 10 on burner side of upper cooling panel. Use varnish, Item 73. Orient elbow pointing up and install two (2) inch length of 5/8 O. D. copper tube, Item 12, tee, Item 38, and a two (2) inch and four (4) inch length of tube.

Use solder, Item 74 and orient per print. Install burner connector nut, Item 70 and front and rear ferrules, Items 71 and 72.

2.3.105 Pre-assemble two (2) each two (2) inch, one (1) each 43 inch. One (1) each 9½ inch 5/8 O. D. copper tube, Item 12, three (3) elbows, Items 11 with solder, Item 74 per print. Install between male connector, Item 42 on the throat side of the lower shroud and the tubing on the upper shroud. Use union, Item 39 to connect the tubes.

2.3.106 Install on the street elbow Item 36, one (1) nipple Item 9, one (1) elbow Item 37, and one (1) coupling Item 31. Use varnish Item 73 and orient to print.

2.3.107 Place an O-Ring gasket, Item 66, at the base of the straight threads of a nipple Item 79.

2.3.108 Install a 1 5/8" piece of copper tubing Item 12, on the nipple, Item 79. Use solder Item 74.

2.3.109 Install a union Swagelok elbow, Item 41, on the 1 5/8" long copper tubing and tighten ½ turn only.

2.3.110 Install the assembly (Reference 2.3.107 - 2.3.109) in the lower port of the No. 2 mirror, Item 20. Retain the AN fitting, Item 79, while tightening the assembly to the correct position.

2.3.111 Install a 15 inch length of hose, Item 32, in the Swagelok elbow, Item 41.

2.3.112 Repeat steps 2.3.107 - 2.3.109.

2.3.113 Install the assembly (Reference 2.3.107 - 2.3.109) in the upper port of the No. 2 mirror, Item 20. Retain the AN fitting, Item 79, while tightening the assembly to the correct position.

2.3.114 Install a 12 inch length of hose, Item 32 in the Swagelok elbow, Item 41 (upper free end vane assembly piping).

2.3.115 Install a two (2) inch length of 5/8 O.D. copper tube Item 12 in the elbow, Item 50 (lower free end vane assembly piping). Use solder Item 74.

2.3.116 Install a tee, Item 38, and a seven (7) inch length of tube Item 12, orient per print, use solder Item 74. On the free end of Item 12 install a burner collector nut Item 70, and a front and rear ferrule Items 71 and 72.

2.3.117 Install and orient to print a 20½ inch, a 19 3/4 inch and a 15 inch length of tube Item 12, using two (2) elbows, Item 11. Use solder Item 74. Connect tube to union elbow Item 41 and tighten fittings.

2.3.118 Install clamp Item 49 per print, using vane stand-off screw.

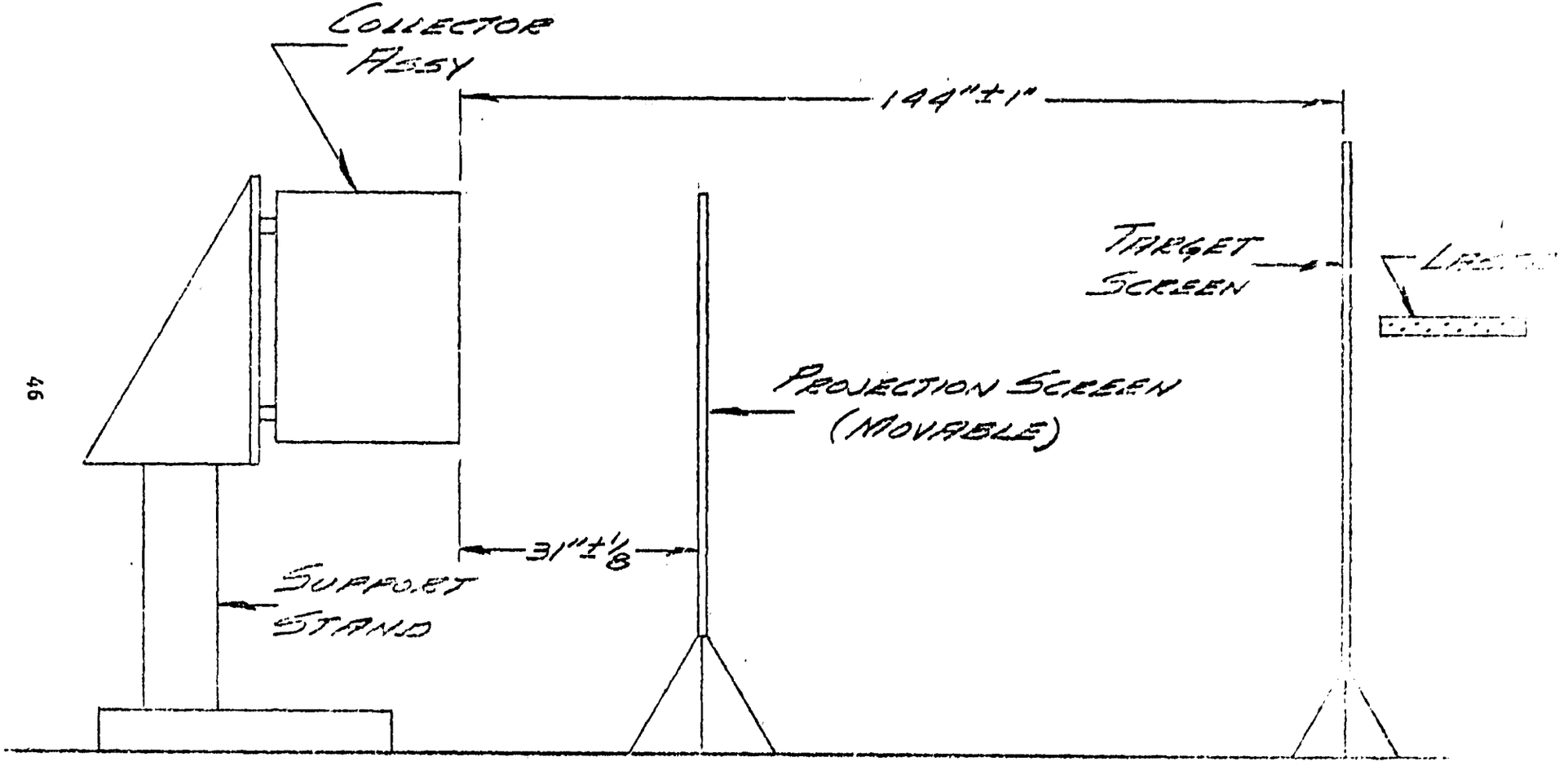
2.3.119 Reinstall upper support tube removed in step 2.3.101. Adjust spacing to dimension previously measured.

2.3.120 Inspection - Final Assembly.

2.3.121 Place assembly on transport cart.

2.3.122 Move to hydro-test.

2.3.123 Install inlet and outlet water lines from test bench to Collector Assembly. With downstream valve open, initiate flow through the system and regulate the upstream pressure to provide a flow rate of 1½ gpm. Record pressure drop across system. Close downstream valve and turn off flow. Pump hydrostatic pressure to 120 psig. Hold 120 psig pressure for five (5) minutes and visually check lines and joints for leakage. Release pressure by opening downstream valve and blow out the system using air purge.



COLLECTOR TEST SET UP
(NOT TO SCALE)

SPLIT ORDER RECORD			
DATE	NO.	QTY	BAL.

ENG. CHANGES		DATE
LET.	E.C.I.	

ELECTRO-OPTICAL SYSTEMS, INC.
A Subsidiary of Xerox Corporation

MANUFACTURING ORDER

M.O. NO. 1000
W.A. NO. 7056-05-31
P.W.O. NO.
QTY | S.N.
NEXT ASSY | QTY

PART NAME Collector Assembly PART NO. 614575
DATE 1-10-67 PAGE 1 OF 2 | EDITION NO. 4 | UNIT Collector
PLANNER R. Tellkamp | EXT. 241 | REQUESTOR W. McCrary

SCHEDULE DATES		INSPECTION
ISSUE		COMPLETION STAMP
IN WORK		
DUE		

WORK CENTER NO.	OPER. NO.	TOOL NO.	OPERATION DESCRIPTION	EST. HRS	COMP.	ACCEPT.
	10		Assemble frame subassembly with hard points, stand offs, two (2) support tubes, (1) cooling panel. (Ref. Procedure #2.3.1 - 2.3.11)			
	15		Quality Control Inspection (Ref. Procedure #2.3.12) Inspect Per II #7056-0			Q. C.
	16		Government Inspection			
	20		Assembly Mirror #2 subassembly with alignment mounts (Ref. Procedure #2.3.13 - 2.3.26).			
	30		Assembly Mirror #1 subassembly with alignment mounts and hoses. (Ref. Procedure #2.3.27 - 2.3.43).			
	40		Assembly Vane Subassembly (Ref. Procedure #2.3.44 to 2.3.53).			
	50		Install Mirrors #1 and #2, Vane assembly and 3rd support tube. (Ref. Procedure #2.3.64 - 2.3.79)			
	60		Align #1 and #2 Mirrors, and Vane Assembly (Ref. Procedure 2.3.80 - 2.3.89)			
	65		Quality Control to inspect alignment of #1 and #2 Mirrors, Vane assembly Inspect Per II #7056-1. Witness operations 2.3.80 through 2.3.89.			Q. C.
	66		Government Inspection			
	70		Assembly Lens Subassembly (Ref. Procedure #2.3.54 to 2.3.63).			
	80		Install and align Lens Subassembly and complete collector alignment (Ref. Procedure #2.3.91 - 2.3.98)			
	90		Record length between frame ends (Ref. Procedure 2.3.101)			
	95		Quality Control to witness point source test and Operation 90 (Ref. Procedure #2.3.92 through 2.3.98 II #7056-1A.			Q. C.
	96		Government Inspection			

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APPROVAL
MFG. W. McCrary | Q.A. R. L. Sibbald | RECEIVED BY | DATE | TOTAL HOURS

SPLIT ORDER RECORD			
DATE	NO.	QTY	BAL.

ENG. CHANGES		DATE
LET.	E.C.I.	

ELECTRO-OPTICAL SYSTEMS, INC.
A Subsidiary of Xerox Corporation

MANUFACTURING ORDER

M.O. NO. 1000
W.A. NO. 7056-05-31
P.W.O. NO.
QTY | S.N.
NEXT ASSY | QTY

PART NAME Collector Assembly PART NO. 614575
DATE 1-10-67 PAGE 2 OF 2 EDITION NO. 4 UNIT Collector
PLANNER R. Tellkamp EXT. 241 REQUESTOR W. McCrary

SCHEDULE DATES	INSPECTION
ISSUE	COMPLETION STAMP
IN WORK	
DUE	

WORK CENTER NO.	OPER. NO.	TOOL NO.	OPERATION DESCRIPTION	EST. HRS	COMP.	ACCEPT.
	100		Assembly 2nd cooling panel and remainder of plumbing (Ref. Procedure #2.3.99 to 2.3.119).			
	105		Quality Control to inspect collector module (Ref. Procedure #2.3.120) Inspect Per II #7056-2.			Q. C.
	106		Government Inspection			
	110		Perform hydro test (Ref. Procedure #2.3.123) Record Pressure Drop			
	115		Quality Control to witness and inspect hydro tests Per II #7056-2A.			Q. C.
	116		Government Inspection			
	120		Quality Control to perform final inspection on collector module and package all photos and paperwork pertaining to this assembly. Inspect per II #7056-3.			Q. C.
	126		Government Inspection			
	130		Collector module to be packaged in the shipping container and prepared for shipment.			
	135		Quality Control to inspect packaging. Inspect Per II #7056-4.			
	136		Government Inspection			
	140 & 145		Shipping department and Quality Control to finalize all paperwork for shipment and ship unit to destination. Inspect Per II #7056-5.			Q. C.
	146		Government Inspection			

APPROVAL
MFG. W.M. McCrary | Q.A. [signature] | RECEIVED BY | DATE | TOTAL HOURS

ELECTRO-OPTICAL SYSTEMS, INC.
A Subsidiary of Xerox Corporation

KIT LIST

KIT NO 1

ASSEMBLY PART NO. 614575 REV. A PLANNER W. Leverton S/N EDITION NO. 1 DATE 8-17-66

DESCRIPTION Frame Subassembly SYSTEM Optical Train UNIT Collector Module W.A. CHARGE 7056-05-31

ISSUED BY ISSUED TO DATE W.A. CREDIT 7056-96-00

ITEM NO.	S N	PART NO.	DESCRIPTION	REF. DESIG	QTY. REQ'D.	1ST ACCUM ISSUED	1ST ACCUM B O	1ST ACCUM B.O. No.	UNIT PRICE	EXTENSION
1		30-001	Frame Collector	Item 1	1					
2	N/A	30-006	Flange Collector Burn	4	3					
3	N/A		Screw HCP 1/4-28 UNF x .50 Lg.	14	11					
4	N/A		Washer, Lock, Spring 1/4" I.D.	15	26					
5	N/A	30-050	Flange Collector to Throat	47	3					
6	N/A		Screw, HCP 1/4 - 28 UNF x .62 Lg.	13	11					
7	N/A	30-028	Point Alignment	21	1					
8	N/A		Nut Mach. Hex 7/16 NC	23	3					
9	N/A	5100-50H	Ring Retainer	48	1					
10	N/A	30-027	Point Alignment	22	2					
11	N/A	30-059	Tube, Support	57	2					
12	N/A	30-058	Plug - Threaded	58	2					
13	N/A		Screw HCP 3/8-16 UNC x .50 Lg.	55	4					
14	N/A		Washer Lock Spring 3/8"	56	4					
15	N/A	30-005	Spacer Cooling Panel	3	4					
16	N/A		Screw HCS 1/4-28 UNF x .75 Lg.	16	4					
17		30-002	Panel Cooling Lower	2	1					
18	N/A		Elbow, Street 90° 3/8 NPT	36	1					
19	N/A	1010-1-6	Connector, Male 5/7"	42	1					
20	N/A		Washer, Flat 1/4 Stn Stl	17	9					

DATE REQUIRED DELIVER TO

FORM NO. CC: Requestor Accounting Material Control Program Office

ELECTRO-OPTICAL SYSTEMS, INC.
A Subsidiary of Xerox Corporation

KIT LIST

KIT NO 1

ASSEMBLY PART NO. 614575 REV. A, PLANNER R. Tellkamp S/N EDITION NO. 1 DATE 10-3-66

DESCRIPTION Frame Subassembly SYSTEM Optical Train UNIT Collector W.A. CHARGE 7056-05-31

ISSUED BY ISSUED TO DATE W.A. CREDIT 7056-96-00

ITEM NO.	S/N	PART NO.	DESCRIPTION	REF. DESIG	QTY. REQ'D.	1ST ACCUM ISSUED	1ST ACCUM B.O	1ST ACCUM B.O. No.	UNIT PRICE	EXTENSION
21			Nipple, 3/8" Close Run Brass	Item 9	1					
22			Elbow, 90° 3/8 NPT Brass	37	1					
23			Coupling, Nylo-seal "F" 5/8" Tube	31	1					

DATE REQUIRED DELIVER TO

CC: Requestor Accounting Material Control Program Office

ELECTRO-OPTICAL SYSTEMS, INC.
A Subsidiary of Xerox Corporation

KIT LIST

KIT NO 2

ASSEMBLY PART NO. 614575 REV. A PLANNER R. Tellkamp S/N EDITION NO. 1 DATE 10-3-66

DESCRIPTION Final Assembly SYSTEM Optical Train UNIT Collector W.A. CHARGE 7056-05-31

ISSUED BY ISSUED TO DATE W.A. CREDIT 7056-96-00

ITEM NO.	S N	PART NO.	DESCRIPTION	REF. DESIG	QTY. REQ'D.	1ST ACCUM ISSUED	1ST ACCUM B O	1ST ACCUM B.O. No.	UNIT PRICE	EXTEN-SION
1		614577	Secondary Mirror Collector No. 2	Item 20	1					
2		614337-1	Stud, Alignment	59	3					
3			Nut, Mach. Semi-fin Hex Jam 1/4-28 UNF Stn Stl	53	3					
4		614332-7	Nut, Alignment	64	3					
5		614334-3	Nut, Flange	62	3					
6			Screw, Cap Hex Soc. 1/4-28 UNF x .62 Lg. Stn Stl	13	9					
7			Washer, Lock Spring, 1/4 Stn Stl	15	9					
8		M.O.1006	Plumbing Upper & Lower Port #2 Mirror	Sub	2					
	51									

DATE REQUIRED DELIVER TO

CC: Requestor Accounting Material Control Program Office

ELECTRO-OPTICAL SYSTEMS, INC.
A Subsidiary of Xerox Corporation

KIT LIST

KIT NO 3 PAGE 1 OF 1

ASSEMBLY PART NO. 614575 REV. A PLANNER R. Tellkamp S/N EDITION NO. 1 DATE 10-3-66
DESCRIPTION No. 1 Mirror Subassembly SYSTEM Optical Train UNIT Collector W.A. CHARGE 7056-05-31
ISSUED BY ISSUED TO DATE W.A. CREDIT 7056-96-00

ITEM NO.	S N	PART NO.	DESCRIPTION	REF. DESIG	QTY. REQ'D.	1ST ACCUM ISSUED	1ST ACCUM B O	1ST ACCUM B.O. No.	UNIT PRICE	EXTENSION
1		614331	Primary Mirror Collector No. 1	Item 19	1					
2		614333-1	Stud, Alignment	60	3					
3			Nut Mach. Semi-fin Hex Jam, 3/4-16 UNF	54	3					
4		614332-3	Nut, Alignment	63	3					
5		614334-1	Nut, Flange	61	3					
6			Screw, Cap. Hex Soc. 1/4-28 UNF x .62 Lg. Stn Stl	13	9					
7			Washer, Lock Spring 1/4 Stn Stl	15	9					
8		M.O.1004	Plumbing, Lower Port #1 Mirror	Sub	1					
9		M.O.1005	Plumbing, Upper Port #1 Mirror	Sub	1					

DATE REQUIRED DELIVER TO

CC: Requestor Accounting Material Control Program Office

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ELECTRO-OPTICAL SYSTEMS, INC.
A Subsidiary of Xerox Corporation

KIT LIST

KIT NO 4

ASSEMBLY PART NO. 614575 REV. A PLANNER R. Tellkamp S/N EDITION NO. 1 DATE 8-19-66

DESCRIPTION Vane Subassembly SYSTEM Optical Train UNIT Collector W.A. CHARGE 7056-05-31

ISSUED BY ISSUED TO DATE W.A. CREDIT 7056-96-00

ITEM NO.	S N	PART NO.	DESCRIPTION	REF. DESIG	QTY. REQ'D.	1ST ACCUM ISSUED	1ST ACCUM B O	1ST ACCUM B.O. No.	UNIT PRICE	EXTENSION
1		30-032	Vane Subassembly	Item 5	1					
2		30-033	Vane Subassembly	6	1					
3		30-034	Vane Subassembly	7	1					
4		30-035	Plate Mounting	24	2					
5		30-036	Plate Mounting	25	1					
6			Screw, Cap Hex Soc. 1/4-28 UNF x .50 Lg. Stn Stl	14	6					
7			Washer, Lock Spring 1/4 Stn Stl	15	18					
8			Washer, Flat 1/4 Stn Stl	17	6					
9	53	30-037	Stand-off	26	6					
10		30-038	Spacer	27	18					
11			Screw, Cap Hex Soc. 1/4-28 UNF x .75 Lg. Stn Stl	16	12					
12			Flexible Metal Hose Assy. (McMaster Carr Supply, Type 4FPT Union	8	4					
			IMPT Coupling, 3/8 Hose I.D. 3/8 PT 12" Lg.							
13			Varnish	73	A/R					
14			Coupling, Nylo-seal "F" 5/8 (1/2 I.D. Tubing) Male Pipe (NPTF)	31	1					
			(Imperial Eastman PN FP08-06-MB)							
15			Elbow 90° 3/8 NPT Bronze	37	2					
16			Nipple, 3/8 x 2.00 Lg. Brass	51	1					
17			(Streamline PN A-1520) Elbow, 1/2 Nom. x 3/8 FPT Wrought	50	1					
18		30-059	Tube, Support	57	1					

DATE REQUIRED DELIVER TO

CC: Requestor Accounting Material Control Program Office

ELECTRO-OPTICAL SYSTEMS, INC.
A Subsidiary of Xerox Corporation

KIT LIST

KIT NO 4

SEMBLY PART NO. 614575 REV. A PLANNER R. Tellkamp S/N EDITION NO. 1 DATE 10-3-66
SCRIPTION Vane Subassembly SYSTEM Optical Train UNIT Collector W.A. CHARGE 7056-05-31
SUED BY ISSUED TO DATE W.A. CREDIT 7056-96-00

EM NO:	S N	PART NO.	DESCRIPTION	REF. DESIG	QTY. REQ'D.	1ST ACCUM ISSUED	1ST ACCUM B.O	1ST ACCUM B.O. No.	UNIT PRICE	EXTEN-SION
9		30-058	Plug, Threaded	Item 58	1					
0			Screw, Cap. Soc. Hd. 3/8-16 UNC x 1/2 Lg. Stn Stl	55	2					
1			Washer, Lock Spring 3/8 Stn Stl	56	2					
2		MO 1003	Plumbing, #1 Mirror to Burner	Sub	1					
3		30-055	Clamp, Pipe	49	1					

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DELIVER TO

CC: Requestor Accounting Material Control Program Office

ELECTRO-OPTICAL SYSTEMS, INC.
A Subsidiary of Xerox Corporation

KIT LIST

KIT NO 5

ASSEMBLY PART NO. 614575 REV. A PLANNER R. Tellkamp S/N EDITION NO. 1 DATE 10-3-66

DESCRIPTION Lens Subassembly SYSTEM Optical Train UNIT Collector W.A. CHARGE 7056-05-31

ISSUED BY ISSUED TO DATE W.A. CREDIT 7056-96-00

ITEM NO.	S N	PART NO.	DESCRIPTION	REF. DESIG	QTY. REQ'D.	1ST ACCUM ISSUED	1ST ACCUM B O	1ST ACCUM B.O. No.	UNIT PRICE	EXTENSION
				Item						
1		30-049	Block, Retaining	44	3					
2		30-024	Flange, Alignment	29	1					
3			Screw, Cap. Soc. Hd. 8-32 UNC x 1/2 Lg. Stn Stl	45	12					
4			Washer, Lock Spring #8 Stn Stl	46	12					
5		30-048	Block, Retaining	43	3					
6		30-025	Ring, Alignment	28	1					
7			Screw, Shoulder .25 dia x .313 Lg. 10-32 UNF x 1/4 Lg. Stn Stl	34	3					
8		30-043	Lens & Structure Subassembly	35	1					
9	55		Screw, Cap. Hex. Soc. 1/4-28 UNF x .50 Lg. Stn Stl	14	3					
10			Washer, Lock Spring 1/4 Stn Stl	15	9					
11			Set Screw, 8-32 UNC x 5/8 Lg. Stn Stl	76	3					
12		30-019	Clamp	30	3					
13		30-018	Collector Lens	30-043	1					
14			Safety Wire	30-043 10	A/R					
15			Screw, Cap. Hex. Soc. 1/4-28 UNF x .75 Lg. Stn Stl	16	6					
16		30-042	Spring	33	3					

DATE REQUIRED DELIVER TO

CC: Requestor Accounting Material Control Program Office

ELECTRO-OPTICAL SYSTEMS, INC.
A Subsidiary of Xerox Corporation

KIT LIST

KIT NO 6

ASSEMBLY PART NO. 614575 REV. A PLANNER R. Tellkamp S/N EDITION NO. 1 DATE 10-3-66

DESCRIPTION Final Assembly SYSTEM Optical Train UNIT Collector W.A. CHARGE 7056-05-31

ISSUED BY ISSUED TO DATE W.A. CREDIT 7056-96-00

ITEM NO.	S N	PART NO.	DESCRIPTION	REF. DESIG	QTY. REQ'D.	1ST ACCUM ISSUED	1ST ACCUM B O	1ST ACCUM B.O. No.	UNIT PRICE	EXTENSION
1		30-002	Panel, Cooling	Item 2	1					
2			Screw, Cap. Hex. Soc. 1/4-28 UNF x .75 Lg. Stn Stl	16	2					
3			Nut, Mach. Semi-fin Hex 1/4-28 UNF Stn Stl	18	6					
4			Screw, Cap. Hex. Soc. 1/4-28 UNF x 50 Lg. Stn Stl	14	8					
5			Washer, Lock Spring 1/4 Stn Stl	15	10					
6			Washer, Flat 1/4 Stn Stl	17	12					
7		C-409-R	Elbow, 90° x 1/2 x 3/8 to MSPS (Nibco Cat CF-1)	10	1					
8		M.O.1001	Plumbing, Upper Cooling Panel	Sub	1					
9		M.O.1002	Plumbing, LowerCooling Pnl to Burner	Sub	1					
56										

DATE REQUIRED DELIVER TO

CC: Requestor Accounting Material Control Program Office

2.4.0 Collimator Alignment and Assembly (Drawing No.614570)

The following procedure outlines the method in which the collimator assembly of the NASA Solar Simulator System will be assembled and aligned at EOS before shipment to Houston.

