TECHNICAL AND ENGINEERING SERVICES FOR INFRARED MEASUREMENT SUPPORT

FINAL TECHNICAL REPORT

1 October 1987

Prepared for:

Naval Research Laboratory
Washington, DC 20375

By:

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Under:

Contract No. N00014-84-C-2442

I. INTRODUCTION

This report summarizes the technical and engineering support provided by Mesa, Inc. to the Naval Research Laboratory (NRL) under contract number N00014-84-C-2442 for the contract period of October 1984 through September 1987. It is in fulfillment of Contract Data Requirements List Sequence Number A003.

The contract required technical and engineering support services from October 1984 through September 1987 for developing an overall procedure to evaluate electronic warfare devices. The support can be divided into two major areas: (1) on-site analytical and engineering support, and (2) participation in infrared field measurement exercises. The specific tasks listed in the contract Statement of Work are as follows:

1. Engineering and Analysis: The contractor shall develop an overall field measurement procedure for evaluating various electronic countermeasure devices. In particular, the procedure will outline the dynamic and static calibration procedures to be used for various commercial thermal imagers, radiometers, interferometer spectrometers and anti-ship missile simulators. These procedures should be designed to utilize present and future hardware upgrades to the Infrared Simulation, Test and Calibration Laboratory.

2. Field Measurement Exercises: During NRL field measurement exercises, the contractor shall utilize and validate the software and hardware techniques developed for the equipment listed under Task 1. A variety of field measurement programs will be performed aboard NRL mobile and stationary platforms such as fixed wing aircraft, helicopters and instrument vans to quantify in radiometric units various infrared emitting targets.

The following paragraphs summarize the technical and engineering support provided by Mesa over the contract period.

II. TECHNICAL PROGRESS

1. VICTOR Simulator Pod

October - December 1984

Attended a VICTOR design review on 24 October 1984. Reviewed hardware interface of Heurikon 68000 microprocessor board with NRL Code: 5753 personnel.

Traveled to Raytheon on 4-7 December 1984 for pre-acceptance test checkout. Several outstanding problems existed with VICTOR system that appeared to be the result of "aircraft hardening." The Inertial Reference Unit (IRU) would not turn off when the overall system power was turned off. The problem was a bent pin shorting to the navigation signal pin in the umbilical chassis connector. The infrared camera positioning system was incapable of moving the camera in a stable manner. The azimuth and elevation actuators were disassembled and shims were installed to remove excess movement in the actuators. The actuators were reinstalled in the system. The base pulse frequency in the camera elevation drive electronics was adjusted from 500 Hz to 200 Hz to increase drive torque. As a result of these two corrections, the camera positioning system worked fine. A stop was placed in the elevation axis to limit the lookdown angle to -20^{o} and the azimuth actuator was adjusted for $\pm 15^{o}$ movement centered on the pod axis.

Performed servo card checkout with Raytheon personnel. The checkout included analysis of input commands and gyro outputs of both azimuth and elevation servo loops. The detector noise was reduced from about 300 mv to 60 mv on detector number zero. Most of the noise was eliminated by connecting a hard ground strap from the seeker back mounting plate to the DEU Multibus 5 volt ground buss. The majority of the remaining noise was being produced in the detector preamp assembly. This was verified when the preamp to postamp cable was disconnected at the preamps and the noise on all detectors dropped to about 5 mv. The infrared camera also became a victim of noise. One of the solutions to the camera noise was to install a ground buss from the pod to the control rack. This solution was not acceptable since the aircraft cabling cannot be changed easily. The TV monitors in the control rack were isolated, which resulted in a 75% reduction of the camera noise. The infrared camera also was mechanically isolated from ground. The camera isolation caused no effect on detector noise and minimal effect on camera noise. Another major problem was that the infrared camera 12 volt power supply went into overvoltage protection and shut down when the ECU was cycled on. The problem was alleviated by connecting the 12 volt sense leads to the 12 volt output leads at the power supply.

Provided major input onto the development of a VICTOR maintenance manual including details how to remove VICTOR subassemblies.

