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MANUFACTURING METHODS AND TECHNOLOGY (MMTE) MEASURE FOR FABRICA--ETC(U)
SEP 76 E T CHAN, G E LILJEGREN DAAB07-76-C-0034

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FIRST QUARTERLY PROGRESS REPORT

FOR

MANUFACTURING METHODS AND TECHNOLOGY (MMTE)

MEASURE FOR FABRICATION OF LOW VOLTAGE

START SEALED BEAM ARC LAMPS

1 June 1976 To 31 August 1976

CONTRACT NO. DAAB07-76-C-0034

U.S. Army Electronics Command
Production Division
Production Integration Branch
Ft. Monmouth, NJ 07703

Varian Associates
EIMAC Division
301 Industrial Way
San Carlos, CA 94070

This project has been accomplished as part of the U.S. Army (Manufacturing and Technology) (Advance Production Engineering) Program, which has as its objectives the timely establishment of manufacturing processes, techniques or equipment to insure the efficient production of current or future defense programs.

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Stinger (Moveable electrode used for lamp ignition)

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

A program is in progress to establish a production capability for the purpose of meeting estimated military needs for the X6335, a 1kw sealed beam xenon arc lamp with low voltage starting mechanism.

Parts for five (5) lamps were fabricated. These parts were ordered for the First Engineering Sample Phase of the contract. Lamp part drawings are complete for the First Engineering Sample. → next page

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Short run welding and brazing fixtures have been fabricated. A reflector mandrel has been machined and polished.

MANUFACTURING METHODS AND TECHNOLOGY (MMTE) MEASURE FOR FABRICATION OF LOW VOLTAGE START SEALED BEAM ARC LAMPS

FIRST QUARTERLY PROGRESS REPORT

1 June 1976 To 31 August 1976

"The objective of this manufacturing and methods technology measure is to establish the technology and capability to fabricate Low Voltage Start Sealed Beam Arc Lamps."

CONTRACT NO. DAAB07-76-C-0034

By

Edwin Chan

Gordon Liljegren

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ABSTRACT

A program is in progress to establish a production capability for the purpose of meeting estimated military needs for the X6335, a 1kW sealed beam xenon arc lamp with low voltage starting mechanism.

Parts for five (5) lamps were fabricated. These parts were ordered for the First Engineering Sample Phase of the contract. Lamp part drawings are complete for the first engineering sample. Short run welding and brazing fixtures have been fabricated. A reflector mandrel has been machined and polished.

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1.0 PURPOSE

The objective of this program is to establish a production capability for the purpose of meeting estimated military needs for a period of two (2) years after completion of the contract, and to establish a base and plans which may be used to meet expanded requirements.

The production capability is intended for the purpose of manufacturing a 1kW sealed beam xenon arc lamp with low voltage starting mechanisms.

The lamp chosen for productizing is the X6257. This lamp has been produced for military searchlight applications. The high voltage version of this lamp was developed initially under contract DAAK02-68-C-0215. The 1kW lamp was further refined on a PEM Contract Number DAAB05-71-C-2609. The low voltage starting X6257 was not developed with government funds, but was developed with EIMAC funds.

This contract is divided into three phases:

1. Engineering sample (deliver 3 units)
2. Confirmatory samply (deliver 3 units)
3. Pilot run (deliver 30 units)

The Engineering Sample Phase is needed in order to allow for incorporation of features which will make the lamp start more reliably, be easier to fabricate, be safer to operate, have a highly accurate mounting surface for optical reference and reduce cost.

Problem areas anticipated are the following:

1. Bearing surfaces for the movable stinger.
2. Accurate cathode tip location relative to the reflector focal point.

2.0 GLOSSARY

LVS.................Low voltage starting

Stinger.............Moveable electrode used for lamp ignition

3.0 NARRATIVE AND DATA

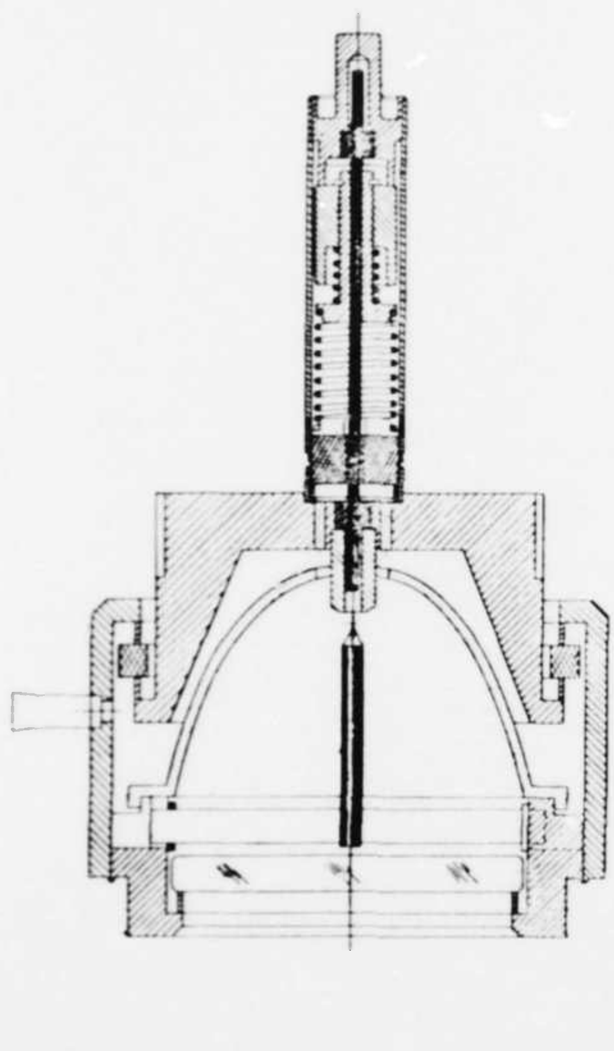
The lamp is comprised of conventional tungsten electrodes positioned in a ceramic/metal structure with a reflector and sapphire window. The arc is located at the focal point of the reflector so that a direct beam is obtained coaxial with the electrodes. The low voltage starting mechanism includes a moveable electrode called the "stinger" which is coaxial with the anode. Figure 1 shows a cross-sectional view of the X6335. This is the configuration of the first engineering sample.

The lamp is filled with up to 20 atmospheres of high purity xenon at room temperature. The lamp spectral output is a typical high pressure xenon arc spectrum as reflected from a silver mirror and transmitted through a sapphire window; the wavelength range is about 130nm to 6500nm. The silver reflector coating was selected for maximum output in the visible and near IR bands.