Equipment Required:

1. C. W. gas laser and collimator lens.
2. Laser stand 614588.
3. Target 5-000.
4. Lens assembly support stand 614586.
5. Assembly and Alignment Stand, collimator 614591.
6. Handling hoist - Adapters 614587.
7. Camera tripods - Majestic.
8. Light source 614583 and power supply.
9. Locator, Position, 2 axis, #4 mirror 614584.
10. Large inside micrometer set.
11. B & L light source locating fixture 614589.
12. Point Source Rod 614682.
13. Projection screen.
14. Lens Assembly Support & Stand 614697.
15. Torque wrenches.

TEST SET-UP

The equipment listed above will be located at the EOS - 125 Vinelo facility in a manner similiar to the attached sketch. In addition the laser stand (614588) will have provision for rotation of the laser so it may be used on two (2) assembly and alignment ranges. The locations of the components critical to the alignment are shown on the sketch.

Inspection for Accountability and Orientation

This inspection will verify that the assembly operations have been performed according to the preceding process steps, and show good workmanship.

2.4.1 Issue Kit No. 7 - Collimator No. 4 mirror assembly.

2.4.2 Accountability, stores and requestor.

2.4.3 Mount collimator support, Item 8 (614335) on assembly stand. Use 12 10-32 x 7/8" socket head cap screws.

2.4.4 Install three (3) alignment nuts, Item 4 (614332-1)."Use Molykote, Item 49 on items 4 and 5." Screw in from stand side of casting with hex of nut toward stand.

Project nut 1/8 inch thru casting.

2.4.5 Install three (3) alignment studs, Item 5 (614333-3), with screwdriver slot toward stand. Do not move alignment nuts. Project 7/16-20 threaded end 1½ inches thru the nut. Install one (1) each of three (3) jam nuts Item 9 on the stud with the full length of the 7/16-20 thread in the clear.

2.4.6 Install No. 4 mirror, Item 1 (614320). Position mirror with tapped holes touching the 7/16-20 threads of the alignment studs. Screw the studs into the mirror in small progressive increments avoiding binding of the threads. Turn stud shoulders snug against the mirror back. Do not over tighten.

2.4.7 Operate the laser and auto-collimate the beam from the reticle of the field lens in the throat simulator stand. Position the tripod mounted B & L light source 4.5 ± .2 inches from the field lens and center in the laser beam. Operate the lamp. Adjust the tilt of the No. 4 mirror by adjusting three (3) alignment nuts, Item 4 so that the focused image from the No. 4 mirror is centered on the laser as it exits from the target screen. Using the z axis position plate (614594) in the center hole of the No. 4 mirror, adjust the alignment nuts, Item No. 4 equally till the micrometer measurement is 4.644 ± .005 from the field lens. Install jam nuts, Item 9 on alignment studs to lock the alignment nuts. Recheck the centralization of the focused point source image on the target and correct if required.

2.4.8 Install No. 4 bezel, Item 47 (31-053), with three (3) each clamps, Item 44 (31-055), Item 45 (31-054), and three (3) each screws, Item 46. Position of the bezel notches is irrelevant.

2.4.9 Issue Kit No. 8 - Collimator Lens Assembly.

2.4.10 Accountability stores and requestor.

2.4.11 Place lens mount, Item 1 (614562), on bench.

2.4.12 Install three (3) brackets, Item 11 (614570), with six (6) each screws and washers, Items 12 and 16. Do not tighten. Brackets, screws and washers are called out on Drawing No. 614570.

2.4.13 Install three (3) each alignment studs, Item 7 (614337 -3) in three (3) alignment nuts, Item 6 (614332 -5). Use Molykote, Item 49 on items six and seven. Project unslotted end of stud 1 3/16 inches out from the nut hex end. Install one (1) each of three (3) jam nuts, Item 10, about 5/8 inch from the uncut end of each stud. Alignment studs, nuts and jam nuts are called out on Drawing 614570.

2.4.14 Install the alignment assemblies in the lens mount. Orient with nut hex toward small lens end, and projecting 3/8 inch from casting.

2.4.15 Mount lens No. 1, Item 3 (31-034). Use four (4) each screws and washers Items 5 and 7. Modify the washers by cutting and/or upsetting to provide proper clearance and clamping action. Tighten screws carefully until washers are snug against lens. Reference Drawing No. 614569.

2.4.16 Mount lens No. 2, Item 4 (31-035). Use retainer ring, Item 2 (614336), and three (3) each screws and washers, Items 6 and 7 (Ref. Drawing No. 614569).

2.4.17 Mount mirror No. 3, Item 2 (614576), called out on Drawing No. 614570). Screw alignment studs about 1/2 inch into mirror casting in small increments. Tighten jam nuts. Orient mirror to casting per section E-E. Install mirror retainer clips 614579.

2.4.18 Accountability and orientation.

2.4.19 Move lens assembly, with mirror to collimator assembly area. Include Drawing 614570 Items: one (1) each support arms, Item 26 (31-019), Item 27 (31-017-2), and Item 28 (31-017); three (3) inserts, Item 14 (31-016); three (3) nuts, Item 29; three (3) screws, Item 35 and Loctite, Item 48.

2.4.20 Position lens assembly on the support stand, 614586.

2.4.21 Position the lens assembly to autocollimate the laser beam from the reticle of the No. 2 collimator lens and at the same time adjust the z axis dimension from the field lens to the No. 1 collimator lens to 31.786 $\pm$ .005 inches.

2.4.22 Install support arm subassemblies, Items 26, 27 and 28, and radius collimator support vane slots for clearance of 1" tubing. Use six (6) each screws, nuts and lockwashers, Items 23, 24 and 25 on the collimator support, and six (6) each Items 17, 24 and 25 on the lens assembly bracket. Tighten finger tight only. With the lens assembly aligned install six (6) each shims, Item 42

(31-059), at the brackets and collimator support as required.

2.4.23 Install three (3) each inserts, Item 14 (31-016), use Loctite Item 48. Install loosely into the inserts three (3) each screws and locknuts, Items 35 and 29.

2.4.24 Issue Kit No. 9 - Tube and Fittings.

2.4.25 Inspection - Accountability.

2.4.26 Install all remaining tubing and fittings. Include one (1) Item 38 Ferulok elbow and three (3) item 37 Ferulok couplings; Do not Tighten fittings into mirror ports, one (1) Item 13, one (1) Item 22, one (1) Item 32, one (1) Item 33, two (2) Item 36 and one (1) Item 43. Tubing on these items and items 26, 27 and 28 may be cut to fit. Solder all joints for vacuum service using Item 34.

2.4.27 Tighten previously installed nuts and cap screws uniformily being careful not to change the alignment. Tighten twelve (12) nuts, Item 24, to sixteen (16) foot pounds torque and the six (6) screws, Item 12, to 96 inch pounds. Bottom screws, Item 35, and tighten locknuts, Item 29.

2.4.28 Remove lens assembly support stand. Use adjustment screws, Item 35, as required to correct small alignment errors due to deflection of the support arms. The center of the autocollimated image from the reticle of the #2 lens must fall within a 0.400 inch diameter circle concentric with the laser beam on the projection screen.

2.4.29 Position the No. 3 mirror to obtain a dimension of 30.517 $\pm$ .005 inches between the vertex of the field lens and plane of the No. 3 mirror center hole. Adjust by turning alignment nuts, Item 6, uniformly in small increments. Install fixture No. 614589 in the assembly stand behind the field lens. Adjust z axis dimension from the field lens to bulb envelope to 8.680 $\pm$ .020. Energize the lamp with 2.0 volts D. C. Adjust the tilt of the No. 3 mirror using the alignment nuts until the projected light pattern is centered on the laser beam as viewed on projection screen. Recheck the 30.517 $\pm$ .005 dimension. Witness by Q. A.

2.4.30 Document the alignment with two (2) each 4 x 5 polaroid photos of the aligned projected image on the target 5-000. Record on the photos the expose time, f number, date and assembly serial number.

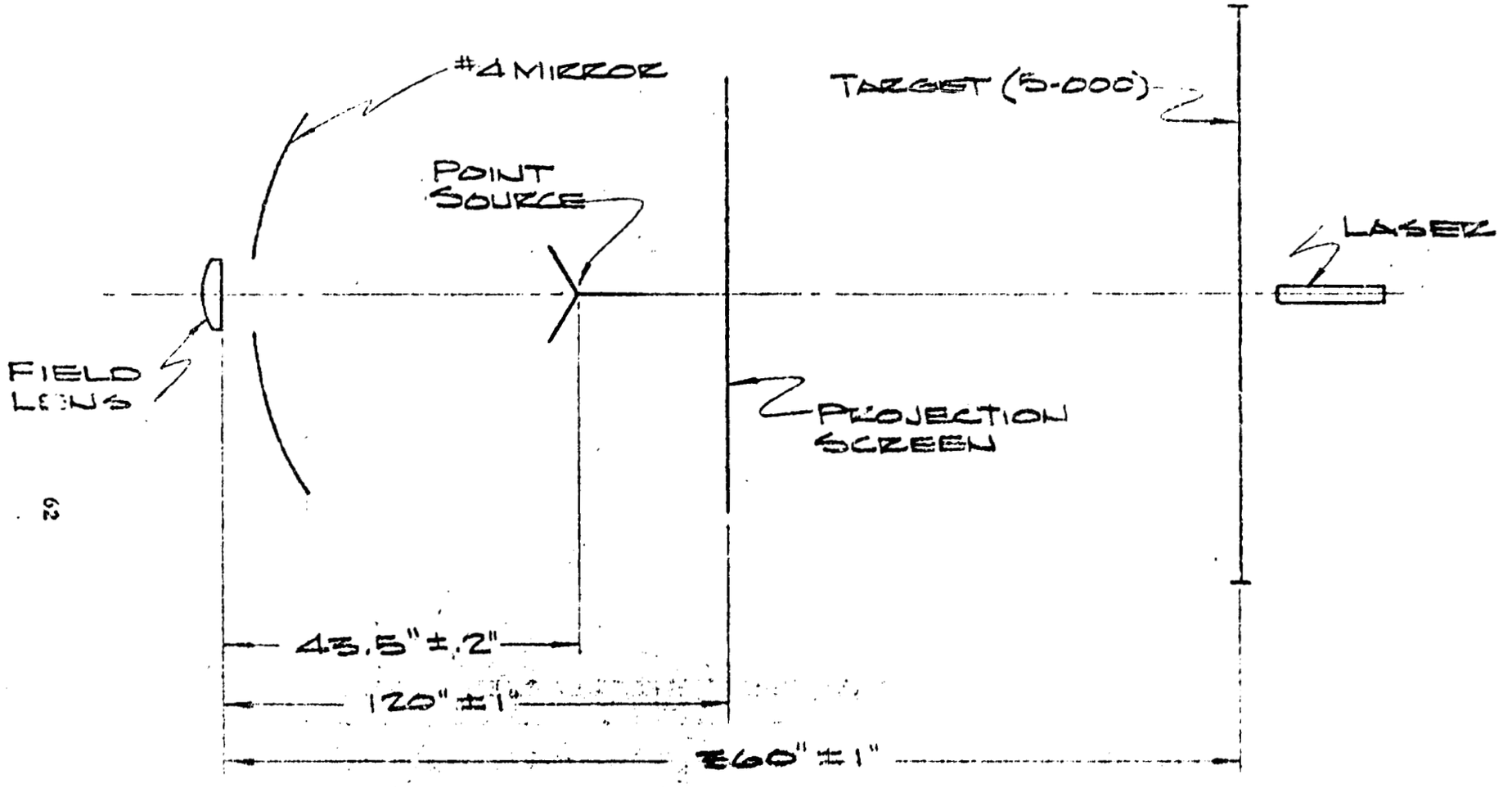
2.4.31 Remove collimator from assembly stand. Mount on cart and move to helium leak test area.

2.4.32 Helium Leak Test of Collimator Assembly

All pre-fabricated lines and components not previously leak-checked shall be tested prior to assembly with a helium mass spectrometer having a sensitivity of 1×10^{-9} standard cc/sec. or better. Upon completion, all components and lines shall be assembled and newly assembled joints shall be leak-checked. The test shall be accomplished by evacuating the lines and castings. Helium at a pressure of 5 to 15 psig shall then be sprayed on all newly formed joints. In the event that leaks are detected, a repair shall be accomplished and the test repeated.

2.4.33 Hydro-test of Collimator Assembly

Install inlet and outlet water lines from test bench to collimator assembly. With downstream valve open, initiate flow through the system and regulate the upstream pressure to 15 psig. Record flow rate through the system. Minimum flow shall be 0.5 gpm. Close downstream valve and turn off flow. Pump hydrostatic pressure to 150 psig and hold for five (5) minutes. Visually check lines and joints for leakage. Release pressure by opening downstream valve and blow out the system using air purge.



COLLIMATOR TEST SET-UP

SCALE: NONE
DWN: [illegible] DATE: [illegible]

REPRODUCIBILITY OF THE ORIGINAL PAGE IS POOR
FOR BETTER COPY [illegible] THE DOCUMENT ORIGINATOR

EOS Form No. 4001 11/64 - 500

SPLIT ORDER RECORD

DATE	NO.	QTY.	BAL.

ENG. CHANGES		DATE
LET.	E.C.I.	

EOS ELECTRO-OPTICAL SYSTEMS, INC.
A Subsidiary of Xerox Corporation

MANUFACTURING ORDER

M.O. NO. 2000
W.A. NO. 7056-07-01
P.W.O. NO.
QTY. | S.N.
NEXT ASSY. | QTY.

PART NAME Collimator Assembly PART NO. 614570
DAT 12-6-66 PAGE 1 OF 2 EDITION NO. 2 UNIT Collimator
PLANNER R. Tellkamp EXT. 241 REQUESTOR W. McCrary

SCHEDULE DATES		INSPECTION
ISSUE		COMPLETION STAMP
IN WORK		
DUE		

WORK CENTER NO	OPER. NO.	TOOL NO.	OPERATION DESCRIPTION	EST. HRS.	COMP.	ACCEPT.
	10		Assemble and Align Collimator Support Assembly, #4 Mirror & Bezel. (Ref. Procedure 2.4.1 - 2.4.8)			
	15		Q. A. witness O. T. Procedure step #2.4.7, Per II #7056-5A			Q. C.
	16		Government Inspection			
	20		Assembly Collimator No. 3 Mirror & Lens Subassembly (Ref. Procedure 2.4.9 - 2.4.19)			
	30		Assembly Collimator Lens Assembly - make plumbing connections and align (Ref. Procedure 2.4.20 - 2.4.31)			
	35		Q. A. witness O. T. Procedure step #2.4.29 and Inspect per II #7056-6			Q. C.
	36		Government Inspection			
	40		Perform Helium leak detection (Ref. Procedure 2.4.32)			Q. C.
	45		Q. C. witness Operation No. 40, Per II #7056-6A			
	46		Government Inspection			
	50		Perform Hydro Test (Ref. Procedure 2.4.33). Flow.....G.P.M.			Q. C.
	55		Q. C. Witness Operation No. 50, Per II #7056-6B			
	56		Government Inspection			

APPROVAL MFG. W. McCrary
Q. A. [signature]
RECEIVED BY:
DATE

TOTAL HOURS
M. O. 2000

EOS

EOS Form No. 4001 11/64 - 500

SPLIT ORDER RECORD

DATE	NO.	QTY.	BAL.

ENG. CHANGES		DATE
LET.	E.C.I.	

EOS ELECTRO-OPTICAL SYSTEMS, INC.
A Subsidiary of Xerox Corporation

MANUFACTURING ORDER

M.O. NO. 2000
W.A. NO. 7056-07-01
P.W.O. NO.
QTY. | S.N.
NEXT ASSY. | QTY.

PART NAME Collimator Assembly PART NO. 614570
DATE 12-6-66 PAGE 2 OF 2 EDITION NO. 2 UNIT Collimator
PLANNER R. Tellkamp EXT. 241 REQUESTOR W. McCrary

SCHEDULE DATES: ISSUE / IN WORK / DUE
INSPECTION: COMPLETION STAMP

WORK CENTER NO.	OPER. NO.	TOOL NO.	OPERATION DESCRIPTION	EST. HRS.	COMP.	ACCEPT.
	65		Q. C. perform final inspection per II #7056-7.			Q. C.
	66		Government Inspection			
	75		Q. C. to inspect Packaging per II #7056-8.			Q. C.
	76		Government Inspection			
	85		Shipping department and Q. C. to finalize all paperwork for shipment and ship unit to destination. Inspect per II #7056-9.			Q. C.
	86		Government Inspection			

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APPROVAL MFG. W. McCrary 12/6/66
Q. A. [signature] 12/6/66
RECEIVED BY:
DATE

TOTAL HOURS
M. O. 2000

EOS

ELECTRO-OPTICAL SYSTEMS, INC.
A Subsidiary of Xerox Corporation

KIT LIST

KIT NO 7 PAGE 1 OF 1

ASSEMBLY PART NO. 614570 REV. N/C PLANNER R. Tellkamp S/N EDITION NO. 2 DATE 9-16-66
DESCRIPTION Collimator Assembly SYSTEM Optical Train UNIT Collimator W.A. CHARGE 7056-07-31
ISSUED BY ISSUED TO DATE W.A. CREDIT 7056-96-00

ITEM NO.	S N	PART NO.	DESCRIPTION	REF. DESIG	QTY. REQ'D.	1ST ACCUM ISSUED	1ST ACCUM B O	1ST ACCUM B.O. No.	UNIT PRICE	EXTENSION
1		614335	Collimator Support	Item 8	1					
2		614332-1	Nut, Alignment 1" -8 UNC	4	3					
3		614333-3	Stud, Alignment	5	3					
4			Nut, Mach. Semi-fin, Jam 3/4-16 UNF Stn Stl	9	3					
5		614320	Primary Mirror	1	1					
6		31-053	Bezel, Primary Mirror	47	1					
7		31-055	Clamp, Bezel Mirror	44	3					
8		31-054	Clamp, Bezel Mirror	45	3					
9	64		Screw, Cap. Hex Soc. 6-32 UNC x 1/2" Lg. Black	46	3					

DELIVER TO

CC: Requestor Accounting Material Control Program Office

ELECTRO-OPTICAL SYSTEMS, INC.
A Subsidiary of Xerox Corporation

KIT LIST

KIT NO 8

ASSEMBLY PART NO. 614569 REV N/C PLANNER R. Tellkamp S/N EDITION NO. 2 DATE 10-4-66
DESCRIPTION Lens Assembly SYSTEM Optical Train UNIT Collimator W.A. CHARGE 7056-96-00
ISSUED BY ISSUED TO DATE W.A. CREDIT 7056-07-31