January - March 1985

Participated in the acceptance testing of the VICTOR simulator at the Raytheon Missile Systems Division in Bedford, MA. Specific tasks included monitoring acceptance tests, recording data, analyzing results and other general support. Also wrote (1) a

description of the noise equivalent irradiance (NEI), and other infrared acceptance test procedures, and (2) additional chapters for the VICTOR maintenance manual, which can be loaded from diskette and read using the on-board computer or BETA system. Prepared a detailed drawing of the yaw servo control electronic for the seeker head.

Attended numerous meetings with Codes 5750, 5753, and 5751 for the purpose of generating a list of discrepancies and essential system operations for the VICTOR system. Attended a meeting with Raytheon and NRL Codes 5750, 5753 and 5751 to discuss present search and track algorithms implemented in VICTOR. Prepared a list of expenses for VICTOR spares. A list of VICTOR laboratory accessories was generated for Code 5750 budget planning. Information on transform function analyzers was gathered and a subsequent TFA demonstration at NRL was set up. The present signal processing algorithm in VICTOR contains numerous branches to subroutines. A first cut at breaking the algorithm into its separate sections was made.

The BETA system power supply failed on 18 March. The power supply was found to have a defective full wave bridge rectifier. A full wave bridge with greater forward current and greater peak inverse voltage was installed in the power supply. Also, a heat sink was added to the rectifier base plate.

April - June 1985

Arranged a meeting between National Technical Systems (NTS), NRL and Mesa personnel at the NTS facility in Hartwood, VA on 9 April. Topics of discussion were capabilities of the NTS facility and the NTS approach to conducting VICTOR vibration tests.

Organized a spares list for the Digital Electronics Unit (DEU) at the printed circuit board level and the component level. Setup spare Heurikon HK68 microprocessor boards for installation in the BETA System.

Contacted Imaging Technology to request availability of extended temperature video boards. Arranged a meeting held on 28 June between Imaging Technology, NRL and Mesa personnel. Imaging Technology's proposal for fabricating extended temperature boards was the topic of discussion.

BETA System: In experimenting with the Imaging Technology boards a noticeable degrading effect on the image occurred when a VCR and STOP motion was used as an input video source. Mesa's recommendation was to fabricate a sync stabilization circuit that would be placed between the VCR output and the Imaging Technology analog processor video input.

Wrote software to set up and exercise D/A board in BETA System.

Attended design reviews at Raytheon on 22-23 April, 5 June and 27-28 June. Topics discussed were seeker gimbal droop problems, infrared camera actuator problems, software documentation status and detector/dewar assemblies and testing.

The major emphasis was a re-design of the current camera gimbal to alleviate problems of vibration and backlash. A new design for linear actuators was proposed. Parts are to be fabricated at NRL and installation made during acceptance testing.

July - September 1985

Established a data base of VICTOR drawing titles and access numbers.

Organized technical data for extended temperature video processing board.

Conducted a feasibility study to convert all VICTOR DEU boards for an extended temperature range capability.

Generated technical requirements for hard disk storage for the BETA system.

Checked on alternative operating systems for VICTOR and BETA. Concluded that the best choice would be the UNIX operating system, as it supports PASCAL, C, FORTRAN and Assembly languages.

Attended a meeting with NRL and Fleet Electronic Warfare Support Group (FEWSG) personnel to discuss the integration of the VICTOR pod with and A-6 aircraft.

Attended an in-house VICTOR software review on 12 August 1985 for interrupt and gimbal driver routines.

Conducted troubleshooting on, and repaired, the BETA A/D converter.

Visited National Technical Systems on 31 July with NRL personnel to discuss VICTOR vibration and environmental testing.

Surveyed vendors for environmental control unit technical data.

Supported acceptance tests of new infrared detectors at Raytheon on 8 August.

Assisted ESD and Code 5170 at NRL in the development of the vibration test plan for VICTOR.

Attended a meeting at Raytheon on 26 September to review VICTOR pod vibration test procedures and to finalize plans for shipping pod to the Naval Avionics Center (NAC).

Supported NRL planning efforts with NAC in preparation for VICTOR vibration tests scheduled for October.

Designed and fabricated actuators for the infrared/television camera gimbal.