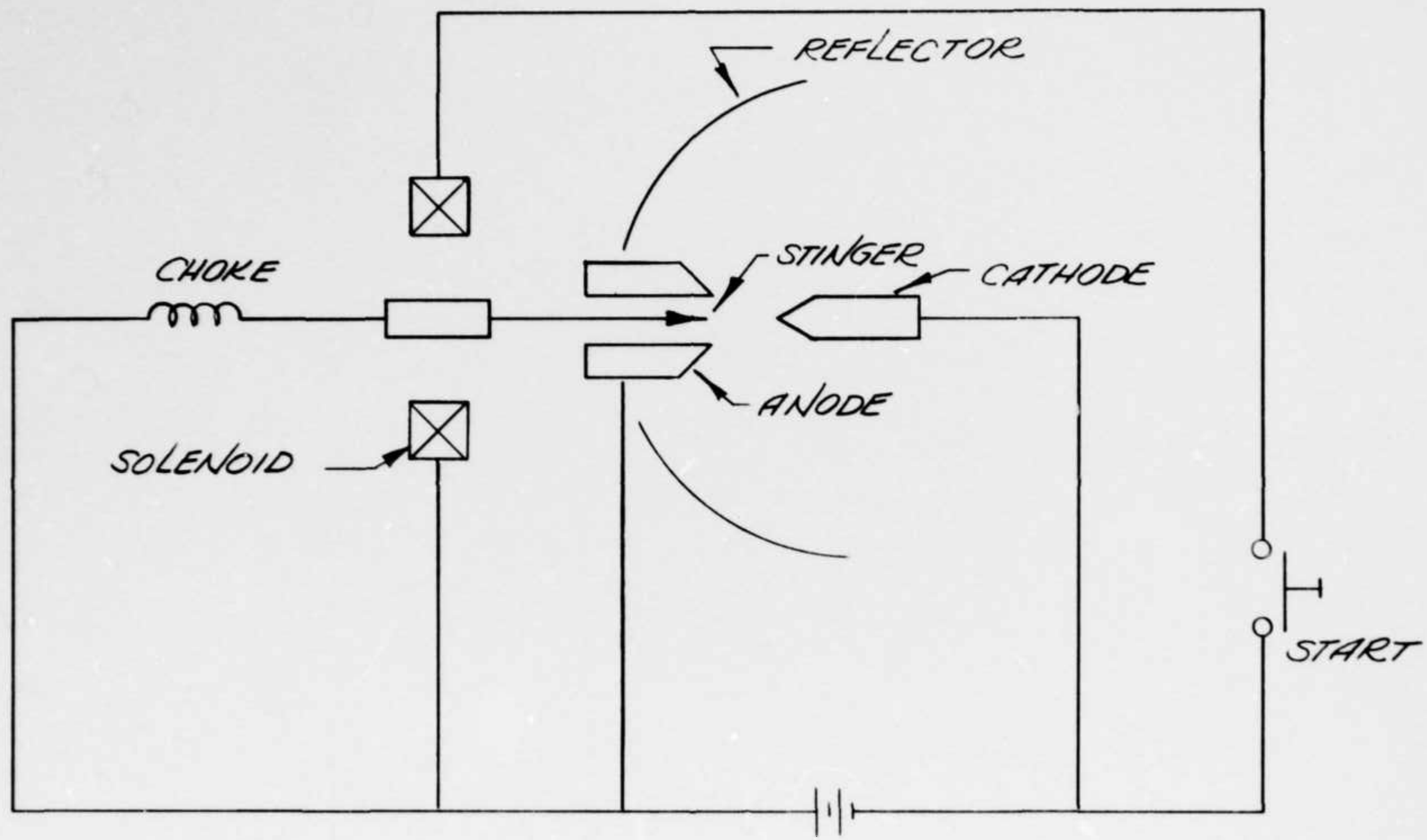
The lamp operating voltage is 19 volts d.c. $\pm$10%. The lamp voltage is determined primarily by the interelectrode gap and the lamp pressure. The lamp acts much like a constant voltage device, that is, large changes in current result in small changes in operating voltage. A sketch of the lamp ignition circuit is shown in Figure 2. Ignition is accomplished by use of the stinger. To commence the start cycle, the solenoid voltage is applied causing the stinger to move forward. The moment the stinger contacts the cathode tip, the electrical circuit is completed and current begins to flow through the choke. After approximately one second, the solenoid voltage is removed and the stinger starts to return to its deenergized position, thus breaking the circuit and stopping current flow. At this time, the stored energy in the choke is dumped into the arc. The stinger then draws this arc bak and transfers the arc to the anode.