ITEM NO.	S N	PART NO.	DESCRIPTION	REF. DESIG	QTY. REQ'D.	1ST ACCUM ISSUED	1ST ACCUM B O	1ST ACCUM B.O. No.	UNIT PRICE	EXTENSION
1		614562	Lens, Mount	Item 1 614569	1					
2		614563	Brackets	Item 11 614570	3					
3			Screw, Cap. Hex Soc. 1/4-20 UNC x .38 Lg. Stn Stl	Item 12 614570	6					
4			Washer, Flat 1/4 Stn Stl	Item 16 614570	6					
5		614337-3	Stud, Alignment	Item 7 614570	3					
6		614332-5	Nut, Alignment	Item 6 614570	3					
7			Nut, Mach. Semi-fin, Jam 1/4-28 UNF	Item 10 614570	3					
8		31-034	Collimator Lens No. 1	Item 3 614569	1					
9			Screw, Mach. Hex Soc. Hd. 4-40 x 1/4 Lg. Cres Stl	Item 5 614569	4					
10			Washer, Flat #6 Cres Stl	Item 7 614569	7					
11		31-035	Collimator Lens #2	Item 4 614569	1					
12		614336	Ring, Retainer	Item 2 614569	1					
13			Screw, Mach. Pan Hd. 6-32 x 3/8 Lg. Cres Stl	Item 6 614569	3					
14		614576	Secondary Mirror	Item 2 614570	1					
15		31-019	Support Arm Subassembly	Item 26 614570	1					
16		31-017-2	Support, Arm Subassembly	Item 27 614570	1					
17		31-017-1	Support, Arm Subassembly	Item 28 614570	1					
18		31-016	Insert, Threaded	Item 14 614570	3					
19			Nut, Mach. Semi-fin, Hex, Jam 1/4-20 UNC Stn Stl	Item 29 614570	3					
20			Screw, Cap. Hex. Soc. 1/4-20 UNC x 1.000 Lg. Stn Stl	Item 35 614570	3					

DELIVER TO

CC: Requestor Accounting Material Control Program Office

ELECTRO-OPTICAL SYSTEMS, INC.
A Subsidiary of Xerox Corporation

KIT LIST

KIT NO 8

ASSEMBLY PART NO. 614569 REV. N/C PLANNER R. Tellkamp S/N EDITION NO. 2 DATE 10-4-66

DESCRIPTION Lens Assembly SYSTEM Optical Train UNIT Collimator W.A. CHARGE 7056-96-00

ISSUED BY ISSUED TO DATE W.A. CREDIT 7056-07-31

ITEM NO.	S N	PART NO.	DESCRIPTION	REF. DESIG	QTY. REQ'D.	1ST ACCUM ISSUED	1ST ACCUM B O	1ST ACCUM B.O. No.	UNIT PRICE	EXTENSION
21			Sealant, Loctite Grade E (2-1) or Equiv.	Item 48 614570	A/R					
22			Screw, Cap, .375 dia Shoulder x 1.38 Lg 5/16-18 UNC x .50 Lg	Item 23 614570	6					
			Hex. Soc Stn Stl							
23			Nut, Mach. Semi-fin Hex, Jam 5/16-18 UNC Stn Stl	Item 24 614570	12					
24			Washer, Lock Spring 5/16 Stn Stl	Item 25 614570	12					
25			Screw Cap. Hex Soc, .375 dia Shoulder x .88 Lg 5/16-18 UNC	Item 17 614570	6					
			x .50 Lg. Stn Stl							
26		31-059	Shim	Item 42 614570	6					
27		614579	Clip, Retainer	Item 10 614576	4					
28			Screw, Cap. Hex Soc. Hd. 4-40 UNC x .38 Lg.	Item 8 614576	4					
29			Washer, Lock #4	Item 9 614576	4					

DELIVER TO

CC: Requestor Accounting Material Control Program Office

ELECTRO-OPTICAL SYSTEMS, INC.
A Subsidiary of Xerox Corporation

KIT LIST

KIT NO 9

SEMBLY PART NO. 614570 REV. A PLANNER R. Tellkamp S/N EDITION NO. 2 DATE 10-4-66
SCRIPTION Collimator Assembly SYSTEM Optical Train UNIT Collimator W.A. CHARGE 7056-07-31
SUED BY ISSUED TO DATE W.A. CREDIT 7056-96-00

ITEM NO.	S N	PART NO.	DESCRIPTION	REF. DESIG	QTY. REQ'D.	1ST ACCUM ISSUED	1ST ACCUM B.O	1ST ACCUM B.O. No.	UNIT PRICE	EXTENSION
1			Elbow, (Parker Ferulok #6C5 BU-SS Stn Stl	Item 38	1					
2			Coupling, (Parker Ferulok #6C5 BU-SS Stn Stl	37	3					
3		M.O.2001	Line, Discharge Water, Primary Mirror, Collimator Assembly	Sub	1					
4		M.O.2002	Line, Return, Water, Cooling Collimator Assembly	Sub	1					
5		M.O.2003	Line, Supply Water, Cooling Collimator Assembly	Sub	1					
6		M.O.2004	Line, Inlet, Water, Secondary Mirror Collimator Assembly	Sub	1					
7		M.O.2005	Line, Discharge, Water Secondary Mirror, Collimator	Sub	1					
8		614579	Clip Retainer 302 Stn Stl	Item 10 614576	4					
9			Washer Lock #4 Stn Stl	Item 9 614576	4					
10	67		Screw, Cap, Hex. Soc Hd. 4-40 UNC x .36 Lg. Stn Stl	Item 8 614576	4					

DELIVER TO

CC: Requestor Accounting Material Control Program Office

2.5.0 Throat Assembly (Drawing 31-100)

The following procedure outlines the assembly of the throat assembly excluding the field lens. This unit will be shipped ready for installation and no alignment will be required.

EQUIPMENT REQUIRED: 1. Handling hoist.
2. Torque wrenches.

Inspection for accountability and orientation. This inspection will verify that the assembly operations have been performed according to the proceding process steps, and show good workmanship.

2.5.1 Issue Kit No. 10.

2.5.2 Install two (2) alignment sockets, Items 22 and 23 (31-100) using eight (8) screws, eight (8) lockwashers, and eight (8) flatwashers, Items 27, 28 and 29. Orient to print and torque screws to 75 inch pounds.

2.5.3 Install Items 25, 26 and 24 (31-100) using four (4) screws and four (4) lockwashers Items 27 and 28. Orient to print and torque screws to 75 inch pounds.

2.5.4 Install intensity control sensor wiring (M. O. 3002) from Item 23 (31-101) to the c-bored hole zone 7B (31-102). Thread the wire through the ring seal Item 6 (31-101) and through the .12 inch hole zone 8C (31-101). Use Item 32 (31-100) to seal wire at these points.

2.5.5 Install connector Item 10 in the c-bored hole zone 7B (31-102) and solder wire from pin A of socket 614685 to socket A of Item 10. Solder wire from pin B of socket 614685 to socket B of Item 10.

2.5.6 On the compression fitting at nozzel end of throat attach a bag containing 12 each Item 30 modified by 614566 and 12 each Item 15.

2.5.7 Inspection for accountability and orientation.

2.6.0 Iris Support Assembly

The following procedure outlines the assembly of the iris support assembly. This unit will be shipped ready for the installation of the iris subassembly and no alignment will be required. Inspection for accountability and orientation. This inspection will verify that the assembly operations have been performed according to the proceeding process steps, and show good workmanship.

2.6.1 Issue Kit No. 11.

2.6.2 Install cable subassembly M. O. 3001. Install connector in hole in base of Item 3, and orient per print 31-115.

2.6.3 Inspection for accountability and orientation.

SPLIT ORDER RECORD

DATE	NO.	QTY.	BAL.

ENG. CHANGES		DATE
LET.	E.C.I.	

EOS ELECTRO-OPTICAL SYSTEMS, INC.
A Subsidiary of Xerox Corporation

MANUFACTURING ORDER

M.O. NO. 3000
W.A. NO. 7056-06-31
P.W.O. NO.
QTY. | S.N.
NEXT ASSY. | QTY.

PART NAME Throat Assembly PART NO. 31-100
DATE 11-10-66 PAGE 1 OF 1 EDITION NO 3 UNIT Throat Assembly
PLANNER R. Tellkamp EXT. 241B REQUESTOR W. McCrary

SCHEDULE DATES | INSPECTION
ISSUE
IN WORK
DUE
COMPLETION STAMP

WORK CENTER NO	OPER. NO.	TOOL NO.	OPERATION DESCRIPTION	EST. HRS.	COMP.	ACCEPT.
	10		Assemble alignment sockets and intensity control sensor wiring. Reference paragraph 2.5.1 thru 2.5.6			
	20		Box kit 12 for shipment with throat			
	25		Q.C. Inspection - accountability and final inspection. (Reference paragraph 2.5.7) II #7056-10A			
	35		Q.C. to inspect packaging per II #7056-11			
	45		Shipping Department and Quality Control to finalize all paper work for shipment and ship unit to destination. Inspect per II #7056-12.			

APPROVAL MFG. [signature] Q. A. [signature] 11/9/66

RECEIVED BY: DATE

TOTAL HOURS

M. O. No. 3000

EOS

SPLIT ORDER RECORD

DATE	NO.	QTY.	BAL.

ENG. CHANGES		DATE
E.T.	E.C.I.	

EOS ELECTRO-OPTICAL SYSTEMS, INC.
A Subsidiary of Xerox Corporation

MANUFACTURING ORDER

M.O. NO. 3200
W.A. NO. 7056-06-31
P.W.O. NO.

PART NAME Iris Support Assembly PART NO. 31-115
DATE 11-10-66 PAGE 1 OF 1 EDITION NO. 3 UNIT Iris Support Assembly
PLANNER R. Tellkamp EXT. 2418 REQUESTOR W. McCrary

QTY. S/N
NEXT ASSY. QTY.

SCHEDULE DATES		INSPECTION
ISSUE		COMPLETION STAMP
IN WORK		
DUE		

CLOSING	OPER. NO.	TOOL NO.	OPERATION DESCRIPTION	EST. HRS.	COMP.	ACCEPT.
	10		Assemble Iris Support Assembly and Iris Control Wiring. Reference para. 2.6.0 thru 2.6.3.			
	15		Q.C. Inspection - inspect per II #7056-10A accountability and final inspection.			
	25		Q.C. to inspect packaging per II #7056-11.			
	35		Shipping Department and Quality Control to finalize all paper work for shipment and ship unit to destination. Inspect per II #7056-12.			

APPROVAL MFG. [signature] Q. A. [signature] RECEIVED BY: DATE

TOTAL HOURS

M. O. 3000

EOS

ELECTRO-OPTICAL SYSTEMS, INC.
A Subsidiary of Xerox Corporation

KIT LIST

KIT NO 10

ASSEMBLY PART NO. 31-100 REV. L PLANNER R.Tellkamp S/N EDITION NO. 3 DATE 11-10-66

DESCRIPTION Throat Assembly SYSTEM Optical Train UNIT Throat Assembly W.A. CHARGE 7056-06-31

ISSUED BY ISSUED TO DATE W.A. CREDIT 7056-96-00

ITEM NO.	S N	PART NO.	DESCRIPTION	REF. DESIG	QTY. REQ'D.	1ST ACCUM ISSUED	1ST ACCUM B.O	1ST ACCUM B.O. No.	UNIT PRICE	EXTENSION
1		31-101	Throat Weldment	Item 1	1					
2		31-120	Socket, Alignment	22	1					
3		31-125-2	Socket, Alignment	23	1					
4			Screw, Cap.Soc. Hd.1/4(.250) 20 UNC x .75 Lg. Stn Stl	27	1					
5			Washer, Lock Split 1/4(.250) Stn Stl	28	12					
6			Washer Flat 1/4(.250) Stn Stl	29	8					
7		31-125-1	Socket, Alignment	25	1					
8			Ball Bushing, Self-Alignment Steel, Torrington Cat #5SBB8	26	1					
9		31-121	Cap. Bearing	24	1					
10			Sealant	32	A/R					
11			Connector, Locking Clip, Type Amphenol #126-216 or Equivalent	10	1					
12			Washer Lock Split #10 Stn Stl	15	12					
13		Modified by 614566	Screw, Cap Hex Soc. #10 (.190) 32 UNF x 7/8 Lg.(Type 440C)Stn Stl	30	12					
14		M.O.3002	Wiring Cable, Sensor	Sub	1					

DATE REQUIRED DELIVER TO

Kit 10

CC: Requestor Accounting Material Control Program Office

ELECTRO-OPTICAL SYSTEMS, INC.
A Subsidiary of Xerox Corporation

KIT LIST

KIT NO 11

ASSEMBLY PART NO. 31-115 REV. A PLANNER R. Tellkamp S/N EDITION NO. 3 DATE 11-3-66

DESCRIPTION Iris Support SYSTEM Optical UNIT Throat Assembly W.A. CHARGE 7056-06-31

ISSUED BY ISSUED TO DATE W.A. CREDIT 7056-96-00

ITEM NO.	S N	PART NO.	DESCRIPTION	REF. DESIG.	QTY. REQ'D.	1ST ACCUM ISSUED	1ST ACCUM B.O	1ST ACCUM B.O. No.	UNIT PRICE	EXTENSION
1		31-116	Support, Iris	Item 3	1					
2		M.O.3001	Wiring Harness, Iris Support	Sub	1					

REQUIRED DELIVER TO

CC: Requestor Accounting Material Control Program Office

ELECTRO OPTICAL SYSTEMS, INC.
A Subsidiary of Xerox Corporation

KIT LIST

KIT NO 12

ASSEMBLY PART NO. 31-118 REV. A PLANNER R. Tellkamp S/N EDITION NO. 4 DATE 10-5-66

DESCRIPTION Field Lens Cell Subassembly SYSTEM Optical Train UNIT Throat Assembly W.A. CHARGE 7056-06-31

ISSUED BY ISSUED TO DATE W.A. CREDIT 7056-96-00

ITEM NO.	S N	PART NO.	DESCRIPTION	REF. DESIG	QTY. REQ'D.	1ST ACCUM ISSUED	1ST ACCUM B.O	1ST ACCUM B.O. No.	UNIT PRICE	EXTENSION
1		31-103	Field Lens Retainer	Item 2	1					
2		31-108	Field Lens Support	3	1					
3			O'Ring, Parker Cat #2-427 Silicone Rubber Comp. S418-6	5	1					
4			Screw, Hex.Soc.Hd #8(.164)-32 UNF x 7/8 Lg. Stn Stl	8	6					
5			Washer, Flat #8 Stn Stl	9	6					
6			Washer, Lock #8 Stn Stl	10	6					
7			Gasket, Silicone Rubber 50 Durometer 6" O.D x 5.38" I.D. x 1/4" Thk	11	1					
8			O'Ring Parker #2-435 Comp. S418-6	13 on 31-100	1					
9			Lock, Washer Split #8 Stn Stl	11 on 31-100	6					
10			Screw, Soc.Hd. #8-32 x 1.125" Lg Stn Stl	14 on 31-100	6					
11			Cable Assembly - Iris Control Throat Assembly	31-126	1					
12		31-117	Manifold	2	1					
13		31-113	Gasket, Iris	4	1					
14			Screw, Socket Hd. #8-32 x 3 1/4" Lg.	6	7					
15			Washer Split Lock #8 Stn Stl	7	7					
16										
17			O'Ring Parker #2-269 Comp. S418-6	5	1					
18		AN 742	Cable Clamp, Nylon #CCN-32	11	1					
19			Screw, Binder Hd. 6-32 x 3/8 Cres Stl	12	1					
20		31-112	Gasket, Iris Support	7 on 31-100	1					

DATE REQUIRED DELIVER TO

CC: Requestor Accounting Material Control Program Office

FORM NO.

KIT LIST

...TICS OPTICAL SYSTEMS, INC.
A subsidiary of Xerox Corporation

KIT NO 12

...ARY PART NO. 31-118 REV. A PLANNER R. Tellkamp S/N EDITION NO. 4 DATE 10-5-66

...CRIPTION Field Lens Cell Subassembly SYSTEM Optical Train UNIT Throat Assembly W.A. CHARGE 7056-06-31

...SUED BY ISSUED TO DATE W.A. CREDIT 7056-96-00

ITEM NO.	S N	PART NO.	DESCRIPTION	REF. DESIG	QTY. REQ'D.	1ST ACCUM ISSUED	1ST ACCUM B.O	B.O. No.		UNIT PRICE	EXTENSION
21			Screw, Soc. Hd #10(.190) 32 x 62 Lg. Stn Stl	6 on 31-100	24						
22			Washer, Lock Split #10 Stn Stl	15	24						

...TE REQUIRED DELIVER TO

...ING NO. CC: Requestor___ Accounting___ Material Control___ Program Office___

Acceptance Test Procedure

to be performed at MSC.

Optical Train Subassemblies

(Collimator and Collector)

Contract NAS 9-5805

3.0 Acceptance Test - MSC Collector

The tests performed at MSC will be identical to those performed at EOS. The tests will consist of only the optical point source test repeated in the same manner as the EOS tests. These tests are described in paragraph 3.1 and 3.2.

The data package accompanying each subassembly will include actual test data on reflector optics, flow and pressure drops on the subassemblies, certificates of compliance for helium leak detection tests, certificates of compliance on material call-outs, etc.

3.1 Acceptance, MSC - Collector Subassembly

Equipment Required:

1. Burner simulator fixture 614593.
2. Post, Alignment 614594.
3. Burner simulator adapter 614595.
4. Optical Flat 614681.
5. Point Source Rod 614682.
6. Adapter, Burner Simulator 614695.
7. Laser and stand GFE, MSC.
8. Optical bench (5-000) MSC GFE.
9. Projection screen.
10. Camera and tripod.

TEST SET-UP

1. Attach burner simulator adapter to burner simulator fixture.
2. Install on the optical bench per 614595.
3. Set-up and operate laser 12 [illegible] from burner simulator.
4. Install optical flat in B. S. fixture.
5. Autocollimate to establish optical axis.
6. Position projection screen camera, etc.

PROCEDURE

1. Remove collector subassembly from crate.
2. Install collector subassembly on burner simulator fixture.
3. Adjust hard points on B. S. to autocollimate collector lens with laser.
4. Install point source in burner simulator after removing optical flat and operate at 2 volts d. c.
5. Photograph projected image on projection screen.
6. Compare EOS photo with MSC photo. If photo shows no misalignment or physical damage to components, MSC photo constitutes acceptance.

SECURITY CLASSIFICATION

REV.

NUMBER

REVISIONS

CHANGE	DESCRIPTION	BY	CHECKED	APPROVED	DATE

REQ'D	ITEM	PART NO.	DESCRIPTION	SIZE	MATERIAL	SPECIFICATION

LIST OF MATERIALS

NEXT ASSY	QTY	UNIT	QTY

ORIGINAL APPLICATION

UNLESS OTHERWISE NOTED:

1. LINEAR DIMENSIONS IN INCHES.
2. TOLERANCES:

	DECIMAL	FRACTIONS	ANGULAR
.X	±	±	±
.XX	±		
.XXX	±		

THIS DRAWING CONTAINS INFORMATION PROPRIETARY TO ELECTRO-OPTICAL SYSTEMS, INC. IT SHOULD NOT BE REPRODUCED, USED OR DISCLOSED TO ANYONE WITHOUT THE PRIOR WRITTEN PERMISSION OF THIS ORGANIZATION.

		DATE
DRAWN		
CHECKED		
APPROVED		
APPROVED		
APPROVED		
RELEASED		
ACT. WT.	CALC. WT.	

ELECTRO-OPTICAL SYSTEMS, INC.,
Pasadena, California • MUrray 1-4671, SYcamore 5-9961

TITLE:

SECURITY CLASSIFICATION	SIZE	NUMBER	REV.
	B		

CODE IDENT NO.		SCALE	SHEET OF

FORM NO. 271

APPENDIX B

INSPECTION TEST PLAN

INSPECTION PLAN

(Amendment No. 4)

ELECTRO-OPTICAL SYSTEMS, INC.

300 N. Halstead
Pasadena, California

60 OPTICAL TRAIN ASSEMBLIES

Contract No. NAS9-5805

31 March 1967

Prepared by Elliott Shepherd
Quality Assurance Engineer

Approved by J. J. Gaughan
Manager, Quality Assurance

W. D. MacCrary
Project Manager

1.0 TABLE OF CONTENTS

1.1	Page 2	Revision Index
1.2	3	Introduction
1.3	4	Organization Chart
1.4	5	Product Flow Chart
1.5	12	Inspection Manual or Procedures
1.6	12	Drawing and Change Control
1.7	12	Control of Procurement Sources
1.8	15	Government Furnished Property (GFP)
1.9	17	Identification, Handling, and Storage of Material
1.10	18	Control of Raw Materials
1.11	19	Inspections and Tests
1.11.1	Page 19	Source Inspection
1.11.2	20	Receiving Inspection
1.11.3	20	First Article Inspection
1.11.4	20	In-Process Inspection
* 1.11.4.1	Page 22	Deleted
* 1.11.4.2	25	Deleted
* 1.11.4.3	35	Deleted
1.11.4.4	44	Inspection Instructions for Collector
* 1.11.4.5	54	Deleted
* 1.11.4.6	56	Deleted
* 1.11.4.7	62	Deleted
1.11.4.8	67	Inspection Instructions for Collimator
* 1.11.4.9	75	Deleted
* 1.11.4.10	78	Deleted
* 1.11.4.11	81	Deleted

* See current revision of Production and Acceptance Test Plan

	1.11.4.12	Page 85	Inspection Instructions for Throat
*	1.11.4.13	89	Deleted.
	1.11.4.14	97	Deleted
	1.11.4.15	106	Test Procedures for Mirrors
	1.11.4.16	120	Inspection Instructions for Mirrors
	1.11.4.17	127	Inspection Traveler for Mirrors
	1.11.4.18	128	Deleted
	1.11.4.19	129	Add'l Inspection Instructions
	1.11.4.20	133	Insp. Check List for Collector
	1.11.4.21	139	Insp. Check List for Collimator
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	1.12	Page 147	Process Control
	1.13	153	Nonconforming Articles
	1.14	153	Control of Inspection, Measuring and Test Equipment
	1.15	153	Indication of Inspection Status
	1.16	154	Preservation, Packaging, Packing and Shipping
	1.17	154	Sampling Inspection
	1.18	156	Records of Inspections and Tests
	1.19	157	Corrective Action
	1.20	158	Inventory of Inspection, Measuring and Test Equipment
	1.21	159	Inspection Check List for Bonding
	1.22	162	Inspection Check List for Cleaning

*See current revision of Production and Acceptance Test Plan.