October - December 1985

During portions of October and November 1985, participated in the VICTOR acceptance testing at the Naval Avionics Center (NAC) in Indianapolis, IN. Following the acceptance test, generated a list of noted problems requiring corrective measures. While reviewing video data tapes, determined that the pod-mounted VCR required vibration isolation. Photo-Sonics, the VCR manufacturer, was contacted and they shipped mounting data and drawings which was then forwarded to Raytheon in Bedford, MA. On 30 December 1985 attended a V4-FEWSG meeting at NRL to discuss which ALQ-170 signals would be routed to VICTOR and how to interface the system to a P-3 aircraft. In preparation for further temperature testing, both NAC and NTS were contacted for chamber availability.

On 19 December 1985, attended a meeting to review technical details of VICTOR acceptance test plan.

January - March 1986

The video boards in the DEU were replaced with spares to determine the source of an intermittent problem in the video display. A shorted ribbon cable going to the AP-512 board was determined to be the problem. A new cable was fabricated and installed.

Assisted in the acceptance testing of VICTOR at Raytheon during 15-19 January 1986.

Attended meetings with Raytheon to review VICTOR performance data. Reviewed VICTOR vibration analysis performed by ESD.

Setup VICTOR in the Electro-Optical Calibration Laboratory at NRL. Rewrote the VICTOR operator's manual.

Downloaded VICTOR documentation onto the Prime computer and provided copies of the source code for review.

April - June 1986

Attended software reviews with NRL and Raytheon on 9-11 April at NRL and 5 June at Raytheon's Missile Systems Division in Bedford, MA.

Specified computer card for future VICTOR.

Checked all spare cards in VICTOR DEU and seeker head. Faulty cards were prepared for delivery to Raytheon.

Worked with summer students converting line drawings to MacIntosh computer drawings.

Shipped VICTOR to CBD and operated VICTOR at CBD.

Tested VICTOR using the LCM augmented with generator heaters. Also tracked targets of opportunity over a several week period.

July - September 1986

Sketched design for infrared television camera gimbal and assisted in its incorporation into VICTOR.

Performed periodic troubleshooting and maintenance on VICTOR electronics in preparation for future laboratory characterization of the system.

2. Electro-Optical Calibration Facility

October - December 1984

Reviewed all drawings pertinent to Room 1143 including mechanical, electronic, plumbing, etc. Developed working drawings of Room 1143 including dimension and power requirements of all equipment. Prepared documentation, layout drawings and viewgraphs on a plan to develop Room 1143 into a calibration facility.

January - March 1985

Transferred equipment to Room 1143 and began configuring the facility according to the previously prepared drawings. Also, installed plumbing and a flow meter for the argon laser water conditioning unit.

3. RF Testing of PENGUIN

October - December 1984

Designed software for data collection from Penguin missile seeker. Reviewed MK 2 Mode 3 documentation for determining what seeker signals must be recorded during the test. Integrated a Kennedy 9-channel digital recorder to the Data Translation data acquisition system via the GPIB Buss.

Attended a meeting with Code: 6652 to review the status of the development of an electromagnetic interference chamber including the control cable entries and exits, RF energy entry points and the missile installation in the chamber.

January - March 1985

Attended a meeting on 13 March with Code 6652 to discuss status of equipment. Code 6652 would like to test Penguin in the latter part of April to first part of May. Code 5751 still needs confirmation from Norwegians that they (Norwegians) will support the test.

April - June 1985

Set up optical and data acquisition equipment in the Electro-Optical Calibration Lab and performed a Noise Equivalent Irradiance (NEI) test on the Penguin P1A. Moved all Penguin support equipment to RF chambers and set up for testing. Testing occurred during 11-14 June and 17-21 June.

July - September 1985

Repaired P1A simulator one-shot multivibrator and phototransistor.

Set up instrumentation in two chamber locations which used different transmitters. Supported two tests conducted in the chamber.

October - December 1985

Began studying the Mark 2 Mod 3 PENGUIN seeker pod for the upcoming RF tests.

4. Multi-Infrared Naval Decoy (MIND)

October - December 1984

Mesa participated in one MIND test series conducted at the Chesapeake Bay Detachment (CBD) of NRL during the reporting period.

The test series at CBD was conducted on 15 November 1984. This was a land-based static firing of several different experimental decoy rounds. The main objective of this test series was to measure the infrared spectral and spatial characteristics of the experimental rounds. Mesa's contributions included participation in test planning, set-up, calibration and operation of the infrared instrumentation, and set-up and operation of a low-frequency acoustic sensor.