3.1 Design and Analysis

The lamp is comprised of three major subassemblies: the



X6335 (1ST ENGINEERING SAMPLE)
FIGURE 1



LAMP OPERATING CIRCUIT

FIGURE 2

anode shell assembly, the stinger assembly and the reflector-cathode-window assembly. The following paragraphs will describe in detail these three assemblies. The description will compare the existing X6257 with the new X6335 which will be built in this program. Problem areas with regard to manufacturability, reliability and cost associated with the X6257 will be discussed as well as the design of the X6335 which is aimed at solving these problems.

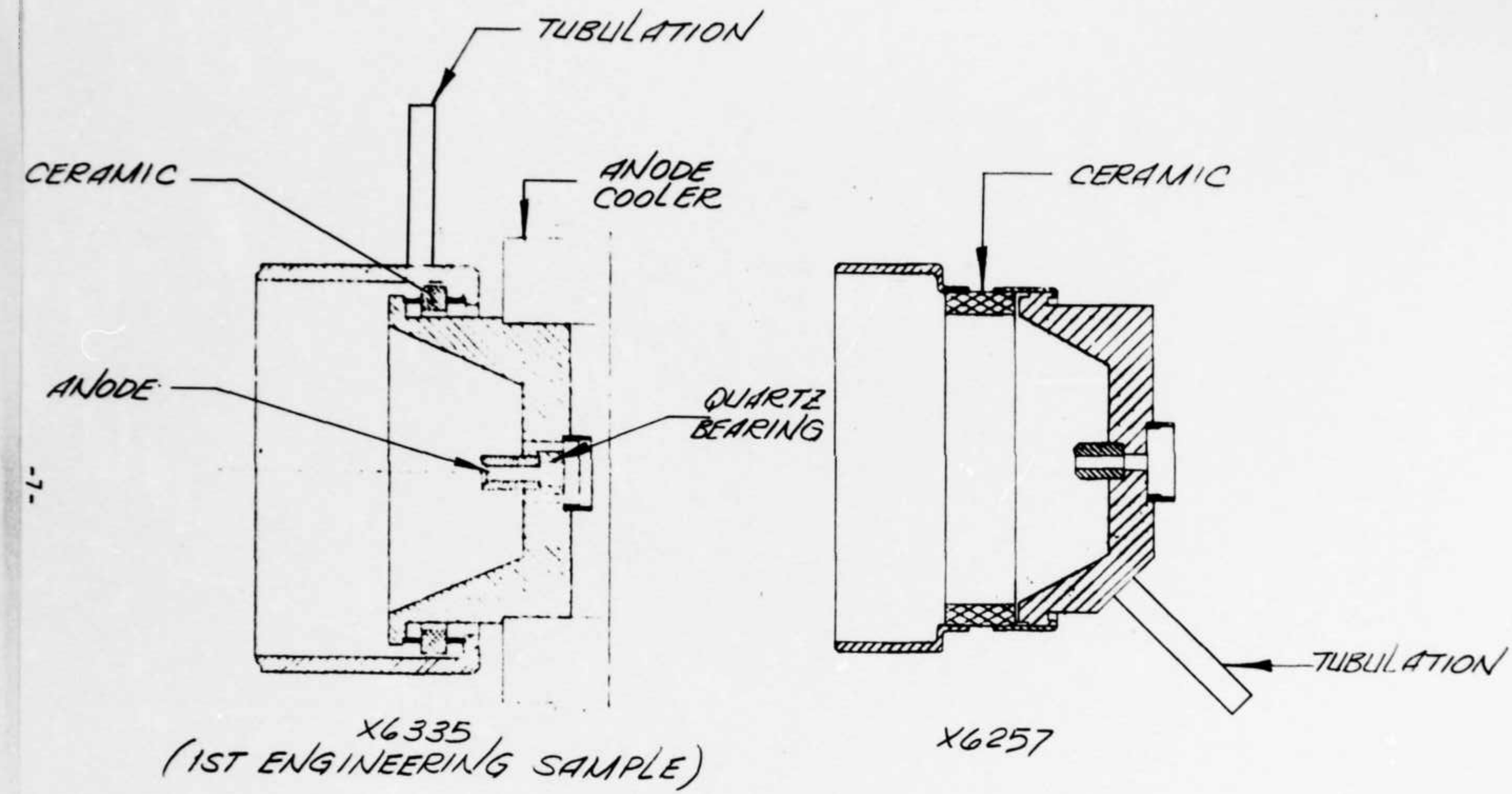
3.1.1 Anode Shell Assembly

The anode shell assemblies for the existing X6257 and the new X6335 are shown in Figure 3. Modifications are aimed at reducing cost and improving the reliability of the lamp.

The reasons for the modifications to the X6257 anode shell assembly are:

1) The ceramic is in tension since the lamp is pressurized.
2) The bearing surface for the stinger is ceramic and hence abrasive.
3) The tubulation is located on an angular flat surface which adds to the cost of the anode cup and reduces the contact area for the anode heatsink.
4) The front bearing is located too far from the anode (Not shown in Figure) therefore allowing too great a cantilever for the stinger when it is in the energized position.

As shown in the figure, the X6335 ceramic is in compression. In addition, the shell and anode cup are designed in such a way that should the seal fail, the two parts will not separate. The tubulation now comes out on the outside of the shell thus allowing the maximum contact between the anode heat-



ANODE SHELL ASSEMBLY
FIGURE 3

sink and the anode cup. Also it is anticipated that the anode cup will be less expensive to machine. The front stinger bearing in the X6335 is located close to the anode thus giving a much shorter cantilever for the stinger. Also in the X6335, the bearing is made of quartz so it will not be abrasive to the stinger.

3.1.2 Reflector-Cathode-Window Assembly

The reflector-cathode-window assemblies for the X6257 and the X6335 are shown in Figure 4. Modifications to the X6257 version of this assembly are aimed at reducing cost and improving the accuracy of the arc location with respect to the reflector focal point for the following reasons:

1) Reflector mounting requires a skilled technician. The reflector OD must be machined.