1. Page 20 and 21 — Asteric Subparagraph 1.11.4.1, 1.11.4.2, 1.11.4.3, 1.11.4.5, 1.11.4.6, 1.11.4.7., 1.11.4.9, 1.11.4.10, 1.11.4.11, 1.11.4.13, 1.11.4.14, 1.11.4.15, 1.11.4.18. Add: *See current revision of Production and Acceptance Test Plan.

2. Delete pages 22 through 43.

3. Delete pages 54 through 66.

4. Delete pages 75 through 84.

5. Delete pages 89 through 119.

6. Delete pages 148 through 152.

7. Page 6 — Delete reference to paragraph 2.3.90. Delete reference to paragraph 2.3.97 and substitute 2.3.92.

8. Page 45 — Change 2.3.3. to 2.3.4.

9. Page 46 — Change paragraph 1.0 to read: EOS Inspector to witness assembly operations 2.3.80 through 2.3.85, 2.3.87 through 2.3.89 and verify that they are performed according to the Collector Assembly Procedure. Use collector check list to record inspection.

10. Page 46 — Add paragraph 2.1
2.1 Verify presence of good workmanship.

11. Page 47 — Change paragraph 1.0 to read: EOS Inspector to witness assembly steps 2.3.92 through 2.3.98 and verify that they were performed according to the Collector Assembly Procedure. Use collector check list to record inspection.

12. Page 47 — Add paragraph 2.1
2.1 Verify presence of good workmanship

13. Page 48 — Change paragraph 1.0 to read: EOS Inspector to verify

		that assembly operations 2.3.16 through 2.3.20, 2.3.20 through 2.3.41, 2.3.47 through 2.3.51, 2.3.56 through 2.3.61, 2.3.64 through 2.3.66, 2.3.68, 2.3.70 through 2.3.74, 2.3.91, 2.3.101 through 2.3.119 were performed according to the collector assembly procedure. Use collector check list to record inspection
14.	Page 134	Void check list paragraphs 2.3.90 and 2.3.81.
15.	Page 134	Change 1 of 5 to 1 of 7.
16.	Delete Pages 135, 136, 137, 138	Substitute revised collector check list dated 7 December 1966, revised page numbers to be 135, 136, 137, 138, 138A and 138B.
17.	Delete Page 1	"Table of Contents" and replace with "Table of Contents" Revised 14 December 1966.
18.	Add	Inspection check list for bonding. Pages 159, 160 and 161.
19.	Add	Inspection check list for cleaning. Pages 162 and 163.
20.	Delete	II #7056-17 Page 130 and substitute II #7056-17 Revision A, dated 1 November 1966
21.	Delete	II #7056-18 Page 131 and substitute II #7056-18 Revision A, dated 1 November 1966
22.	Delete	Inspection Traveler Page 127 and substitute Inspection Traveler Revision A dated 12 December 1966
23.	Delete	Inspection Traveler, Page 128

Appendix Contents

Inspection Plan Page Numbers	
135 through 138B	Revised Collector Check List
1, 1A	Revised Table of Contents
159 through 161	Inspection Check List for Bonding
162 through 163	Inspection Check List for Cleaning
130	Revised II #7056-17 Cleaning, Revision A
131	Revised II #7056-18 Bonding, Revision A
127	Revised Inspection Traveler, Revision A

1.1 Revision Index

Revision	Date
Original	May 13, 1966
Revision 1	September 22, 1966

1.2 Introduction

This document describes the Quality Assurance Program which Electro-Optical Systems, Inc. will implement during the production and testing of the Optical Train Program. It is intended to be in compliance with the requirements of:

A. NASA Publication NPC 200-3, dated April 1962

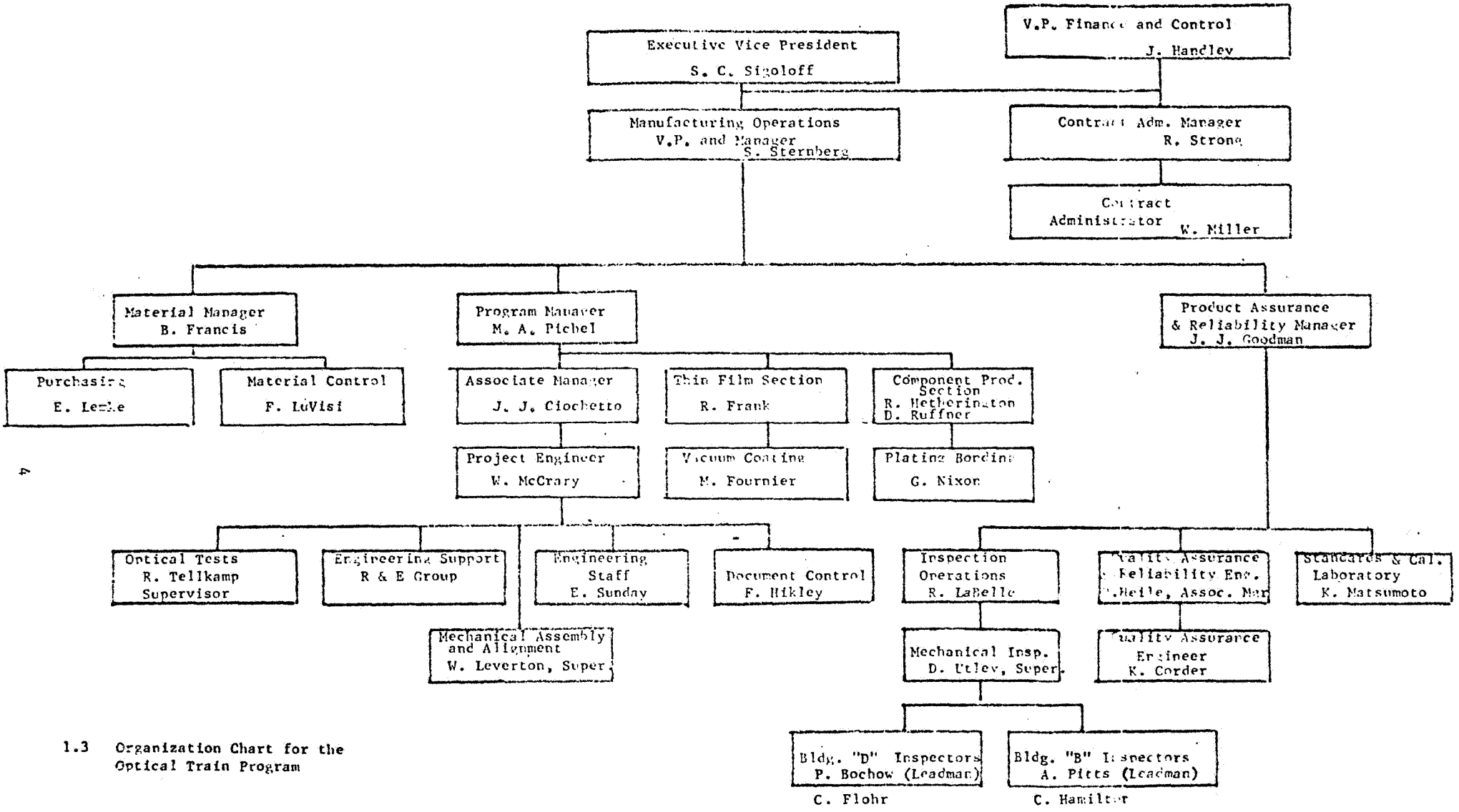
B. NASA Publication NPC 200-3, Inspection System Notes, not dated

C. EOS Product Assurance Manual, Volume 1, Quality, dated October 1963

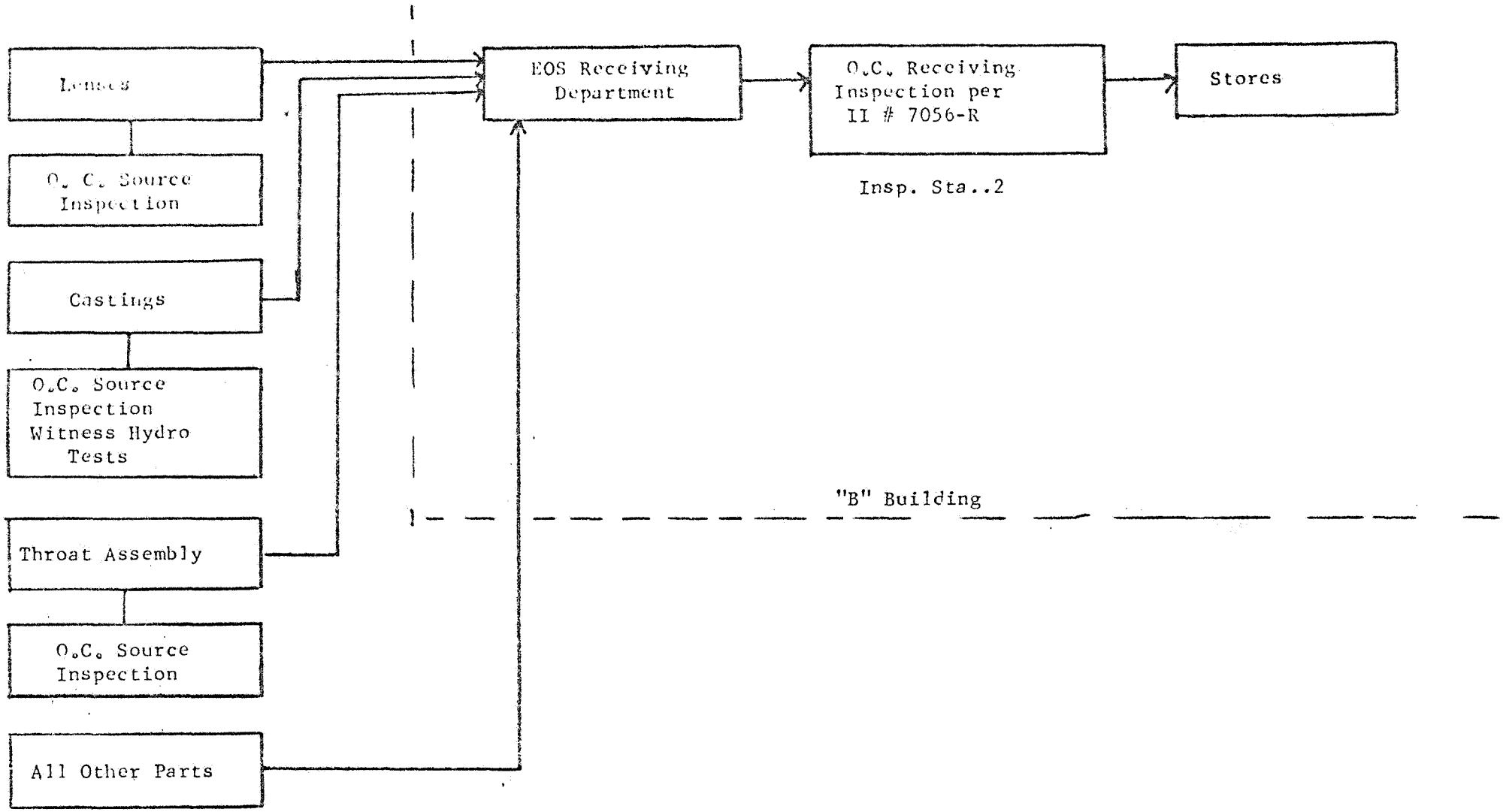
D. NASA Publication RA-001-008-1, Preparation of Supplier Inspection Plan, dated January 1966

E. Optical Train Assembly, Contract NAS 9-5805, dated March 16, 1966

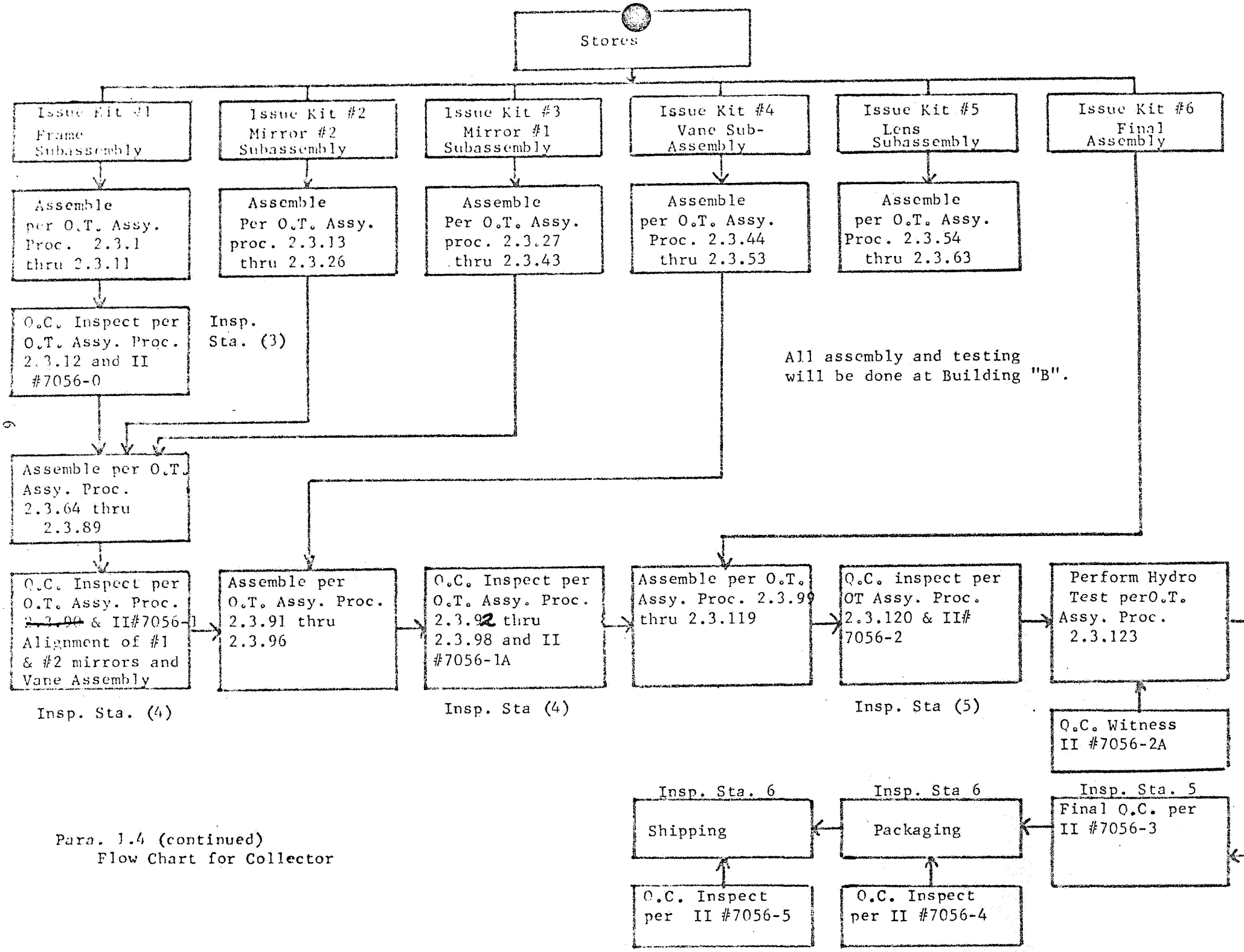
F. NASA Publication NPC 200-2, dated April 1962, Section 8



1.3 Organization Chart for the Optical Train Program

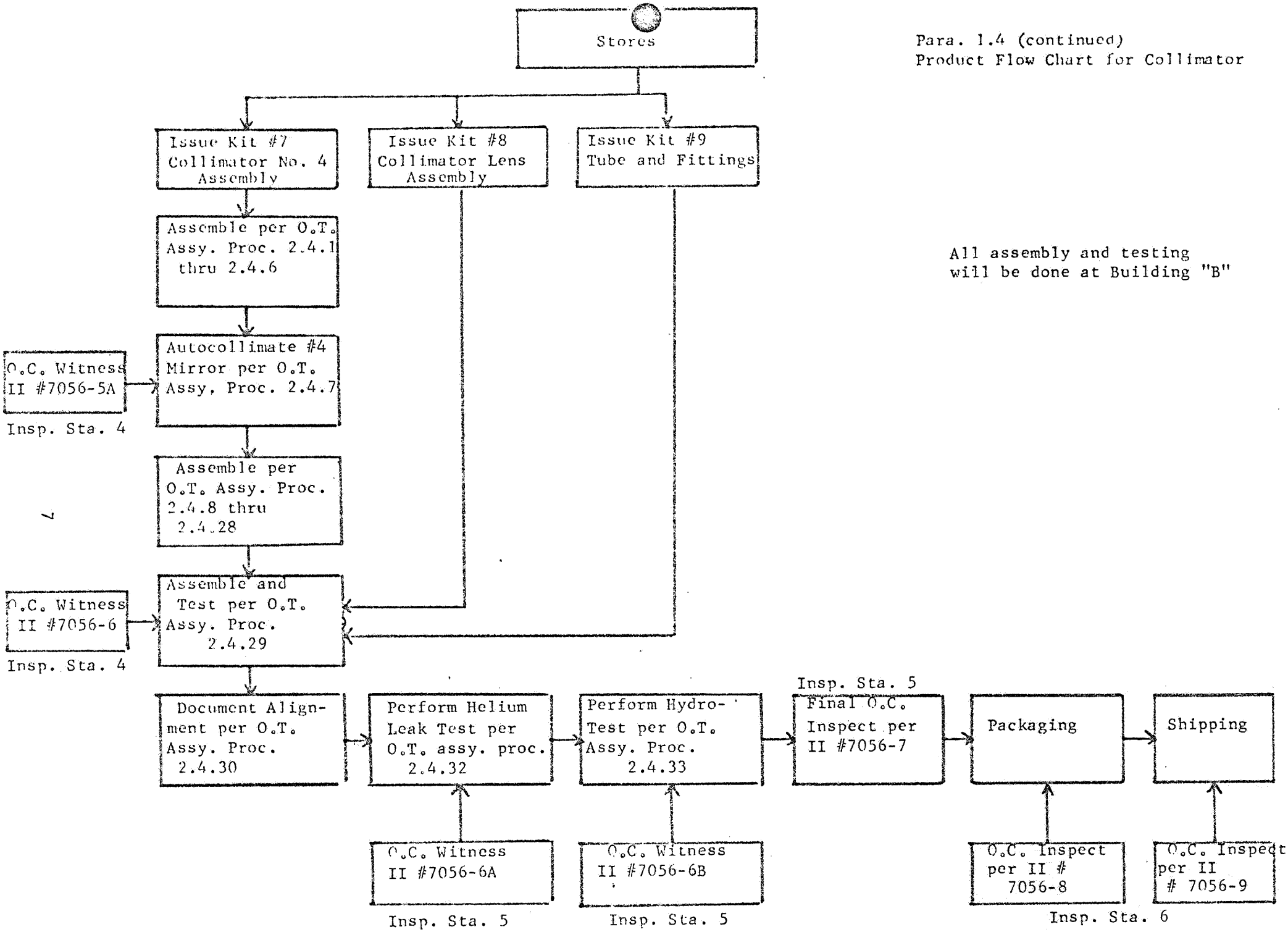


Para. 1.4 Product Flow Chart for Incoming Parts



Para. 1.4 (continued)
Flow Chart for Collector

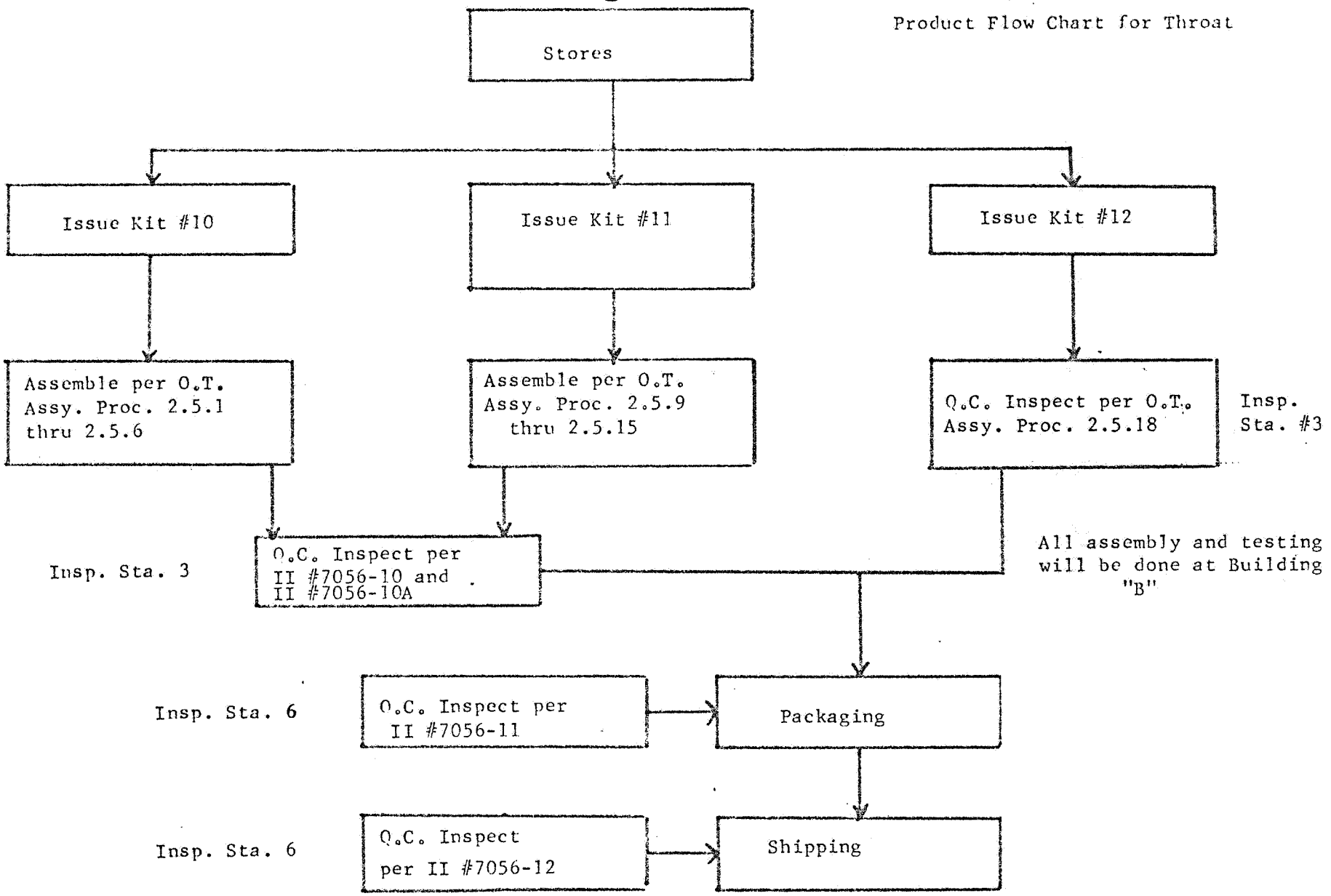
Para. 1.4 (continued)
Product Flow Chart for Collimator