On 3 December 1984, Mesa supported a test conducted at the Atlantic Research Corporation (ARC) in Gainesville, Virginia. The purpose of this test was to measure the infrared spatial extent of a decoy developed by ARC.

January - March 1986

Prepared equipment for MIND field test at Talley Defense Systems in Mesa, Arizona. The Mesa Model 1034 Radiometer was borrowed from the Naval Surface Weapons Center/White Oak Laboratory. The filter in Channel 1 was replaced with a filter specified by NRL and the software was changed to operate with the new filter spectral band. The PRT-5 radiometers were set up and calibrated for irradiance responsivities in the lab.

Supported MIND field test at Talley facilities on 26-27 March 1986.

April - June 1986

Performed data reduction from previous MIND tests at Talley Defense Systems in Mesa, Arizona.

July - September 1986

Set up and operated the BOMEM FTIR spectrometer in the Chemistry Division to measure spectral emissions of downscaled MIND grains in laboratory tests. Interferograms of the grain energy were recorded, and Fourier transformed. After an instrument response was generated by dividing the spectra from a blackbody by a theoretical blackbody function, spectra radiance signatures were reduced and reviewed.

5. Infrared Decoy Simulation

October - December 1984

Mesa wrote and implemented a program change in the infrared simulator model. It removes the assumption that the seeker is active at time t=0 by incorporating a feature wherein seeker turn-on can be activated at discrete range intervals. This change was placed in an old version of the model software and will be moved to the current version after verifying correctness and accuracy. Several operational computer runs were made during the reporting period with the results provided to NRL personnel for review and analysis.

January - March 1985

Began a detailed review of the Distraction Model with Aerodynamics (DMAD) for infrared decoys. The review included the model structure, algorithms, geometry and coding. The goal of this review was to provide detailed documentation for DMAD as to how the code relates to the NRL technical report written by Calomaris and Boggs so that new users will be able to understand the workings of this complex computer program.

April - June 1985

Three modifications were added to the DMAD program and the program was frozen to conduct production data runs. The first change, to modify the scanner logic to a single line unidirectional mode, was coded and tested. The second change, to incorporate distraction/seduction, has been coded and tested. However, the results generated by this change was not incorporated into the statistical data base. The final change, to install a range function, has been partially coded and will be finished as time permits.

6. Infrared Instrumentation

October - December 1984

Installed and checked out a new 128 kilobyte memory board in the Data Translation system. Also, installed a new real-time clock board in the Data Translation. Wrote software for communication with the real-time clock board. Installed batteries in Timing Control Unit (TCU) and checked out TCU in ISI digital video system.

Installed new Nicolet 1280 spectrometer data equipment racks. Cabled system units together and loaded distribution from floppy disks to system hard disk. Successfully ran checkout software on system.

January - March 1985

Refurbished an old trailer acquired by Code 5750 for the VICTOR pod. This included removing an air conditioning unit, a propane heater, four of eight equipment racks, unnecessary wiring, a raised floor and carpeting; repairing floors and ceiling; and installing wiring for heat and lights.

Attended a meeting at Inframetrics, Inc. in Bedford, MA to discuss current radiometric imager capabilities. Developed draft specifications for an Inframetrics Model 2100 two-color radiometric thermal imager. Reviewed Inframetrics proposal to NRL for the two-color imager.

April - June 1985

Evaluated Barnes, Minarad and C.I. spectral radiometer specifications and performance capabilities.

During the week of 24 June, Neil Payne of Mesa attended a technician level class at Inframetrics, Inc. to learn how to use the Model 525 and 600 series thermal imaging systems.

July - September 1985

Repaired Sabre-6 recorder by aligning end of tape and beginning of tape photosensors.

Installed and checked out a magnetic tape controller in the Data Translation data acquisition system.

Repaired P2 simulator preamp, and also discovered a bad detector.

Attended a meeting at Inframetrics on 27 September to interface requirements for mounting a multi-element Model 445 into VICTOR.

October - December 1985

Recommended specific parts to upgrade the Nicolet Zeta Plotter to operate with the ISI and Data Translation computers.

Developed specifications for ANSI CRT terminals and high resolution graphics terminal.

Specified rotational translation stages and miscellaneous optical hardware such as optical benches, holders, etc. for the Electro-Optical Calibration Lab.