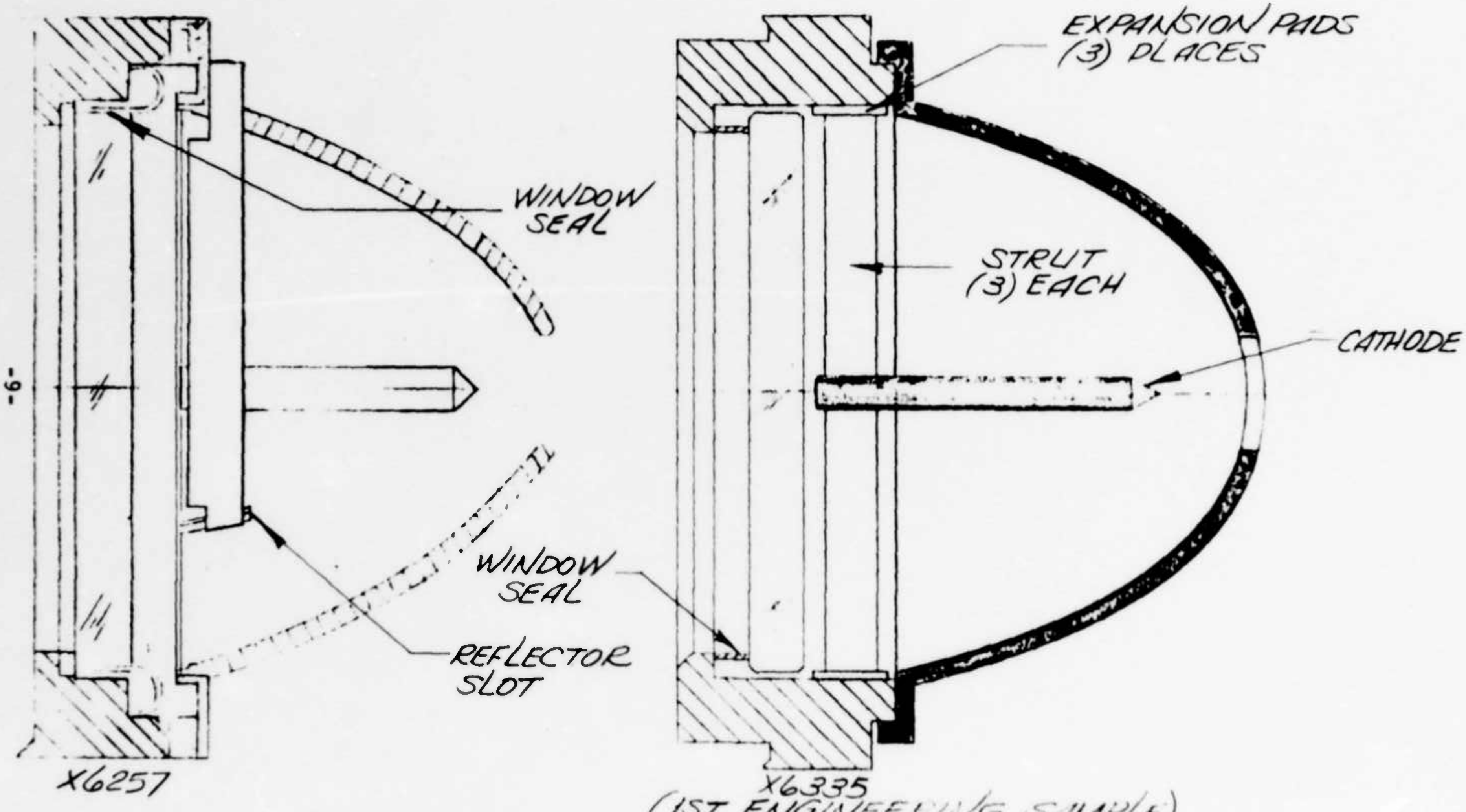
2) Strut mounting does not allow for sufficient expansion so there is a possibility of cathode misalignment during operation.

3) Window uses an OD seal which requires a tight tolerance on the window OD which increases cost.

4) Slots must be machined in the reflector for the cathode struts.

The X6335 reflector is designed so that a highly accurate flange is electroformed as part of the reflector. This flange maintains reference surfaces within $\pm .0005$ inches.

This will allow for accurate location of the cathode tip both axially and concentrically. This will simplify the reflector mounting during assembly and will not require any special skills on the part of the assembler.



REFLECTOR - CATHODE - WINDOW ASSEMBLY
FIGURE 4

The absence of machined slots in the reflector used for the X6335 will result in a significant cost reduction. The reflector OD does not need to be machined because the OD surface plays no part in the alignment.

The cathode strut assembly is brazed to the cathode housing with a copper pad interface. This will allow the strut to expand without deforming and thus hold cathode concentricity during operation.

The window modification is a two-fold improvement. The knife-edge seal is favored because the lamp is a pressure vessel. The reason this seal has not been used in the past is because it reduces the clear aperture area of the window which is needed for a parabolic type reflector. With the X6335, the light beam is converging because of the elliptical reflector thus allowing a clear aperture smaller than the reflector diameter. The knife-edge seal also reduces the cost of the window because there is no need for a tight tolerance on the window diameter.

3.1.3 Stinger Assembly

The X6335 stinger assembly has two modifications which are aimed at improving the starting reliability of the lamp. These changes involve the bearing material and the bearing location. The bearing must be made of an insulating material so that the stinger is electrically isolated from the anode. The bearing must also be able to withstand high temperature, and act as a linear bearing to allow free movement of the tungsten stinger. The X6257 stinger has proven to be a very rugged assembly which has been able to withstand severe environmental testing in both shock and vibration without breaking.

The problem has been that during life, the stinger tends to stick and does not move freely in the bearings. This problem has been attributed to the bearing material and the location of the bearings.

In the X6257, the two bearings are located close together so that when the stinger is energized, there is a considerable cantilever. With the X6335 design, the bearings are nearer the end of the stinger shaft so that the cantilever is greatly reduced.