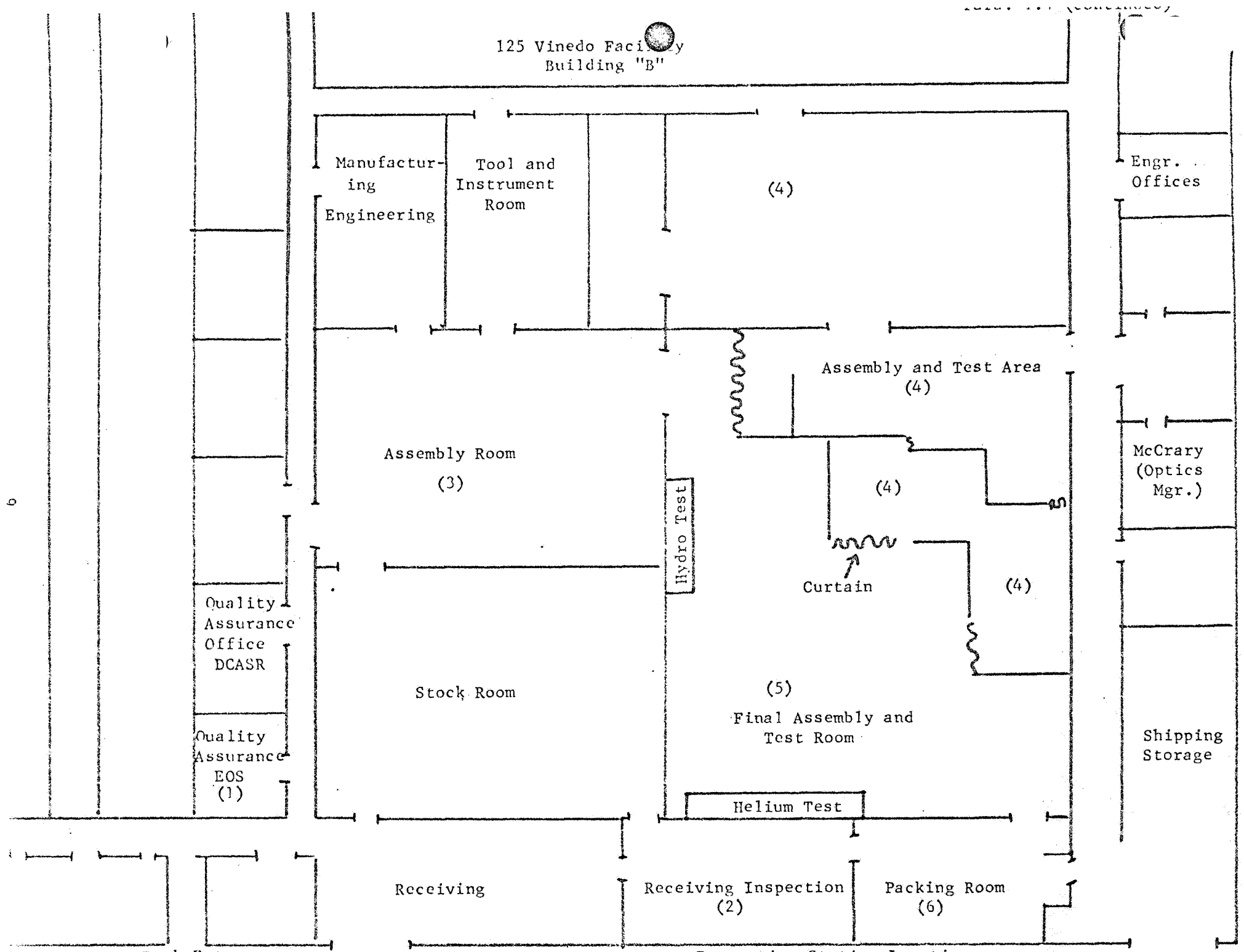


All assembly and testing will be done at Building "B"

Para. 14 (continued)

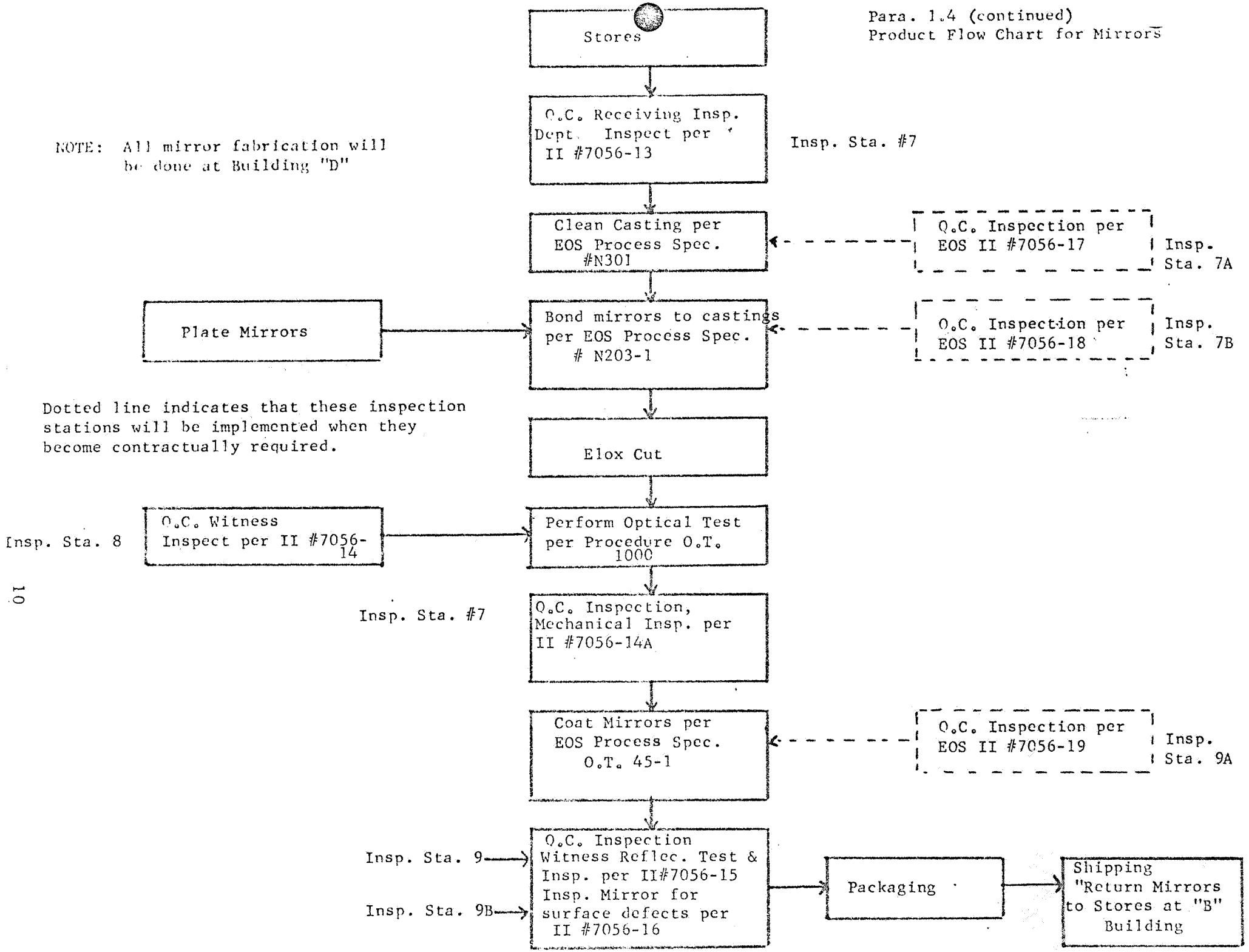
Product Flow Chart for Throat



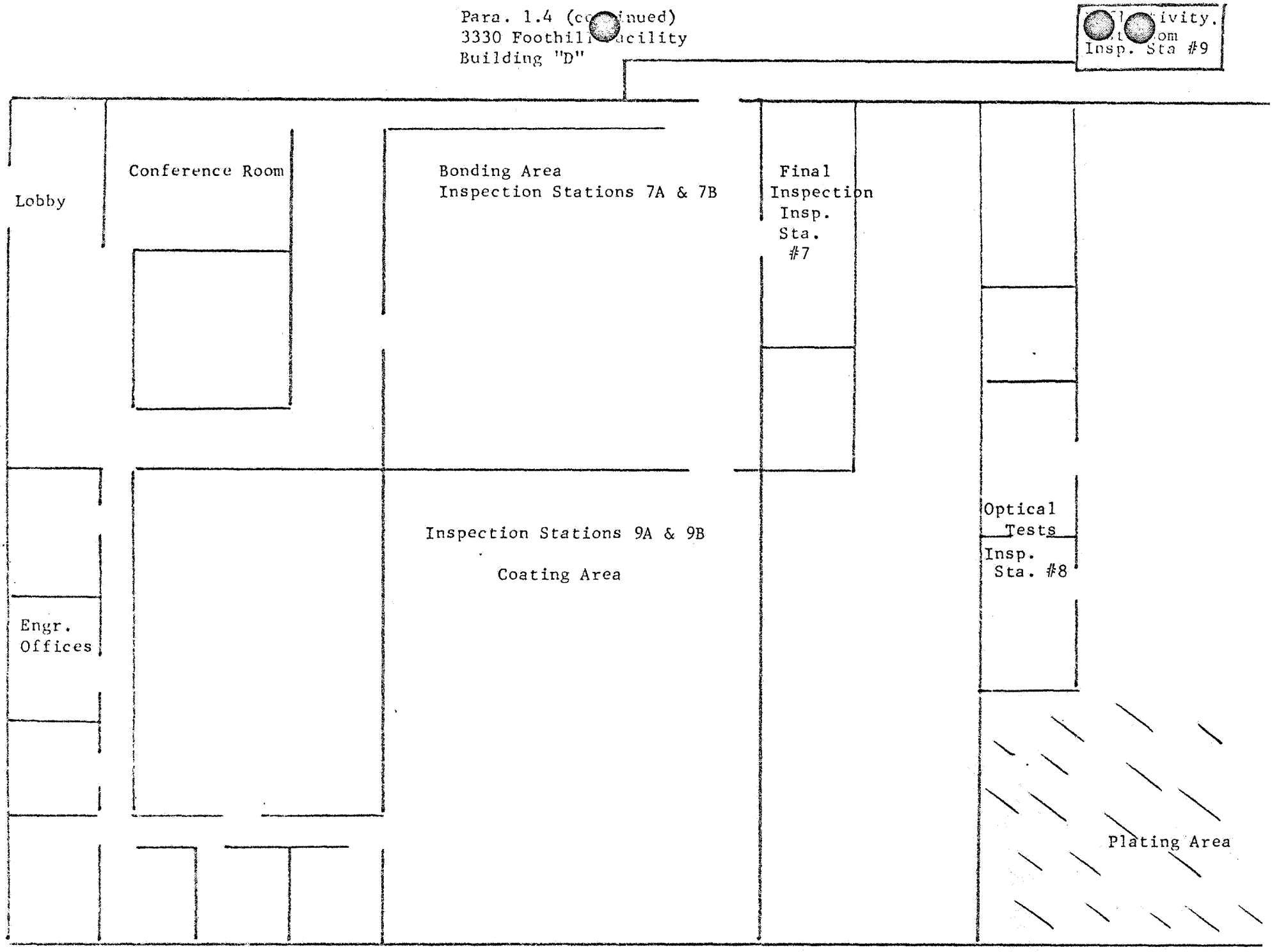

125 Vinedo Facility
Building "B"
Manufacturing Engineering
Tool and Instrument Room
(4)
Engr. Offices
Assembly and Test Area
(4)
Assembly Room
(3)
Hydro Test
(4)
McCrary (Optics Mgr.)
Curtain
(4)
Quality Assurance Office DCASR
Stock Room
(5)
Final Assembly and Test Room
Shipping Storage
Quality Assurance EOS
(1)
Helium Test
Receiving
Receiving Inspection
(2)
Packing Room
(6)
Back Entrance
Inspection Station Location
(1) Control Center (2) Rec. Insp. (3) In-Process Insp. (4) Optical Test Insp. (5) Final Insp. (6) Shipping Insp.

Para. 1.4 (continued)
Product Flow Chart for Mirrors

NOTE: All mirror fabrication will be done at Building "D"



Para. 1.4 (continued)
3330 Foothill Facility
Building "D"



1.5 Inspection Manual or Procedures

Paragraph 1.6 through 1.19 are the procedures for the operation of the inspection system.

1.6 Drawing and Change Control

A drawing and change control system providing for controlled distribution, usage, and removal of control documents and changes is maintained by the Document Control Clerk in the program office. Drawing record cards itemize the status of each drawing and a Drawing Distribution Record indicates the points of dispensation.

Procedures for making drawing changes are outlined in the Design and Drafting Manual which is an integral part of the Corporate Policy and Procedures of Electro-Optical Systems, Inc.

When an Advance Document Change Notice is inaugurated, the Quality Assurance (or Inspection office) receives a copy and attaches it to the print. Until the change notice is recorded on the drawing and new prints distributed, the notice becomes part of the drawing.

1.7 Control of Procurement Sources

1.7.1 Maintenance of Records, tests and Inspections Performed at the Source

Suppliers for major items (those items listed in 1.7.3 will be required to maintain complete records of all inspection efforts performed.

1.7.2 Source Inspection as Required

The name of the supplier, item and the degree to which source inspection will be conducted is indicated below:

Supplier	Item	Degree of Source Inspection
Applied Optics	31-035	100% inspection
and Mechanics	31-111	100% inspection
Pennsylvania	31-034	100% inspection
Optical Co.	30-018	100% inspection
Coast Metal Craft	31-100	100% inspection on the completed assemblies to critical dimensions and first article evaluation on one each of the parts.

NOTE: Pennsylvania Optical Co. glass will be inspected at EOS or AOM using AOM test plates.

1.7.2 (continued)

Supplier	Item	Degree of Source Inspection
Aerolab	30-001-1	First Article
	30-001-2	First Article
Phoenix Aluminum and Magnesium Co.	614320	First Article
B & H Precision Tool & Die Co.	30-021	First Article
	30-022	First Article
	30-023	First Article

Policy O-3-A of the EOS Product Assurance Manual describes the procedure that will be implemented for conducting source inspection and illustrates the So7rce Inspection tag which will accompany material accepted at the source.

Upon receipt of material which has been accepted at the source by an EOS Source Inspector, as illustrated by an acceptance stamp in the indicated space on the Source Inspection tag, a check for identification and damage during shipment will be conducted by Receiving Inspection. If the items are still acceptable, the Receiving Inspector's stamp will be again placed upon the Source Inspection tag. The accepted material will then be shipped to Stores.

1.7.3 Control of Purchase Orders, Including Quality Assurance Review or Approval

The purchase orders for the major parts will contain the following Q.A. requirements:

(a) EOS to perform receiving inspection to drawing and specification requirements.

(b) Certificate of Compliance required from vendor

(c) This Statement:

Complete records of all inspection efforts performed shall be maintained and made available to EOS/or the Government representative. These records will substantiate conformance with all inspection and test requirements necessary to assure compliance with the purchase order requirements. Vendor inspection equipment to be traceable to National Bureau of Standards. Positive methods of segregation of nonconforming material shall be utilized. The Government and/or EOS reserves the right to inspect and test any or all of the materials included in this order at the suppliers plant.

1.7.3 (continued)

The major parts are listed by part number as follows:

30-001	30-027	30-002	31-117
30-048	30-028	30-025	614331
30-058	30-037	30-024	31-126
30-053	31-016	30-018	614332-1
31-055	30-005	31-034	614332-2
30-049	30-006	31-035	614333-3
30-036	30-026	31-111	614337-3
30-054	30-032	614355	614333-1
30-035	30-033	31-100K	614332-3
30-019	30-034	614577	614335
30-059	31-054	614576	

The purchase orders for the remainder of the parts will contain the following requirements:

(a) EOS to perform receiving inspection to drawing and specification requirements or check for identity and damage (as applicable.

(b) Certificate of Compliance required from vendor.

1.7.4 Corrective Action At Source

The following corrective actions will be taken with vendors who supply discrepant items:

(a) Material will be returned to the vendor for rework to specification and drawing requirements.*

(b) A Corrective Action Request letter (CAR) will be sent to the vendor. The CAR letter will show the details of the problem (number of units of product, number of shipments, number of defective units, description of the defects, etc.) as applicable), and request a reply from the vendor within 15 working days. If the vendor fails to respond to the CAR within the allotted time or his corrective action recommendation is not acceptable he will be disapproved as an EOS vendor.

1.7.5 Vendor Selection, Such as Quality History, Preferred Parts, etc.

Vendors for major parts will be qualified and selected for use on this program in one of the following ways:

(a) Evaluation of the vendor performance on past programs by means of the Supplier History Cards (Policy O-3-C of the EOS PAM).

(b) Vendor Surveys (Policy O-12 of the EOS PAM).

*If the material is bought by the Material Review Board it will not be returned to the vendor, but a Corrective Action Request will be sent.

1.7.6 Government Source Inspection Purchase Order Statements (NPC 200-3, Paragraph 3.2)

Purchase Orders will be presented to the resident government representative in order that he may determine the need for Government Source Inspection. The Purchase Orders for the major parts listed in paragraph 7.2C will contain the following statement:

> "The Government and/or EOS reserves the right to inspect and test any or all of the materials included in this order at the suppliers plant."

1.8 Government Furnished Property (GFP)

All Government furnished equipment, upon receipt, will be inspected for identification and damage. In the event damage or inoperable equipment is found, a report outlining extent and probably cause will be sent to the Government for disposition.

The following is a list of the GFP which EOS now has:

One each Collimator Subassembly - Part No. RCA 31-000
One each Collector Subassembly - Part No. RCA 30-000
One each Throat Subassembly - Part No. RCA 31-100
One each Carbon Arc Burner Subassembly - Part No. RCA 10-000
One each 400 Ampere-80 Volt DC Power Supply Perkin Electronic - M 3475
One each Chamber "E" Radient Intensity Measuring System (RIMS)
One lot Electrical Switch Gear
One each Test Bench Control Station
Two each - Blower and Motor Assembly
One each - Indexing Panel Air Cyl. Item 4 Drawing 18000
One each - Timer Repeat Cycle with Motor Item 2 Drawing 21000
Two each - Positive Position Control Subassembly Item 45 Drawing 10000
One each - Switch, Water Pressure Item 55 Drawing 10000
One each - Switch, Micro with Lever Item 20 Drawing 18000
One each - Space Arc Subassembly Item 44 Drawing 10000
One each - Positive Jaw Subassembly Item 51 Drawing 10000
Three each - Insert, Tungsten Item 10 Drawing 190000
One each Drive, Positive Carbon Item 39 Drawing 10000
Six each - 32-046 Ball Clamps
Twelve each - 10-32NF by 3/4" long socket head cap screws and lockwashers
One anode and one cathode quick disconnect. Does not include cable.
One Argon Quick Disconnect, one air Quick Disconnect.

1.8 (continued)

One each - Mechanism, Threading Item 40 Drawing 10000

One each - Relay, Time Delay (2 sec.)

One each - Flash Plate

One each - Exhaust Switch with Vane Assembly

One each - Collimator Handling Fixture

One each - Spare Collector Lens

One lot - Bag Spare Collector Parts

One each - OSRAM Lamp Power Supply

One each - Control Console, Harness, and Connector

One each - RIMS Console and Harnessing

One each - RIMS Fixture

Six each - Radiometers

Four each - Fuse Boxes

One each - Hood Assembly Item 42 Drawing 100000

One each - Fitting "L" Hose Item 66 Drawing 10-000

One each - K & E Alignment Stand

One each - Inside Micrometer Set - 4" (Starrett Catalog No. 823E)

One each - Point Source Light (Vince Tyrrell)

One each - Each spool .005" Stainless Steel Wire

One each - Each Radiant Movie Screen 40" x 40" Lenticular

One each - 5-400 Alignment Fixture Assembly Collector Assembly

One each - 5-500 Carbon Arc Alignment Fixture Assembly

One each - 5-600 Collector-Burner Alignment Fixture Assembly

One each - Relay, Meter-Model 29XA - Range 0-500 DC Micrometer 280 ohm Resistance

One each - Relay, Time Delay (5 sec.)

One each - Ness. Module Q.D. Hardware ("J" Panel)

One Lot - Associated A, Air Flow Gauges

One each - Meter Control Board Diode - 2N1605A

One each - OSRAM Lamp

One each - 0-160 psig Water Pressure Gauge

One lot - Pipe Fittings

One each - Servo Amplifier

One each - Air Solenoid Valve

One water inlet Quick Disconnect and one water outlet quick disconnect.

One each - Panel mounted (Fisher-Porter) gauges 1.74 SCFM

One each - Panel mounted (Fisher-Porter) gauges SN 650 GE 1002B8

One each - Panel Mounted (Fisher-Porter) gauges 4.90 SCFM

1.8 (continued)

Six feet - Gray Vinyl Tubing

One each - Pressure Sensing Switch

One each - Iris-Shroud Assembly

One each - Iris-Subassembly

One each - Shroud Gasket

One each - Iris "O" Ring

Two each - Field Lens Assembly with "O" Rings

One each - Spare Field Lens

Three each - 30-052 Cantalever

One each - Argon Regulator

Two each - 0 to 4.8 gpm Flow Meters

One each - Solar Cell

One each - 5-200 Throat Alignment Fixture

One each - 7-600 Lamp Bracket

Periodic inspections of the GFP will be performed by EOS O.C. during this program. These inspections will verify accountability and that proper controls are being used to prevent damage or deterioration during handling or storage.

1.9 Identification, Handling and Storage of Material

A. Identification of limited-life items with expected life indicated. Policy Q-11 of the EOS Product Assurance Manual describes the procedure for assuring storage control for items that deteriorate with time. The Age Control tag exhibited therein will be attached to all items requiring this action.

B. Specific handling devices for delicate parts, etc. The mirrors and lenses are the items which require special handling procedures. These items will be stored in their shipping containers and will not be opened until needed for assembly. Only persons who have had sufficient experience on the handling of optical components will be allowed to handle the mirrors and lenses.

C. Identification of inspection status on stored items. All boxes of parts in stores will either have a Source Inspection or Receiving Inspection Acceptance Tag affixed. These tags are illustrated in Policy Q-3-B, page 4a of the EOS Product Assurance Manual.

1.10 Control of Raw Materials

The control of raw materials will be done by requiring the vendors to furnish Certificates of Compliance. The Certificates of Compliance required from the vendors will be to different degrees of stringency dependent upon the criticality of the item they are making. The following is a summary of the requirements EOS has imposed on vendors to date:

A. A Certificate of Compliance to EOS PURCHASE ORDER REQUIREMENTS IS REQUI required from all vendors.

B. Material certifications are required from the following vendors:

Part No.	Vendor
8307-100	Dow Radio
2" dia. check plate	AOM
PIC #4329U	P.I.C. Design Corp.
AN816-6-8	Air Hardware, Inc.
AN 6290-6	Cal-State Seal
Stainless Steel Bar Stock Typ 304, 3/8" x 1-1/8"	Jessop Steel of California
Stainless Steel Angle Typ 304, 1" x 1" x 3/10"	Jessop Steel of California
Stainless Steel Bar Stock Typ 303, ½" x 1"	Jessop Steel of California
Tubing per MIL-T-8504 5/8" O.D. x .065 w	Tube Sales
304 cres steel 614699-1	Rick Machine Shop
614699-3	Rick Machine Shop
614699-5	Rick Machine Shop
126-197	R&C Electronics
126-196	R&C Electronics
614331	Parker Pattern and Foundry
614577	Parker Pattern and Foundry
4302	McMaster-Carr Supply Co.
Permology #2000	Perma-Latem
30-024	B&H Precision Tool and Die Inc.
30-025	B&H Precision Tool and Die Inc.
30-038	Trio Metal Stamping, Inc.
30-035	Design Machine Products
3/4" nominal type L soft	Iler Pipe and Supply Co.
3/8" nominal type L soft	Iler Pipe and Supply Co.
5/8" O.D. x .035 wall soft Ann.	Iler Pipe and Supply Co.
3/8" O.D. x .032 wall soft Ann.	Iler Pipe and Supply Co.
1/4" O.D. x .030 wall soft Ann.	Iler Pipe and Supply Co.
30-032	Swift-Cor Tool and Engineering Inc.
30-033	Swift-Cor Tool & Eng. Inc.
30-034	Swift-Cor Tool & Eng. Inc.

1.10 (continued)

30-026	B&H Precision Tool and Die
30-005	Crown Valley Thread, Inc.
31-016	Crown Valley Thread, Inc.
30-019	Design Machine Products
30-054	
30-036	
30-049	
30-053	
30-001	Aerolab Dev. Co.
614320	Phoenix Aluminum & Magnesium Co., I

C. Physical and Chemical Certifications of all materials and processes are required from the following vendors:

Part No.	Vendor
614579	Pierce Precision Sheet Metal
30-038	Short Run Stamping Co., Inc.
614355A	Phoenix Aluminum & Magnesium Co., I
31-100	Coast Metal Craft
31-117G	Sigma Casting Corp.
31-113A	Gasket Mfg. Co., Inc.
614352-1	Quintesco, Inc.
614352-5	
614333-3	
614377-3	
614333-1	
614332-3	
614332-7	
614337-1	Holling Inter Mountain
614334-1	Holling Inter Mountain
614334-3	Holling Inter Mountain
614562	Crown Pattern and Foundry
614563	Crown Pattern and Foundry
614335	Design Machine Products

1.11 Inspections and Tests

1.11.1 Source Inspection

Policy Q-3-A of the EOS Product Assurance Manual describes the procedure that will be implemented for conducting source inspection and illustrates the Source Inspection tag which will accompany material accepted at the source.

Upon receipt of material which has been accepted at the source by an EOS Source Inspector, as illustrated by an acceptance stamp in the indicated space on the Source Inspection tag, a check for identification and damage during shipment will be conducted by Receiving Inspection. If the items are still acceptable, the Receiving Inspector's stamp will be again placed upon the Source Inspection tag. The accepted material will then be shipped to Stores.

1.11.2 Receiving Inspection

On all material which has not been source inspected by EOS, Receiving Inspection (per EOS PAM, Policy Q-3-B) will be conducted. Specific instructions for receiving inspection are contained in II #7056-R.

1.11.3 First Article Inspection

A First Article Evaluation Report, in accordance with Policy Q-7 of the EOS Product Assurance Manual, will be prepared for all parts.

1.11.4 In-Process Inspection

The assembly operations necessary to go from the piece part level to the subassembly level will be defined on Manufacturing Orders (MO's). These MO's will designate the inspection steps to be performed during the assembly operations. By affixing the inspector's stamp to the MO beside each inspection step as it is performed, the MO (which travels with the hardware throughout the fabrication process) serves as the in-process inspection record. Policy Q-3-D of the EOS Product Assurance Manual describes the procedure for in-process inspection.

The following section contains the manufacturing Orders, Test and Assembly Procedures, Kit Lists and Inspection Instructions that will be used to control the assembly and test operations for this program.

This documentation is organized as follows:

1.11.4.1 Manufacturing Orders for Collector
1.11.4.2 Assembly and Test Procedure for Collector
1.11.4.3 Kit Lists for Collector
1.11.4.4 Inspection Instructions for Collector
1.11.4.5 Manufacturing Orders for Collimator
1.11.4.6 Assembly and Test Procedure for Collimator
1.11.4.7 Kit Lists for Collimator
1.11.4.8 Inspection Instructions for Collimator
1.11.4.9 Manufacturing Orders for Throat

1.11.4.10 Assembly and Test Procedure for Throat

1.11.4.11 Kit Lists for Throat

1.11.4.12 Inspection Instructions for Throat

1.11.4.13 Manufacturing Orders for Mirrors

1.11.4.14 Revised Manufacturing Orders for Mirrors (to be incorporated when they become contractually required)

1.11.4.15 Test Procedures for Mirrors

1.11.4.16 Inspection Instructions for Mirrors

1.11.4.17 Inspection Traveler for Mirrors

1.11.4.18 Revised Inspection Traveler for Mirrors (to be incorporated when it becomes contractually required)

1.11.4.19 Additional Inspection Instructions (to be incorporated when they become contractually required)

1.11.4.20 Inspection Check List for Collector

1.11.4.21 Inspection Check List for Collimator

1.11.4.22 Inspection Check List for Throat

1.11.4.23 Inspection Instructions for Receiving Inspection

* See current revision of production & Acceptance Test Plan

1.11.4.4 Inspection Instructions for Collector



EOS

II# 7056-0

INSPECTION INSTRUCTION

PART NO.	REV.
PART NAME Collector In Process Inspection	
INSPECTION STATION OR AREA 3	

PREPARED BY	DATE	APPROVED BY	DATE	SUPERSEDES
K. Corder		KJ7/RPH	10/4/66	

1.0 Verify that assembly operations 2.3.4 through 2.3.11 have been performed according to the assembly procedure. Use collector check list to record inspection.

2.0 Verify presence of good workmanship.

3.0 Verify that all test and inspection equipment is calibrated.

4.0 Stamp M.O.

EOS

II#7056-1

INSPECTION INSTRUCTION

PART NO.	REV.
PART NAME Collector In Process Inspection	
INSPECTION STATION OR AREA 4	

PREPARED BY	DATE	APPROVED BY	DATE	SUPERSEDES
K. Corder		WT/RPH	10/4/66	

1.0 EOS inspector to witness assembly operations 2.3.80 through 2.3.85, 2.3.87 through 2.3.89 and verify that they are being performed according to the Collector Assembly procedure. Use Collector Check List.

2.0 Use collector check list to record inspection.

2.1 Verify presence of good workmanship.

3.0 Verify that all test and inspection equipment is calibrated.

4.0 Stamp M.O.

EOS

II #7056-1A

INSPECTION INSTRUCTION

Point Source Test

PART NO.	REV.
PART NAME Collector In Process Inspection	
INSPECTION STATION OR AREA 4	

PREPARED BY	DATE	APPROVED BY	DATE	SUPERSEDES
K. Corder		WT/RPH	10/4/64	

1.0 EOS inspector to witness assembly steps 2.3.92 and 2.3.98 and verify that they were performed according to the Collector Assy procedure. Use collector check list to record inspection.

2.0 Verify that all test and inspection equipment is calibrated.

2.1 Verify presence of good workmanship.

3.0 Stamp M.O.

E O S

II #7056-2

INSPECTION INSTRUCTION

PART NO.	REV.
PART NAME Collector In-Process Inspection	
INSPECTION STATION OR AREA 5	

PREPARED BY	DATE	APPROVED BY	DATE	SUPERSEDES
K. Corder		RPH	10/4/66	

E.O.S. Inspector to

1.0 A Verify that assembly operations 2.3.16 thru 2.3.20, 2.3.30 thru 2.3.41, 2.3.47 thru 2.3.51, 2.3.56 thru 2.3.61, 2.3.64 thru 2.3.66, 2.3.70, 2.3.74, 2.3.101 thru 2.3.109 have been performed according to the assembly procedure. Use collector check list to record inspection.

2.0 Verify presence of good workmanship.

3.0 Verify that all test and inspection equipment is calibrated.

4.0 Stamp M.O.

EOS

II #7056-2A

INSPECTION INSTRUCTION

PART NO.	REV.
PART NAME: Collector Hydro Test	
INSPECTION STATION OR AREA: 5	

PREPARED BY	DATE	APPROVED BY	DATE	SUPERSEDES
K. Corder	[illegible]	MF/RCH	10/4/66	

1,0 EOS inspector to witness Hydro Test and verify that it is performed in accordance with assembly step number 2.3.123. Use the collector check list to record the inspection.

2.0 Verify that all test and Inspection equipment is calibrated.

3.0 Stamp M.O.

EOS

II #7056-3

INSPECTION INSTRUCTION

PART NO.	REV.
PART NAME Collector Final Inspection	
INSPECTION STATION OR AREA 5	

PREPARED BY	DATE	APPROVED BY	DATE	SUPERSEDES
K. Corder		MF/RPH	10/4/66	

1.0 Verify that the collector check list is complete and that all operations were acceptable.

2.0 Verify that the collector M.O is complete and that all operations were acceptable.

3.0 Vefify that all RDR's, ISR's and MRB's pertaining to this subassembly have been processed correctly and that any rework required and/or MRB's have been bought off by the Government.

4.0 Present the check list, completed M.O.'s and bought off MRB's to the Government inspector for Final buy off.

5.0 Stamp M.O.

6.0 Attach final acceptance tag on unit and stamp. Have Government inspector stamp Final acceptance tag.

EOS

II #7056-4

INSPECTION INSTRUCTION

PART NO.	REV.
PART NAME Collector Packaging Inspection	
INSPECTION STATION OR AREA 6	

PREPARED BY	DATE	APPROVED BY	DATE	SUPERSEDES
K. Corder	[illegible]	2nd/RPH	10/4/66	

1.0 Verify that unit is mounted correctly in its shipping container (drawing #614758)

2.0 Record any deficiencies (on a ISR) which could cause damage in transient and forward to the responsible Q.A. Engineer and project Manager.

3.0 Stamp M.O.

EOS

INSPECTION INSTRUCTION

II #7056-5

PART NO.	REV.
PART NAME Collector Shipping Inspection	
INSPECTION STATION OR AREA 6	

PREPARED BY	DATE	APPROVED BY	DATE	SUPERSEDES
K. Corder	10-4-66		10-4-66	

1.0 Verify that the following documents are filled out properly and included in the data package:

1.1 EOS QA certified copy of test report for each unit

1.2 EOS Certificate of Compliance for each unit.

1.3 DD 250

1.4 GBL

1.5 Inspection Travelers for each unit (#1 and #2 mirrors)

2.0 Stamp shipping block on acceptance tag.

3.0 Stamp M.O.

4.0 File MO's, Inspection Traveler for Mirrors, Acceptance Tag, Shipping Tag, ISR's, MRB's and any other pertinent information in a folder that is identified by the un8ts serial number. Make a separate file for each unit.

1.11.4.8 Inspection Instructions for Collimator

EOS

INSPECTION INSTRUCTION

II #7056-5A

PART NO	REV.
PART NAME COLLIMATOR IN-PROCESS INSPECTION	
INSPECTION STATION OR AREA 4	

PREPARED BY	DATE	APPROVED BY	DATE	SUPERSEDES
K. Corder	10/4/66	RPH	10/4/66	

1.0 EOS inspector to witness assembly step No. 2.4.7. Verify that the collimator support subassembly is aligned in accordance with assembly step 2.4.7. Use the collimator check list to record this inspection.

2.0 If the collimator support subassembly is aligned correctly stamp M.O.

3.0 Verify that all test and inspection equipment is calibrated.

EOS

INSPECTION INSTRUCTION

II # 7056-6

PART NO.	REV.
PART NAME: COLLIMATOR IN-PROCESS INSPECTION	
INSPECTION STATION OR AREA: 4	

PREPARED BY	DATE	APPROVED BY	DATE	SUPERSEDES
K. Corder		RPH	10/7/66	

1.0 EOS inspector to witness assembly step No. 5 ~~2.4.29~~ 2.4.28 through 2.4.30 and verify that all assembly operations are performed according to the procedure.

2.0 After completion of assembly step No. 2.4.29, verify that assembly operations 2.4.3 thru ~~2.4.6~~, 2.4.8, 2.4.12 thru 2.4.17, 2.4.21 through 2.4.23, 2.4.26 thru 2.4.27 + 2.4.30 were performed correctly. Use collimator check list to document this inspection.

3.0 Verify that all test and inspection equipment is calibrated.

4.0 Verify the presence of good workmanship.

5.0 Stamp M.O.

EOS

INSPECTION INSTRUCTION

II # 7056-6A

PART NO.	REV.
PART NAME COLLIMATOR HELIUM LEAK DETECTION	
INSPECTION STATION OR AREA 5	

PREPARED BY	DATE	APPROVED BY	DATE	SUPERSEDES
K. Corder		JJT/RPH	10/4/66	

1.0 EOS inspector to witness the Helium Leak Test and verify that it is performed according to assembly procedure, paragraph 2.4.32. Use the collimator check list to record this inspection.

2.0 Verify that all test and inspection equipment is calibrated.

3.0 Stamp the N.C.

EOS

INSPECTION INSTRUCTION

II #7056-6B

PART NO.	REV.
PART NAME COLLIMATOR HYDRO TEST	
INSPECTION STATION OR AREA 5	

PREPARED BY	DATE	APPROVED BY	DATE	SUPERSEDES
K. Corder	10/4/66	RPH	10/4/66	

1.0 EOS inspector to witness the Hydro Test and verify that it is performed according to assembly procedure paragraph 2.4.33. Use the collimator check list to record this inspection.

2.0 Verify that all test and inspection equipment is calibrated.

3.0 Stamp M.O.

EOS

INSPECTION INSTRUCTION

II #7056-7

PART NO.	REV.
PART NAME COLLIMATOR FINAL INSPECTION	
INSPECTION STATION OR AREA 5	

PREPARED BY	DATE	APPROVED BY	DATE	SUPERSEDES
K. Corder		MT/RPH	10/1/66	

1.0 Verify that the collimator check list is complete and that all operations were acceptable.

2.0 Verify that the collimator M.O. is complete and that all operations were acceptable.

3.0 Verify that all RDR's, ISR's and MRB's pertaining to this subassembly have been processed correctly and that any rework required and/or MRB's have beer bought off by the government.

4.0 Present the check list, completed M.O.'s and bought-off MRB's to the government inspector for final buy-off.

5.0 Stamp M.O.

6.0 Attach final acceptance tag on unit and stamp. Have government inspector stamp final acceptance tag.

EOS

INSPECTION INSTRUCTION

II #7056-8

PART NO.	REV.
PART NAME COLLIMATOR PACKAGING INSPECTION	
INSPECTION STATION OR AREA 6	

PREPARED BY	DATE	APPROVED BY	DATE	SUPERSEDES
K. Corder		JH7/RPH	10/4/66	

1.0 Verify that unit is mounted correctly in its shipping container (Drawing No. 614759).

2.0 Record any deficiencies on an ISR which could cause damage in transient and forward to the responsible C.A. Engineer and Project Manager.

3.0 Stamp M.O.

EOS

INSPECTION INSTRUCTION

II #7056-9

PART NO.	REV.
PART NAME . COLLIMATOR SHIPPING INSPECTION	
INSPECTION STATION OR AREA 6	

PREPARED BY	DATE	APPROVED BY	DATE	SUPERSEDES
K. Corder		2H7 / RPH	10/4/66	

1.0 Verify that the following documents are filled out properly and included in the data package:

1.1 EOS O.A. certified copy of test report, for each unit.

1.2 EOS Certificate of Compliance, for each unit.

1.3 DD 250

1.4 GOL

1.5 Inspection travelers for each unit (#3 and #4 mirrors).

2.0 Stamp shipping block on acceptance tag

3.0 Stamp M.O.

4.0 File MO's, Acceptance Tag, Shipping Tag, ISR's, MRB's, and any other pertinent information in a folder that is identified by the units serial number. Make a separate file for each unit.

1.11.4.12 Inspection Instructions for Throat

EOS

INSPECTION INSTRUCTION

II #7056-10

PART NO.	REV
PART NAME THROAT IN-PROCESS INSPECTION	
INSPECTION STATION OR AREA	

PREPARED BY	DATE	APPROVED BY	DATE	SUPERSEDES
K. Corder	10/1/66	RPH/bh	10-4-66	

1.0 EOS inspector to verify that assembly operations 2.5.2 thru 2.5.6 [illegible] were performed according to the assembly procedure. Use throat check list to record inspection.

2.0 Verify that all test and inspection equipment used is calibrated.

3.0 Verify the presence of good workmanship.

4.0 Verify that the throat check list is complete and that all operations were acceptable.

Verify that the throat M.O. is complete and that all operations were acceptable.

Verify that all RIR's, ISR's and MRB's pertaining to this sub-assembly have been processed correctly and that any rework required and/or MRB's have been bought off by the government.

Present the check list, completed M.O.'s and bought off MRB's to the government inspector for final buy off.

Stamp M.O.

Attach final acceptance tag on unit and stamp. Have government inspector stamp final acceptance tag.

EOS

INSPECTION INSTRUCTION

II #7056-11

PART NO.	REV.
PART NAME THROAT PACKAGING INSPECTION	
INSPECTION STATION OR AREA 6	

PREPARED BY	DATE	APPROVED BY	DATE	SUPERSEDES
K. Corder	10/6/66	RPH/MT	10/4/66	

1.0 Verify that unit is mounted correctly in its shipping container (drawing No. 614757).

2.0 Record any deficiencies on an ISR which could cause damage in transient and forward to the responsible Q.A. Engineer and Project Manager.

3.0 Stamp M.O.

EOS

INSPECTION INSTRUCTION

II No. 7056-12

PART NO.	REV.
PART NAME THROAT SHIPPING INSPECTION	
INSPECTION STATION OR AREA 6	

PREPARED BY	DATE	APPROVED BY	DATE	SUPERSEDES
K. Corder	10/1/66	RPH/317	10/4/66	

1.0 Verify that the following documents are filled out properly and included in the data package:

1.1 EOS Certificate of Compliance for each unit.

1.2 DD 250

1.3 GBL

2.0 Stamp shipping block on acceptance tag and M.O.

3.0 Stamp M.O.

4.0 File M.O.'s, Acceptance Tag, Shipping Tag, ISR's, MRB's and any other pertinent information in a folder that is identified by the units serial number. Make a separate file for each unit.

1.11.4.16 Inspection Instructions for Mirrors

EOS

INSPECTION INSTRUCTION

II #7056-14

PART NO.	REV.
PART NAME: OPTICAL TEST	
INSPECTION STATION OR AREA:	

PREPARED BY	DATE	APPROVED BY	DATE	SUPERSEDES
K. Corder	10/1/66	RPH/mm	10/4/66	

1.0 EOS inspector will be notified by optical test personnel when a mirror is ready for test.

2.0 EOS inspector to verify that all test and inspection equipment used is calibrated.

3.0 EOS inspector to witness Optical Tests and verify that the test is run in accordance with the following procedures:

Mirror #1 - Process Specification #O.T.1000 Appendix 1

Mirror #2 - Process Specification #O.T.1000 Appendix 2

Mirror #3 - Process Specification #O.T.1000 Apperdix 3

Mirror #5 - Process Specification #O.T.1000 Appendix 4

4.0 If the mirrors pass the optical tests the inspector is to acceptance stamp the inspection traveler, M.O. and Final Optical Test Sheet.