3.2 FABRICATION

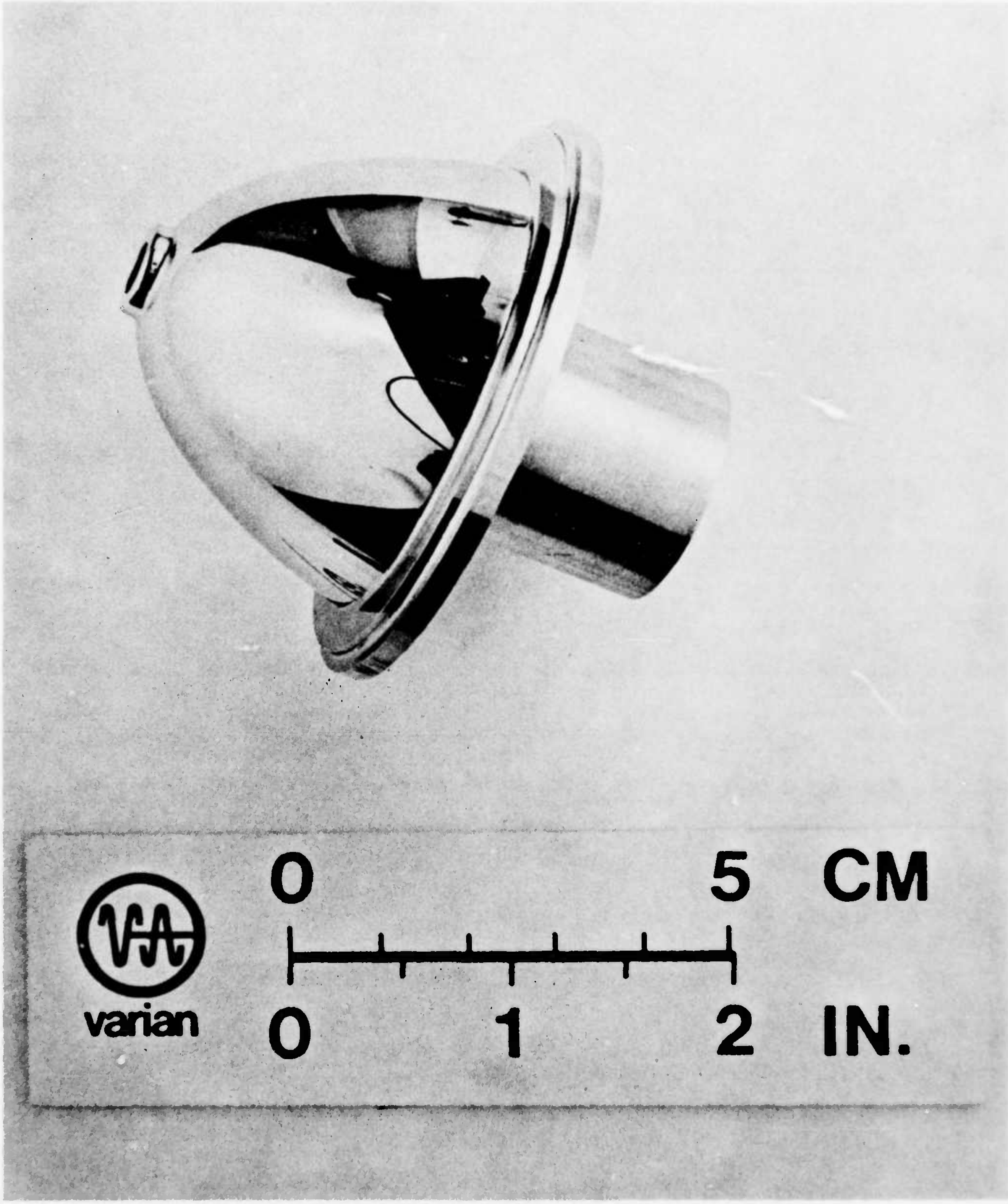
A reflector mandrel to be used for X6335 reflectors has been machined and polished. Reflectors for the first engineering sample phase have been electroformed. The reflector contour is the same as the contour used on the X6257 (f-number = 1.33). The reflector mandrel is shown in Figure 5.

3.3 TESTING

Testing has been limited to pressure testing of subassemblies. The window assembly was tested to 1950 PSI with no evidence of leakage or deformation of the window seal. This pressure level is far in excess of the level that the lamp will see during operation. The window assembly was not tested to failure because 1950 PSI was the maximum pressure available in the test equipment.

3.4 CONCLUSION

Lamp parts have been fabricated and subassemblies built. The subassemblies have been pressure tested



REFLECTOR MANDREL
FIGURE 5

with no signs of leakage or deformation.

Short run tooling has also been fabricated. A reflector mandrel has been machined and polished.

The program is progressing well and no assembly problems have been encountered.

4.0 PROGRAM FOR NEXT INTERVAL

1. Deliver the first engineering sample and test report.
2. Fabricate and test the second engineering sample.

5.0 PUBLICATIONS AND REPORTS

None.

6.0 IDENTIFICATION OF PERSONNEL

Resumes of key personnel are included in the following pages. Dr. Carl F. Knopp has overall responsibility for this program and is Chief Technical Consultant.

Mr. Ed Chan is Program Manager during the engineering improvement phase. Mr. Harlow Lloyd will be Program Manager of the pilot production phase and Mr. Bud Stuart will be Project Engineer.