EOS

INSPECTION INSTRUCTION

II #7056-14A

PART NO.	REV.
PART NAME: MECHANICAL INSPECTION	
INSPECTION STATION OR AREA: 7	

PREPARED BY	DATE	APPROVED BY	DATE	SUPERSEDES
K. Corder	10/1/66	RPH/317	10/4/66	

1.0 EOS inspector to measure the I.D. and O.D. of the mirrors using a Vernier Caliper. The I.D. and O.D. dimensions and tolerances for the various mirrors are contained on the following drawings:

Mirror #1	614331
Mirror #2	614577
Mirror #3	614576
Mirror #4	614320

2.0 EOS inspector to also check the location and width of the slots on the No. 4 mirror.

3.0 Verify that all inspection equipment used is calibrated.

4.0 Verify presence of good workmanship.

5.0 If mirrors are acceptable, EOS inspector is to stamp inspection traveler and M.O.

EOS

INSPECTION INSTRUCTION

II #7056-15

PART NO.	REV.
PART NAME: REFLECTIVITY	
INSPECTION STATION OR AREA: 9	

PREPARED BY	DATE	APPROVED BY	DATE	SUPERSEDES
K. Corder	10/1/66	R-PH/MF	10/4/66	

1.0 EOS inspector to verify the following:

A. That EOS supplied MSC 12 representative sample coatings on glass slides.

B. That MSC returned 6 of the slides.

C. That the sample number corresponds to appropriate replication number and is related to proper mirror serial number as indicated on the M.O.

2.0 EOS inspector to witness reflectivity test and verify that specular reflectivity readings are taken at 380, 550 and 850 millimicrons for each mirror and that the measured reflectivity of the production sample is not more than 2% below the reflectivity of the standard (average for the six samples), slide for the wavelength tested.

3.0 If the slides are acceptable, stamp the M.O.; inspection traveler and enter sample S/N along with reflectivity reading for each test in the reflectivity record book. Book is to be kept in the inspection files.

EOS

INSPECTION INSTRUCTION

II #7056-16

PART NO.	REV.
PART NAME: FINAL INSPECTION	
INSPECTION STATION OR AREA: 9B	

PREPARED BY	DATE	APPROVED BY	DATE	SUPERSEDES
K. Corder	10/1/66	RH/MH	10/4/66	

1.0 Verify that edge seal SR-82 has been applied to the I.D. and O.D. of all mirrors.

2.0 Verify that the surface quality corresponds to the following requirements:

2.1 Additionally, 1% of the usable surface area of each mirror may exceed its tolerances provided that no single defect shall have an area greater than 1/10 of 1% for Mirrors No. 1, 2, and 3, and 1/20 of 1% for Mirror No. 4. Areas effected by edge sealing of coatings and/or non-usable inside diameters and outside diameters, as previously defined during the course of the contract, shall not be included in the 1% allowance.

2.2 Additionally, for Mirrors No. 1, 2, and 4, a photograph of the projected "flash" will be made where feasible. If apparent abnormalties are noticed, the mirrors will be repositioned and the prescribed tests will be performed to include the questionable areas. Mirrors will be acceptable if the measured deviations do not exceed the mirror reflector figure tolerances and para. 2.1.

2.3 Mirrors No. 1,2, and 3 shall have no more than 1% of the surface area being non-reflective with further limitations to area defined in 2.1 above. Mirror No. 4 shall have only 1/4 of 1% allowable surface defect area except for an allowable 1/4 inch wide band at inner and outer edges. In total only 1% surface defects shall be allowable.

2.4 The 1% area allowable for optical slope defects and the above defined or coating defect areas shall not be considered additive. No more than one percent shall be allowed for the total of both types of defects.

2.5 The presence of mirror surface defects which are normal to the replicated mirror processes and which are not obviously the result of poor workmanship shall not be cause for rejection. Pits and digs replicated from the master shall not exceed the allowable areas above.

3.0 Chart #1 is to be used to judge the surface quality of the mirrors.

4.0 Verify that all operations on the M.O.'s and inspection travelers have been completed.

5.0 Verify that all ISR's have had the rework accepted by the DCAS inspector, (stamp ISR), or have been dispositioned "use as is" by EOS QA Engineering and the project manager if discrepancy is within contractual requirements.

6.0 Verify that all MRR's have been bought off by EOS and DCAS.

7.0 If the mirrors and documentation are acceptable, stamp the final inspection block on the M.O. and inspection traveler.

SURFACE DEFECTS CHART #1

Mirror No.	A Reflective Area IN^2	1% A 1% of Reflective Area IN^2	Maximum Blemish Size % Area	Dia	No.	MAXIMUM NUMBER OF SPOTS OF NO GREATER DIAMETER THAN 3/4"	1/2"	3/8"	1/4"	3/16"	1/8"	3/32"	1/16"	1/22"
			1/10 %											
1	530	5.3	.53	.82	10	12	27	48	108	192	432	768	1787	6883
2	148	1.48	1/10	.43	10	-	-	13	30	53	120	214	482	1922
3	110	1.1	1/10 .11	.37	10	-	-	-	22	40	90	159	358	1428
4	1277	12.77	1/20 .64	.90	20	29	65	115	260	462	1040	1850	4161	16,584

EOS QUALITY ASSURANCE
INSPECTION TRAVELER
NASA MIRRORS

CONTRACT NO.
NAS9-5805

Revision A
12-12-66

P/N: _____

S/N: _____

	GOVT. INSPEC. B	EOS	DATE
1. Inspect Casting			
2. Inspect Cleaning of Casting			
3. Inspect Bonding of Mirror to Casting			
4. Witness Optical Test			
5. Mechanical Inspection			
6. Inspect Coating of Mirror (coating test)			
7. Witness Reflectivity Test Reflectivity test may be performed after completion of final inspection and release of mirrors for assembly.			
8. Final Inspection			

1.11.4.19 Additional Inspection Instructions for Mirrors
(to be incorporated when they become contractually required)

EOS

INSPECTION INSTRUCTION

II #7056-17

PART NO.	REV. A
PART NAME: Cleaning	
INSPECTION STATION OR AREA: 7B	

PREPARED BY	DATE	APPROVED BY	DATE	SUPERSEDES
. Corder	11-1-66	[signature]	12/15/66	

1.0 Inspect the cleaning operation for all mirrors. Record inspection on cleaning inspection check list.

2.0 Verify that all test and inspection equipment used is calibrated.

3.0 Verify that production personnel have copies of and are using the latest revision of the cleaning procedure (EOS Directive 12-2).

4.0 Stamp manufacturing order and inspection traveler.

EOS

INSPECTION INSTRUCTION

II #7056-18

PART NO.	REV.
	A
PART NAME	
Bonding	
INSPECTION STATION OR AREA	
7B	

PREPARED BY	DATE	APPROVED BY	DATE	SUPERSEDES
C. Corder	11-1-66			

1.0 Inspect the bonding operation for all mirrors. Record inspection on bonding inspection check list.

2.0 Verify that all test and inspection equipment used is calibrated.

3.0 Verify that all material requiring age control is within its current use date.

4.0 ~~Verify~~ that the bonding test is performed in accordance with the torque shear ~~adhesion test procedure~~ EOS Directive No. 15-2.

5.0 Verify that the production personnel have copies of and are using the latest revision of the bonding procedure (EOS Directive 15-2).

6.0 Stamp manufacturing order and inspection traveler.

EOS

INSPECTION INSTRUCTION

II #7056-18-A

PART NO.	REV.
PART NAME: Bonding	
INSPECTION STATION OR AREA: 7B	

PREPARED BY	DATE	APPROVED BY	DATE	SUPERSEDES
F. E. Schwalbe	1-11-67	M. Forcette for RPH	1/12/67	

1.0 Witness and verify that the bonding test is performed in accordance with the torque shear adhesion test procedure, EOS Directive No. 15-2. Record value on Manufacturing Order (MO).

2.0 Stamp Manufacturing Order and Inspection Traveler.

EOS

INSPECTION INSTRUCTION

II #7056-19

PART NO.	REV.
PART NAME: COATING	
INSPECTION STATION OR AREA: 9A	

PREPARED BY	DATE	APPROVED BY	DATE	SUPERSEDES
K. Corder	10/1/66	RPH/217	10/4/66	

1.0 EOS inspector to perform the coating test referenced in para. 4.11 of MIL-M 13508A on all mirrors.

2.0 Stamp M.O. and Inspection Traveler.

1.11.4.20 Inspection Check List for Collector

Inspection Check List
for Collector

Serial No.

Para. Nos. Reference Assembly Procedure	Brief Description of Inspection Requirement	
	Verify that the parts listed are installed in accordance with Drawing 614575 and the assembly procedure.	
	Inspection per II #7056-0	
2.3.4	(3) flanges, item 4(30-006), flat face out	
	(9) Screws and lockwashers, items 14 and 15.	
2.3.5	(3) flanges, item 47 (30-050), flat face out	
	(9) Screws and lockwashers, items 13 and 15	
2.3.6	(1) point, item 21 (30-028)	
	(1) nut, item 23	
	(1) ring, item 48	
2.3.7	(2) points, item 22 (30-027)	
	(2) nuts, item 23	
2.3.8	(2) lower support tubes, item 57 (30-059)	
	(2) threaded plugs, item 58 (30-058)	
	(4) screws and lockwashers, items 55 and 56	
2.3.9	(4) spacers, item 3 (30-005)	
	(4) screws and lockwashers, items 15 and 16	
2.3.10	(1) fittings, item 36	
	(1) connector, item 42	
	Varnish all pipe threads, item 73	
2.3.11	(1) cooling panel, item (30-002)	
	(2) screws, item 13	
	(2) screws, item 14	
	(4) lockwashers, item 15	
	Inspection per II #7056-1	
2.3.90	~~Verify that mirrors #1, #2 and vane subassembly are in alignment.~~	
2.3.81	~~Verify that the reticle for Mirror #1 is centered on the laser beam.~~	

~~Item 81~~

VOID

INSPECTION CHECK LIST

FOR COLLECTOR

REVISED DECEMBER 7, 1966

Para. Nos. Reference Assembly Procedure	Brief Description of Inspection Requirement	Serial No.
	Inspection per II #7056-1 Revised November 7, 1966	
2.3.80	Verifyautocollimation of alignment rod, fixture No. 614681.	
2.3.81	Verify centering of No. 1 mirror reticle on laser beam. Torque item 13 to 75 in lbs.	
2.3.82	Verify centering of No. 2 mirror reticle on laser beam. Torque.	
2.3.83	Verify .794 $\pm$ .005" dimension	
2.3.84	Verify illumination of I.D. of No. 2 mirror	
2.3.85	Verify the focused image on the laser beam at the projection screen.	
2.3.87	Verify positioning of alignment fixtures.	
2.3.88	Verify that items 14 and 16 are tight.	
2.3.89	Verify that point source rod is installed.	

INSPECTION CHECK LIST

FOR COLLECTOR

REVISED DECEMBER 7, 1966

Para. Nos. Reference Assembly Procedure	Brief Description of Inspection Requirement	Serial No.
	Inspection per II #7056-1A Revised November 7, 1966	
2.3.92	Verify lens reticle centered in laser beam.	
2.3.93	Verify that projected laser image from the front and rear surfaces are autocollimated.	
2.3.94	Verify 8.141 ± .005" dimension,	
2.3.95	Verify optical flat is centered in laser beam. Check torque.	
2.3.96	Verify dimension 5.442" ± .005".	
2.3.97	Verify fixture is removed.	
2.3.98	Verify point source light test.	

INSPECTION CHECK LIST

FOR COLLECTOR

REVISED DECEMBER 7, 1966

Para. Nos. Reference Assembly Procedure	Brief Description of Inspection Requirement	Serial No.
	Inspection per II #7056-2	
2.3.16	Verify installation of (3) ite s 53 on (3) items 59.	
2.3.17	Verify installation of (3) items 64.	
2.3.18	Verify installation of items 59, 53 and 64.	
2.3.19	Verify installation of (3) items 62.	
2.3.20	Verify installation of reticle plate.	
2.3.30	Verify installation of (3) items 54.	
2.3.31	Verify installation of (3) items 63.	
2.3.32	Verify installation of item 60.	
2.3.33	Verify installation of (3) items 61.	
2.3.34	Verify installation of item 12 on item 78.	
2.3.35	Verify installation of item 41.	
2.3.36	Verify installation of item 66.	
2.3.37	Verify installation of item 32.	
2.3.38	Verify installation of items 66, 77 and 41.	
2.3.39	Verify installation of item 32 and 69.	
2.3.40	Verify that hose assemblies are connected to mirrors.	
2.3.41	Verify installation of reticle plate.	
2.3.47	Verify installation of (2) items 24, (1) item 25, (6) items 14, 15 and 17.	
2.3.48	Verify installation of (2) items 26, (3) items 27, (2) ite s 15 and 16.	

INSPECTION CHECK LIST

FOR COLLECTOR

REVISED DECEMBER 7, 1966

Para. Nos. Reference Assembly Procedure	Brief Description of Inspection Requirement	Serial No.
	Inspection per II #7056-2	
2.3.49	Verify installation of (4), items 8.	
2.3.50	Verify installation of (2) items 37, (1) item 51 (1) item 31.	
2.3.51	Verify installation of (1) item 50.	
2.3.56	Verify installation of (3) items 44, (6) items 45 and 46.	
2.3.57	Verify installation of (3) items 43, (6) items 45 and 46.	
2.3.58	Verify installation (3) items 34.	
2.3.59	Verify installation of item 35, (3) items 14 and 15.	
2.3.60	Verify installation of (3) items 76, (3) items 30.	
2.3.61	Verify installation of lens 30-018, and item 77.	
2.3.64	Verify installation of No. 2 mirror.	
2.3.65	Verify installation of mirror hoses.	
2.3.66	Verify connection of hose to cooling panel.	
2.3.68	Verify installation of No. 1 mirror.	
2.3.70	Verify installation of vane subassembly.	
2.3.73	Verify that mirror and vane hoses are connected.	
2.3.74	Verify installation of 3rd support tube.	
2.3.91	Verify installation of (2) items 30, (4) items 15 and 16, (3) items 33, lens assembly.	

INSPECTION CHECK LIST

FOR COLLECTOR

REVISED DECEMBER 7, 1966

Para. Nos. Reference Assembly Procedure	Brief Description of Inspection Requirement	Serial No.
	Inspection per II #7056-2	
2.3.101	Verify recorded length frame ends vs. tube.	
2.3.102	Verify installation of cooling panel.	
2.3.103	Verify installation of item 69.	
2.3.104	Verify installation of items 10, 73, 12, 38.	
2.3.105	Verify installation of items 12 and 11.	
2.3.106	Verify installation of items 36, 9, 37, 31 and 73.	
2.3.107	Verify installation of item 66.	
2.3.108	Verify installation of items 12, 79 and 74.	
2.3.109	Verify installation of item 41.	
2.3.110	Verify installation of assembly in Paragraphs 2.3.107 thru 2.3.109.	
2.3.111	Verify installation of item 32 and 41.	
2.3.112	Verify steps 2.3.107 thru 2.3.109 repeated.	
2.3.113	Verify installation of assembly in paragraphs 2.3.107 thru 2.3.109.	
2.3.114	Verify installation of item 32 and 41.	
2.3.115	Verify installation of items 12, 50 and 74.	
2.3.116	Verify installation of items 38, 12, 74, 70, 71 and 72.	
2.3.117	Verify installation of items 12, 11 and 74.	
2.3.118	Verify installation of item 49.	

INSPECTION CHECK LIST

FOR COLLECTOR

REVISED DECEMBER 7, 1966

Para. Nos. Reference Assembly Procedure	Brief Description of Inspection Requirement	Serial No.
	Inspection per II #7056-2	
2.3.119	Verify installation of upper support tube.	
	Inspection per II #7056-2A	
2.3.123	Perform Hydrostatic Test.	

1.11.4.21 Inspection Check List for Collimator

INSPECTION CHECK
LIST FOR COLLIMATOR

Serial Nos.

Ref. Nos. Reference Assembly Procedure	Brief Description of Inspection Requirements
	Verify that the parts listed are installed in accordance with Drawing 614569 and the Assembly Procedure
	Inspection per II #7056-5A
2.4.7	Witness assembly step 2.4.7 .
	Verify 43.5" ± .2" measurement
	Verify that the mirror is focused on the laser beam
	Verify 4.644" ± .005" measurement
	Inspection per II #7056-6
2.4.29	Witness assembly step 2.4.29
	Verify that the projected light from the mirror is centered on the laser beam
	Verify 30.517" ± .005" measurement
2.4.3	(1) collimator support, item 8
	(12) 10-32 X 7/8" socket head cap screws
2.4.4	(3) alignment nuts, item 4
2.4.5	(3) alignment studs, item 5
	(1) each of (3) jam nuts, item 9
2.4.6	(1) #4 mirror, item 1
2.4.8	(1) #4 bezel, item 47
	(3) clamps, item 44, 45
	(3) screws, item 46
2.4.12 (3	(3) brackets, item 11
	(6) screws and washers, items 12 and 16
2.4.13	(3) alignment studs, item 6
	(4) alignment nuts, item 7
	(1) each of three jam nuts, item 10
2.4.14	Install the alignment assemblies in lens mount
2.4.15	(1) lens #1, item 3
	(4) screws and washers, items 5 and 7
2.4.16	(1) lens #2, item 4
	(1) retainer ring, item 2
	(3) screws and washers, items 6 and 7

2.4.17	(1) mirror #3, item 2
2.4.22	(1) support arm, item 26
	(1) support arm, item 27
	(1) support arm, item 28
	(6) screws, nuts, lockwashers, items 23, 24 and 25
	(6) items 17, 24 and 25
	(6) shims, item 42
2.4.23	(3) inserts, item 14 use loctite
	(3) screws and lockwashers, items 35 and 29
2.4.26	(1) item 38
	(3) item 37
	(13) pieces of tubing lengths as required Items 20, 21, 40 and 41
	(6) item 18
	(3) item 19
	(2) item 36
	(1) item 39
	Solder joints
2.4.27	(12) nuts, item 24, check torque 16 ft-lbs.
	(6) screws, item 12 check torque 75 in-lbs.
	Inspection per II #7056-6A
2.4.32	Witness helium leak check per assembly procedure para. 2.4.32
	Inspection per II #7056-6B
2.4.33	Witness hydro-test per assembly procedure para. 2.4.33

1.11.4.22 Inspection Check List for Throat

Inspection Check List

For Throat

Serial No.

Para. Nos. Reference Assembly Procedure	Brief Description of Inspection Requirements
	Verify that the parts listed are installed in accordance with Drawing 31-100 and the assembly procedure. Inspection per II #7056-10
2.5.2	(2) alignment sockets, Items 22 and 23, (8) screws, (8) lockwashers, (8) flatwashers, items 27, 28, 29. Check torque (75 inch pounds)
2.5.3	(1) item 25 (1) item 26 (1) item 24 (4) screws (4) lockwashers, items 27 and 28 Check torque (75 inch pounds)
2.5.4	Install intensity control sensor wiring. Check soldering per applicable paragraphs of EOS Manufacturing Manual (cold solder joints, etc.)
2.5.5	(1) Item 10 Solder wire from pin A of 614685 to socket A of item 10. Solder wire from pin B of 614685 to socket A of item 10. Check soldering per applicable paragraphs of EOS Mfg. Manual.
2.5.6	(12) items 30 modified by 614566 (12) items 15 Verify items listed on Kit 12 are boxed for shipment (accountability)
2.6.2	(1) item 2 (1) item 3 (1) item 4 (7) item 6 (7) item 7 (7) 8-32 nuts in item 1
2.6.3	(1) item 5 in item 2
2.6.4	Install clamp cable subassembly. Install connector in item 3.

1.11.4.23 Inspection Instructions for Receiving Inspection

EOS

INSPECTION INSTRUCTION

II #7056-R

PART NO.	REV.
PART NAME: RECEIVING INSPECTION	
INSPECTION STATION OR AREA: 2	
Building "B"	

PREPARED BY	DATE	APPROVED BY	DATE	SUPERSEDES
K. Corder	10/1/66	RPH/317	10/4/66	

1.0 General - Receiving Inspection shall be in accordance with Policy O-3-B of the EOS Product Assurance Manual.

2.0 Inspection procedures are to be in accordance with para. 1.17 herein.

3.0 All equipment used to perform inspections and test must be calibrated.

4.0 The following is a brief description of the way that documentation should flow in the Receiving Inspection area:

4.1 Parts are received from shipping with 4 copies of the receiving report. All parts are then logged in the Receiving Log Book.

4.2 EOS inspector keeps all copies of receiving reports until inspection is completed.

4.3 After inspection is completed and the parts are dispositioned, one copy of the receiving report and all certs are filed in the receiving inspection area (under vendors file). The disposition of the parts and date inspection was completed is written on all of the Receiving Reports. The remaining 3 copies of the receiving reports are returned to the shipping department.

4.4 After inspection of the parts, the log book is completed, i.e. acceptance or rejection stamped, RDR # recorded, etc.

4.5 If there are discrepant parts a RDR is filled out by the inspector, and the parts are placed in the bond room.

4.6 If the parts are acceptable an acceptance tag is filled out and the parts are transferred to the store room with the tag.

EOS

INSPECTION INSTRUCTION

II #7056-13

PART NO.	REV.
PART NAME: RECEIVING INSPECTION	
INSPECTION STATION OR AREA: BUILDING "D"	

PREPARED BY	DATE	APPROVED BY	DATE	SUPERSEDES
K. Corder	10/1/66	RPH/JMT	10/4/66	

1.0 Verify that the castings are not damaged.

2.0 Verify that the traveler is received with the parts and is properly filled out.

1.11.5 Final Inspection

Policy O-3-E of the EOS Product Assurance Manual describes the final inspection procedures that will be implemented on this program.

1.11.6 Shipping Inspection

Policy O-3-F of the EOS Product Assurance Manual describes the shipping inspection procedures that will be implemented on this program.

1.12 Process Control

The special processes used on this program are:

(1) Cleaning aluminum for bonding

(2) Bonding nickel skin to aluminum casting

(3) Coating Front Surface of Mirrors

The procedures used to control these processes are contained herein.

1.13 Nonconforming Articles

1.13.1 Receiving Inspection

A Receiving Discrepancy Report, (RDR), will be written for all discrepant material received from suppliers. The RDR form and the procedure used in filling out this form is described in Policy O-3-B of the EOS Product Assurance Manual.

1.13.2 In-Process Inspection

An Inspection Squawk Report, ISR, will be written for all discrepant material found during the assembly, test, packaging, and shipping operations. The ISR form and the procedure used in filling out this form is described in Policy Q-3-D of the EOS Product Assurance Manual.

1.13.3 Bond Room

All discrepant material will be kept in the bond room. Although, if assemblies are too large to fit in the bond room or discrepant items become too numerous, they will be identified with a rejection tag and stored where practicable.

1.13.4 Material Review Board

Policy Q-4-A of the EOS Product Assurance Manual describes the Material Review procedure that will be implemented for all Minor Defects (minor defects are those defects that do not affect form, fit or function). Members of the Material Review Board shall include:

EOS Quality Engineer

EOS Project Engineer

Government Quality Assurance Representative (resident)

The MRB procedure will conform to Section 8 of NPC 200-2.

1.14 Control of Inspection, Measuring and Test Equipment

Policy O-15 of the EOS Product Assurance Manual describes the method used on this program to assure conformance to MIL-C-45662A and MIL-I-45607A.

1.15 Indication of Inspection Status

EOS maintains a stamp issuance and control program wherein each stamp is traceable to a particular inspector and the type of inspection action; (e.g.) in-process or final inspection. Stamp design is such that it does not conflict with or resemble Government Inspection identification. Policy O-13 of the EOS Product Assurance Manual describes the inspection stamp control program at EOS.

1.16 Preservation, Packaging, Packing and Shipping

Policy Q-3-F of the EOS Product Assurance Manual describes the packaging and shipping inspection procedures that will be implemented on this program.

1.17 Sampling Inspection

1.17.1 In-Process Inspection

1.17.1.1 Collector (614575) - Each collector will be inspected to the assembly drawing and assembly procedure requirements.

1.17.1.2 Collimator (614570) - Each collimator will be inspected to the assembly drawing and assembly procedure requirements.

1.17.1.3 Throat (31-100) - The throats will be inspected as follows:

A. Throat vendor will perform 100% inspection on first five throats built. Vendor will supply documentation verifying inspections.

B. EOS will perform a first article evaluation one of each of the parts and on one assembly. This will be done by an EOS Source Inspector.

C. EOS will inspect critical dimensions on throat 100%. This will be done by an EOS Source Inspector. The critical dimensions are listed as follows:

(reference drawing 31-101 Page 1 of 1)

(1) 11-A-.015

(2) #10 (.190) 32 UNF x .50 deep 22 holes

(3) $9.000^{+.004}_{-.000}$

(4) $5.00 \pm .002$

(5) ⌀-B-.002 TIR

(6) 11-A-.005

(7) $10.562^{+.000}_{-.003}$

1.17.1.3 Throat (continued)

AC. (continued)

(8) $\frac{1}{}$ -A-.020
-B-

(9) 11-A-.005

(10) 32.120

(Reference Drawing 31-101 Page 1 of 2)

(11) 2.250 ± .002

(12) 12.750 ± .002

(13) 4.500 ± .002

(14) 12.250 ± .002

(15) 10.000 ± .002

(16) 8.375 ± .002

(17) $1.501 \begin{matrix} + .002 \\ - .000 \end{matrix}$

(18) ½ (.250) 20 UNC

1.17.1.4 Mirrors 614577 Each mirror will be inspected in accordance
614331 with the inspection requirements on the
614320 mirror manufacturing order.
614576

1.17.2 Receiving Inspection

1.17.2.1 Lenses 30-018 Each lens will be inspected to the
31-034 drawing requirements
31-035
31-111

1.17.2.2 Castings 614576-1 #3
614577-1 #2
614330-1 #1
614321-1 #4
614335

Each casting will be inspected for the following:

(1) Visual examination

(2) Sample inspection 100% to drawing requirements. Sample size based on MIL-STD-105D, Level I, AQL 2.5.

1.17.2.3 Parts

The remainder of the parts for this program will be sample inspected. The sample size will be based on MIL-STD-105D, Level I, AQL 2.5. Acceptance and rejection, drawing of samples, normal, tightened and reduced inspection will be in accordance with MIL-STD-105D.

1.18 Records of Inspections and Tests

1.18.1 Receiving Inspection

The following is a list of the records kept in the Receiving Inspection area:

A. All parts upon receipt are logged in an EOS log book.

B. If the parts are acceptable, the EOS log book is acceptance stamped and an acceptance tag is filled out which will travel with the parts to the store room. If the parts are rejected the log book is "D" stamped and a Receiving Discrepancy Report is filled out. A rejection tag is also fastened to the bag or box of rejected parts.

1.18.2 In-Process Inspection

The Manufacturing Order will be the document which contains the record of all in-process inspections. This document will travel with the item throughout the assembly process. The Manufacturing Orders that will be used on this program are contained in para. 1.11.

1.18.3 Final Inspection

Records of Final Inspections will be recorded on the "Final Acceptance Tag". This tag is illustrated in Policy Q-3-E of the EOS Product Assurance Manual.

1.18.4 Shipping Inspection

Records of Shipping Inspections will be recorded on the "Final Acceptance Tag". This tag is illustrated in Policy Q-3-F of the EOS Product Assurance Manual.

1.19 Corrective Action

Policy Q-4-C of the EOS Product Assurance Manual describes the corrective action procedures which will be implemented on this program. Corrective action communication with the vendors will be maintained through R. J. LABelle of the EOS Vendor Surveillance Department, with a copy to the cognizant Product Assurance Engineer.

1.20 Inventory of Inspection, Measuring and Test Equipment

The following is a listing of the inspection, measuring and test equipment available for use by inspection and quality personnel for this procurement:

Thread Gauges (All Van Keuren)

1.1 ½-13 NC 2A
1.2 ½-13 UNC 2B
1.3 ½-20 NF 2A
1.4 ½-20 UNF 2B
1.5 3/4-10 NC 2A
1.6 3/4-10 UNC 2B
1.7 7/8-14 NF 2A
1.8 7/8-14 UNF 2B
1.9 1-8 NC 2A
1.10 1-8 UNC 2B
1.11 8-32 UNC 2A
1.12 10-32 UNF 2A
1.13 ¼-20 UNC 2A
1.14 10-32 UNF 2B
1.15 ¼-20 UNC 2B
1.16 3/8-16 UNC 2A
1.17 5/16-18 UNC 2A
1.18 5/16-18 UNC 2B
1.19 7/16-20 UNF 2A
1.20 7/16-20 UNF 2B
1.21 ½-13 UNC 2A
1.22 ½-13 UNC 2B
1.23 5/8-11 UNC 2A
1.24 5/8-11 UNC 2B
1.25 3/4-16 UNF 2A
1.26 3/4-16 UNF 2B
1.27 7/8-14 UNF 2A
1.28 7/8-14 UNF 2B
1.29 1-8 NC 2A
1.30 1-8 NC 2B
1.31 8-32 NC 2A
1.32 8-32 UNF 2A
1.33 ¼-20 NC 2A
1.34 ¼-20 UNC 2A
1.35 7/16-20 NF 2A
1.36 7/16-20 UNF 2B
1.37 3/8-16 NC 2A
1.38 3/8-16 UNC 2B
1.39 3/8-24 NF 2A
1.40 3/8-24 UNF 2B

Inspection Tools

2.1 Center Mike 12" Sorenson
2.2 Center Mike 7" Sorenson
2.3 Booster Bar 12" Sorenson
2.4 Setting Master Sorenson
2.5 Inside Micrometer 1" to 2" B&S
2.6 Inside Micrometer .2" to 1.2" S&T
2.7 12" Toolmaker Square B&S
2.8 3/8 to 2¼ Adjustable Parallels B&S
2.9 7" Vernier Caliper B&S
2.10 (2) Dial Indicator .008 x .0001 B&S
2.11 Intrimik .800 to 1.000 x .0002 B&S
2.12 Intrimik 1.000 to 1.200 x .0002 B&S
2.13 Intrimik 1.200 to 1.400 x .0002 B&S
2.14 Intrimik 1.400 to 1.600 x .0002 B&S
2.15 Intrimik Extension .8 to 1.6 B&S
2.16 Setting Ring for Intrimik .8 to 1.2 B&S
2.17 Setting Ring for Intrimik 1.2-1.6 B&S
2.18 Micrometer 0 to 1" B&S
2.19 Micrometer 1 to 2" B&S
2.20 Micrometer 2 to 3" B&S
2.21 Micrometer 3 to 4" B&S
2.22 Micrometer 4 to 5" B&S
2.23 Micrometer 5 to 6" 2
2.24 Drill Index .0135 to .039, Hoot
2.25 Ace Drill Index .040 to .228
2.26 Ace Drill Index .234A to .413Z
2.27 Ace Drill Index .062-Y16 to .500½"
2.28 Quality Control Co. Height Gauge Scope, Mod. 2A
2.29 Scherr Tumica Telescoping Gauge No. 70B
2.30 Scherr Tumica Telescoping Gauge No. 70C
2.31 Scherr Tumica Telescoping Gauge No. 70D
2.32 Scherr Tumica Telescoping Gauge No. 70E
2.33 Scherr Tumica Telescoping Gauge No. 70F
2.34 Mahr Bevel Protractor 5' Readout
2.35 Ace Optical Micrometer

INSPECTION CHECK LIST
FOR BONDING
EOS #7056-40

Date 12/12/66 Rev original

ORIGINATED BY Karl L. Gaerter

APPROVED BY [illegible]

Paragraph Nos. ref. Bonding Procedure (EOS ref. 15-2)	INSPECTION REQUIREMENT	S/N's
1.0	Verify that only the equipment and materials listed in the procedures are used. Verify that the bonding procedure is performed in the sequence indicated without interruption.	
1.3	Verify that the back of the replica is scrubbed with a clean bristly brush using Institutional Formula White King or equivalent. NOTE: Cleanser which contains chlorine or Bromine bleach cannot be used.	
.5	Verify that the surface of replica is wetted down with deionized water.	
	Verify that surface of replica is swabbed down gently with "Amway" solvent detergent (or equivalent) and that all impurities and oil stains are removed. (Does not apply to No. 3 replica).	
1.6	Verify that the replica is rinsed clean with deionized water. Verify mirror is blown dry with air. Verify that the oil and water trap in the air line is checked once per week.	
2.1 *	Verify that the conversion coating is removed from face of casting by using cleanser (Institutional Formula White King or equivalent) and a clean bristle brush or grade 00 steel wool.	
	Verify that casting is blown dry with clean air.	
3.1	Verify that the bonding fixture surface is clean from dust, dirt and epoxy prior to mounting replica and casting.	
3.4	Verify that the back of the replica is rinsed with 200° proof absolute ethyl alcohol.	
	Verify that a coat of "Epocast K Primer" is applied with a brush or spray gun over the bonded area.	

* Paragraph 2.1 only applies to No. 3 casting.

INSPECTION CHECK LIST

FOR BONDING

EOS #7056-40

DATE 12/12/66 REV proposal

ORIGINATED BY Karl F. Gordon

APPROVED BY _____

Paragraph Nos. Ref. Bonding Procedure (EOS Dir. 15-2)	INSPECTION REQUIREMENT	S/N's
	Verify that the "K Primer" cures for ½ hour at room temperature before applying epoxy.	
	For Hand Mix	
4.1	Verify that the preparation of the adhesive is as follows: Weight out: 500 gms 1210 and 500 gms 9615 for Mirror #1 200 gms 1210 and 200 gms 9615 for Mirror #2 200 gms 1210 and 200 gms 9615 for Mirror #3 800 gms 1210 and 800 gms 9615 for Mirror #4 Verify scale is calibrated. Verify that the epoxy is within its use date (check age control tag). Verify that the epoxy is mixed thoroughly. Verify that the epoxy is used within ½ hour after mixing.	
4.2	For Frozen Pre Mix Verify that tubes of epoxy (3 tubes for #1 mirror, 1 tube for #2 and #3 mirror, 5 tubes for #4 mirror) are immersed in hot water 120°F to 150°F and allowed to thaw for 5 to 12 minutes. Verify that water has not entered into the back of the cartridge and contaminated the epoxy. Verify that epoxy is used within one-half hour after thawing. Verify that the epoxy is within its use date (check age control tag).	
4.3 4.4 4.5	Verify that the casting to be bonded has been cleaned in accordance with process Spec 12-2. The cleaning inspection check list must be complete. Visual inspect the casting to assure that it is clean and dry.	

INSPECTION CHECK LIST

FOR BONDING

EOS #7056-40

Date 12/12/66 Rev Original

ORIGINATED BY Karl L. Gordon

APPROVED BY [illegible]

Paragraph Nos. Ref. Bonding Procedure (EOS Dir. 12-2)	INSPECTION REQUIREMENT	S/N's
	Verify that epoxy is applied to back of replica and front of casting with air injection gun or equivalent.	
	Verify that epoxy is spread evenly with clean spreader.	
	Verify casting is positioned on back of reflector and centered using centering plate.	
4.6	Verify that no pressure other than that of the casting weight is used to hold the casting to the reflector.	
4.7	Verify that the excess epoxy is not removed until four (4) hours minimum after bonding.	
4.8	Verify that the mirror assembly cures at room temperature for a minimum of 12 hours before it is removed from the bonding fixture.	
4.9	Verify that the nickel bonding traveler is filled out completely.	

INSPECTION CHECK LIST
FOR CLEANING
EOS #7056-14

Date 12/12/86 Rev Original

ORIGINATED BY Karl E. Gunter

APPROVED BY _____

aragraph Nos.
ef. Bonding
rocedure (EOS
ir. 12-2)

	INSPECTION REQUIREMENT	S/N's
1.0	Verify that the pre-clean solution contains 5 to 7 oz of Turco 4215 per gallon of water. Verify temperature of pre-clean solution to be between 160°F and 180°F.	
[1.1 & 1.2]	Verify that casting is immersed into cleaner solution and allowed to soak for 15 minutes.	
1.3	Verify casting is spray rinsed using deionized water.	
2.0	Verify that the etch solution contains 5 to 7 oz. of Turco Aluminetch No. 3 per gallon of water. Verify temperature of etch solution to be between 140° and 160°F.	
[2.1 & 2.2]	Verify that casting is immersed into etching solution and allowed to etch between 5 and 10 seconds.	
2.3	Verify casting is spray rinsed using deionized water.	
3.0	Verify that the deoxidize solution contains: Turco Nitradd 12 to 20% by Vol - Nitric Acid (42°Be) 60 to 80% by Vol.	
3.1	Verify that casting is immersed into the deoxidizer solution for a minimum of 15 seconds.	
3.3	Verify that casting is rinsed with deionized water.	
3.4	Verify that all traces of deoxidizer solution are removed.	
4.0	Verify that the conversion coating contains 1 to 1.5 oz. of Iridite 14-2 per gallon of water and that its Electrometric pH is between 1.4 and 1.6.	

INSPECTION CHECK LIST

FOR CLEANING

EOS #7056-14

Date 12/12/66 Rev Original

ORIGINATED BY Karl L. Loeder

APPROVED BY _____

paragraph Nos. Ref. Bonding Procedure (EOS Dir. 12-2)	INSPECTION REQUIREMENT	S/N's
4.1 & 4.2	Verify that casting is immersed into conversion coating for 3 to 4 minutes while it is still wet from the deoxidize rinse. If it is allowed to dry the deoxidize operation must be repeated.	
4.3	Verify that the casting is rinsed with deionized water.	
4.4	Verify that casting is dry prior to bonding. If casting is not to be bonded immediately, verify that it is wrapped in clean wax paper and stored in a clean dry place.	

APPENDIX C

DRAWING LIST

EXHIBIT A

COLLECTOR SUBASSEMBLY

Drawing	Revision	Description
614575	B	Collector Assembly (Sheet 1 of 2)
614575	B	Collector Assembly (Sheet 2 of 2)
30-001	S	Frame, Collector
30-002	D	Panel, Cooling
30-005	N/C	Spacer, Cooling Panel
30-006	B	Flange, Collector
30-018	F	Collector Lens
30-019	N/C	Clamp
30-021	N/C	Collar
30-022	C	Flange
30-023	H	Vane
30-024	D	Flange Alignment
30-025	N/C	Ring, Alignment
30-026	L	Structure Collector Lens Alignemnt
20-027	N/C	Point, Alignment
30-028	A	Point, Alignment
30-032	E	Vane Subassembly
30-033	C	Vane Subassembly
30-034	E	Vane Subassembly
30-035	C	Plate, Mounting
30-036	C	Plate, Mounting
30-037	B	Stand-Off
30-038	N/C	Spacer
30-042	N/C	Spring
30-043	E	Lens and Structure Subassembly
30-048	A	Retaining Block
30-049	A	Retaining Block
30-050	A	Flange, Collector

COLLECTOR SUBASSEMBLY (Continued)

Drawing	Revision	Description
30-055	A	Clamp, Pipe
30-056	A	Bar, Support
30-057	B	Plate
30-058	N/C	Plug, Threaded
30-059	A	Tube, Support
30-060	N/C	Clip, Lens Support
614330	C	Casting, Weldment, Primary Mirror
614331	A	Primary Mirror (Mirror No. 1)
614332	D	Nut, Alignment (-3, -7)
614333	A	Stud, Alignment, Large (-1)
614334	B	Flange, Nut, Collector Alignment (-1, -3)
614337	B	Stud, Alignment, Small (-1)
614577	A	Collector Mirror, Secondary (No. 2 Mirror)
614699	N/C	Adapter, Modified Nipple

COLLIMATOR SUBASSEMBLY

Drawing	Revision	Description
614570	B	Collimator Assembly
31-003	N/C	Stud, Lifting Plate, Rear Support
31-011	B	Arm, Support
31-016	B	Insert, Threaded
31-017	B	Arm, Support Subassembly
31-019	B	Arm, Support Subassembly
31-034	E	Collimator Lens #1
31-035	E	Collimator Lens #2
31-053	N/C	Bezel, Primary Mirror
31-054	N/C	Clamp, Bezel, Mirror
31-055	N/C	Clamp, Bezel, Mirror
31-059	A	Shim
614320	D	Primary Mirror, Collimator (No. 4 Mirror)
614321	C	Casting, Primary Mirror, Collimator
614332	D	Nut, Alignment (-1, -5)
614333	A	Stud, Alignment, Large (-3)
614335	C	Support Subassembly, Collimator
614336	A	Ring, Retainer
614337	B	Stud, Alignment, Small (-3, -5)
614562	A	Lens Mount, Collimator
614563	A	Bracket, Lens Assembly
614566	N/C	Threaded Parts for Vacuum Application
614569	N/C	Lens Assembly, Collimator
614576	C	Mirror Assembly, Secondary, Collimator (No. 3 Mirror)
614579	N/C	Clip, Retainer No. 3 Mirror
614688	N/C	Line, Supply, Water Cooling
614689	N/C	Line, Return, Water Cooling
614690	A	Line, Discharge, Water, Primary Mirror
614691	N/C	Line, Input, Water, Secondary Mirror
614692	A	Line, Discharge, Water, Secondary Mirror

THROAT SUBASSEMBLY

Drawing	Revision	Description
31-100	M	Throat Assembly
31-101	T	Throat Weldment (Sheet 1 of 2)
31-101	T	Throat Weldment (Sheet 2 of 2)
31-102	G	End Plate Subassembly
31-103	F	Field Lens Retainer
31-104	E	Neck, Welding
31-105	J	Insert, Plate
31-106	D	Ring, Seal
31-107	E	Throat Pipe
31-108	G	Field Lens Support
31-109	D	Cooling Loop
31-110	H	Bellows Assembly
31-111	E	Field Lens
31-112	N/C	Gasket, Iris Support
31-113	A	Gasket, Iris, Iris Support Subassembly
31-115	B	Iris Support Subassembly
31-116	H	Support, Iris - Iris Support Subassembly
31-118	B	Field Lens Cell Subassembly
31-120	B	Socket, Alignment
31-121	A	Cap, Bearing
31-125	B	Socket, Alignment
31-126	A	Cable Assembly, Iris Control
31-127	B	Tube and Support Subassembly, Iris Support Subassembly
614685	N/C	Feedthrough and Socket Arrangement

HANDLING EQUIPMENT DRAWINGS

Drawing	Revision	Description
614582	N/C	Lift Device, Collector Assembly
614585	N/C	Assembly and Transport Fixture, Collector
614586	A	Support, Lens Assembly
614587	N/C	Crane Adapter, Collimator Assembly
614596	N/C	Cart, Collimator Handling (Horizontal Installation)
614686	N/C	Adapter, Lifting (C. G.) Collimator Assembly (Crane Adapter)
614687	N/C	Lifting Device, Collimator Assembly (Crane Adapter)

MSC ACCEPTANCE TEST EQUIPMENT DRAWINGS

Drawing	Revision	Description
614589	N/C	B & L Light Source Locating Fixture
614590	N/C	Fixture Collimator, MSC Final Acceptance
614593	A	Fixture, Burner Simulator
614594	N/C	Post, Alignment, Burner Simulator Fixture
614595	A	Adapter, Burner Simulator (MSC)
614681	N/C	Optical Flat
614682	N/C	Point Source Rod
614695	N/C	Adapter, Burner Simulator (EOS)

EOS TEST AND ALIGNMENT EQUIPMENT DRAWINGS

Drawing	Revision	Description
614583	N/C	B & L Point Light Source

EOS TEST AND ALIGNMENT EQUIPMENT DRAWINGS (Continued)

Drawing	Revision	Description
614584	N/C	Locator, Position, Z Axis, #4 Mirror
614588	N/C	Stand, Laser
614589	N/C	B & L Light Source Locating Fixture
614591	N/C	Stand, Assembly, and Alignment Collimator
614592	N/C	Stand, Burner Simulator
614593	A	Fixture, Burner Simulator
614594	N/C	Post, Alignment, Burner Simulator Fixture
614597	N/C	Plate, Recticle, Alignment Fixture
614598	N/C	Plate, Mounting, Reticle Alignment Fixture
614599	N/C	Throat Simulator
614681	N/C	Optical Flat
614682	N/C	Point Source Rod
614683	N/C	Vane Assembly Locator Rod
614684	N/C	Vane Alignment Fixture
614693	N/C	Fixture, Reticle Alignment, Collimator
614694	N/C	Fixture, Reticle Alignment, Collector
614695	N/C	Adapter, Burner Simulator (EOS)
614697	N/C	Lens Assembly Support and Stand