Time allotted to the contract is shown in Figure 6.

CARL F. (FRITZ) KNOPP, PhD

Dr. Knopp joined the Illuminator Systems Division a year ago as its Manager. He has overall profit center responsibility with the engineering, manufacturing and marketing functions reporting to him. Dr. Knopp, in turn, reports directly to the EIMAC General Manager and Division Vice-President.

As Vice-President, and one of the three co-founders of Optical Radiation Corporation, he was the senior technical member of this new company which pioneered many new developments in the high intensity illumination systems areas. He was responsible for the design and development of numerous products, both military and commercial. Among these were an FAA certified, airborne mounted, remote controlled searchlight; a servo controlled 2 kW searchlight for the Gunship program; an aircraft mounted narrow beam gunfire simulator; and a complete product family of high intensity cinema projection light sources.

Fritz Knopp's prior experience includes the technical and managerial direction of the Advanced Illumination Systems Department at Electro-Optical Systems. Here he developed a prototype, helicopter mounted 2 kW searchlight, a target acquisition searchlight for pilot rescue, and several infrared countermeasure systems based upon the searchlight configurations. At AVCO Corporation, as Senior Staff Scientist, he was the program manager for an airborne infrared countermeasure system which successfully met all design goals, including flight test qualification.

As a result of these successful programs, Dr. Knopp has achieved a high proficiency in the management and technical direction of development and manufacturing programs for high intensity illumination systems. He has overall profit center responsibility for this program, and he will contribute immensely from his extensive engineering background in similar programs.

Education:

Northwestern University	1961-1964	PhD Mechanical Engineering
Northwestern University	1959-1961	M.S. Mechanical Engineering
Valparaiso University	1950-1959	B.S. Mechanical Engineering

Professional:

Member Sigma Xi, Optical Society of America, SMPTE
Author and/or co-author of 11 major technical publications

EDWIN T. CHAN

Ed Chan has been a Senior Development Engineer in the Illuminator Systems Division since 1971. He presently has prime responsibility for the development of all lamps and associated electronics.

His accomplishments include the development of the 1 kW sealed beam, low voltage starting xenon illuminator for which a patent has been granted. This lamp when operated in the TIXI searchlight, survived a shock in excess of 700 G's in both transverse and axial directions.

Mr. Chan has developed all of the commercial systems presently in production. These include a U.L. approved fiber optics illuminator system for medical endoscopy applications, an automated sub-system used in the alignment and exposure of semiconductor wafers, and a flash exposure and camera system for photographing the fundus of the eye. All of the standard, off-the-shelf commercial systems, have been developed by Ed Chan.

Mr. Chan is Program Manager during the MMTE phase of this program and is responsible for the lamp and the electronics.

Education:

Healds College, San Francisco 1953-1956 B.S.E.E.

Professional:

Holder of basic patent on low voltage starting lamp and several related components.

GORDON E. LILJEGREN

Gordon Liljegren has been associated with the Illuminator Systems Division since 1969 as a Development Engineer and presently as project manager of audio-visual projection systems.

His accomplishments include the successful development, environmental testing and delivery of three TIXI searchlight systems. Previously he was responsible for the development of several extensive computer programs necessary for the design and analysis of tailored reflectors for specific applications. In particular he developed a program to design the reflector contour, knowing the micro-brightness distribution of the arc and the desired near-field distribution. He has also developed programming for the numerically controlled machining of the reflector mandrels.

Education:

San Jose State 1969 M.S.E.E.
San Jose State 1958-62 B.S.E.E.

Professional:

Member of Optical Society of America. Holder of several patents on reflector design and co-holder of the basic patent on the SBIR searchlight design.

W. HARLOW LLOYD

Harlow Lloyd has been associated with the Illuminator Systems Division since 1969, primarily in the areas of production engineering and at present, as production manager. As such he is responsible for the manufacture of the lamps and the associated power conditioning equipment, including the systems integration of these components.

His past experience includes program management of several production orders for the manufacture of high reliability devices, such as squibs and detonators for the Polaris Missile. He was program manager of the PEM contract for sealed beam xenon lamps, and he is presently the program manager of the TOW Missile lamp development.

Harlow Lloyd will be Program Manager for the pilot production phase of this program.

Education:

San Jose State 1948-1952 A.B. Chemistry

Professional:

Holder of patents on two vacuum/leak detection devices.

WILLIAM R. STUART

Mr. Stuart has been with EIMAC since 1940. During this period he has served in various engineering and supervisory positions in development, preproduction and production. He served as head of the assembly department for power grid tubes for approximately ten years, and as model shop manager for three years. He has done development work on a number of different metal-ceramic electron devices. He has been instrumental in the development of heat sinked and ruggedized designs and has a number of patents covering basic construction designs and concepts relating to high intensity lamps and power grid tubes. He is the designer of the present line of standard production lamps.

Mr. Stuart is sole inventor on fourteen patents and co-inventor on three patents.

Mr. Stuart will be Project Engineer on the pilot production phase of the program.

GORDON R. LAVERING

Gordon Lavering recently rejoined the Illuminator Systems Division as Project Engineer. He has Program Manager responsibility for the design and development of all searchlight systems.

Mr. Lavering joined Eitel-McCullough (now EIMAC Division of Varian Associates) in 1959 as an Environmental Test Engineer and was promoted to Supervisor, Environmental Test Section in 1961. He next joined the Research and Special Engineering Department where he was responsible for the design of advanced versions of both liquid and gas cooled heat exchangers for high power density devices; qualification and model production of space vehicle running/docking lights for both the Apollo Command Module and the LEM; and was responsible for the design of hydrogen detector devices for applications in liquid sodium reactor loops.

Mr. Lavering's previous work in the Illuminator Systems Division included the design, development, and limited flight testing of EIMAC's first xenon arc lamp searchlight, which was mounted on the exterior of an airplane. In a similar program, Mr. Lavering produced a modular, ruggedized xenon searchlight designed for tank mounted field evaluation.

Education:

University of California, Berkeley 1956 B.S. Mechanical Engineering

Professional:

Mr. Lavering has five patents issued, two pending, one application for re-issue and several active patent disclosures. He presented a talk on spacecraft lighting to the Society of Automotive Engineer's Sub-Committee of aircraft lighting.

Mr. Lavering is a registered professional engineer, licensed in the State of California.

VICTOR E. KRISTEN

Mr. Kristen joined the Illuminator Group at EIMAC in April of 1975. He is the Supervisor of the Design and Drafting Group and thus responsible for new product design/manufacturing interface, cost estimates, machining and assembly processes and vendor liaison.

He has overall responsibility for the mechanical design and documentation of illuminator products both military and commercial. These product areas include searchlight lamps, TOW lamps, shillelagh lamps, medical applications, audio visual applications and numerious other commercial applications.

Mr. Kristen's previous Senior Manufacturing Engineering experience has been with International Video Corporation, Ampex Corporation and Webcor Incorporated.

EDUCATION

Mr. Kristen is a graduate of Crane Technical Institute and is a certified Manufacturing Engineer.

Charles H. McGlew

Mr. McGlew joined EIMAC in 1963 as a master technician and has been involved in development lab prototype work during this time. His responsibilities include the design of brazing and welding fixtures used in the manufacture of xenon lamps.

For the past seven years, Mr. McGlew has been responsible for building of first-of-a-kind prototype lamps. His vast knowledge of brazing techniques has been an invaluable contribution to our lamp efforts here at EIMAC.

Mr. McGlew has been responsible for the fabrication of several first-of-a-kind lamps. These lamps include the X6219 and X6220 (built on a PEM program), Shillelagh lamps, the X6257 low voltage starting searchlight lamp, the X6335 lamp being built on this program and several lamps for commercial applications.

Prior to joining EIMAC, Mr. McGlew was employed by Sylvania as a Master Technician in an R&D Laboratory.

GEORGE CALKINS

Mr. Calkins has been with EIMAC for approximately two years. During this period he has served as Senior Designer in several military applications including TOW missile lamps, Shillelagh lamps and searchlight lamps. In addition he has been responsible for the design of several commercial efforts in the field of medical application and in audio visual.

Before joining EIMAC Mr. Calkins was a Senior Designer for the Singer Company, Lockheed Missiles and Space Company and Philco Ford.

He has considerable experience in military specifications regarding design and documentation of a military product.

NICHOLAI (NICK) I. PICOULIN

Mr. Picoulin joined the EIMAC Illuminator Group in 1966 as a Master Electronics Technician. He is currently Supervisor of the Electronic Technician Group. He is involved with the design, fabrication and testing of prototype electronic circuits associated with xenon lamps. He is also responsible for all photometric testing.

Mr. Picoulin will be responsible for all testing in this program and therefore responsible for the design of burn in equipment and life test equipment.

He will be responsible for electronic support for all environmental testing. He has considerable experience in Mil-Standard environmental test methods.

Before joining EIMAC Nick was employed by General Electric as a Journeyman Electronic Technician.

MANHOURS CHARGED TO CONTRACT FOR PROFESSIONAL AND SKILLED TECHNICAL PERSONNEL FOR PERIOD JUNE 1976 THROUGH AUGUST 1976.

Ed Chan....................112 Hours

Gordon Liljegren............78 Hours

Victor Kristen...............8 Hours

George Calkins..............68.5 Hours

Charlie McGlew..............25 Hours

Nick Picoulin...............10.5 Hours

Figure 6

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