From information provided by Code 5752, fabricated a wirewrap printed circuit board.

Specified parts list for original parallel I/O printed circuit board in VICTOR and BETA systems.

Performed laboratory calibration on Inframetrics 210 and 445 thermal imagers, and 3-5 and 8-14 um radiometers.

Drew up video recorder and meteorology data sheets on an IBM personal computer.

Began use of AUTOCAD software on IBM PC. Prepared VICTOR drawings, and infrared thermal imager setups using AUTOCAD.

Traced all cabling and CPU board jumpers. Determined that problems with the system were related to a defective floppy disk drive and operating system software not being compatible with existing hardware. Nicolet agreed to replace floppy and provide a new operating system without charge. An additional 64K of memory was recommended for the system.

Became familiar with the operation of the software for the Nicolet FT-IR program for reducing interferometer spectrometer spectra.

Checked out and calibrated a new Racal analog tape recorder for operation with the interferometer.

January - March 1986

A. Block Interferometer/Spectrometer and Nicolet 1180 FT-IR System

During January and February 1986, Mesa staff members concentrated on learning the capabilities of both the Block Interferometer/Spectrometer and the Nicolet 1180 FT-IR Data System. The Block Interferometer/Spectrometer was set up in the Electro-Optical Calibration Laboratory. An indium antimonide (InSb) detector was installed and a series of blackbody calibrations were performed. The instrument response was generated on the Nicolet 1180 FT-IR system. The instrument could not determine a blackbody's temperature that differed from the original blackbody used to generate the original instrument response. The original mercury-cadmium-telluride (HgCdTe) detector was installed and the calibration procedure was

repeated. Again, any blackbody temperature that differed from the calibration blackbody could not be accurately determined. By comparing data from previous instrument responses and analyzing the raw interferogram it was determined that the detector and the signal cube mirror were out of alignment.

B. Inframetrics 210 Thermal Image System

The Inframetrics 210 System was calibrated in the lab at various blackbody temperatures. At each temperature a video voltage was noted with both filters out, one filter in and two filters in.

C. Minirad Spectral Radiometer

Conducted a performance evaluation of the Minirad spectral radiometer at NRL.

D. Nicolet 1280 FT-IR System

Obtained and installed the latest version of the operating system software and corrected known software faults as listed in a memo from Chemistry Department dated November 1985.

April - June 1986

A. Minarad Spectal Radiometer

Traveled to Minarad to checkout the Minirad Model SA-200 radiometer. Setup the SA-200 and NRL's IBM PC to check out the system after delivery. Learned operation of SA-200 and determined that their software was flawed. Was then tasked to write software for the Minarad radiometer.

The following subroutines have been written for the Minarad program:

1. CPU-Minarad RS232C communications
2. Data transfer
3. Data storage to hard disk
4. Data retrieval from disk
5. Screen graphics
6. Error handling
7. Minarad status display
8. Minarad command sequencer
9. Linear plots
10. Autoscale linear and log plots
11. Sliding cursor analysis
12. Blackbody generation
13. Area integration.

B. Data Translation

Wrote software for data acquisition on the Data Translation.

Specified new operating system for Data Translation.

C. ISI

Specified RGB monitor for ISI Data System.

D. E-O Lab Equipment

Assisted in the transfer of instrumentation from Infrared Lab to the Electro-Optical Calibration Facility.

E. Software Support

Developed software programs for IBM PC for infrared sensor calibrations, and ran LOWTRAN routines, SIG and PLOT, on the Prime computer.

July - September 1986

A. Inframetrics 2100

Assisted in the development of system characterization and calibration procedures for the Model 2100 radiometric thermal imager.

B. Minirad Spectral Radiometer

Developed software to analyze spectral data and installed software options for spectral filtering and integration.

C. BOMEM FTIR Spectrometer

Worked closely with BOMEM personnel to initially set up, checkout and align the spectrometer at NRL. Also participated in initial technical training sessions at NRL. Spent time to develop hands-on capability with the optical hardware, electronic hardware and computer operating software.

D. Provided electrical and electronic support to prepare the Likki Tiki for infrared radiometric testing.

September - December 1986

A. Inframetrics 2100

Calibrated a circular variable filter supplied by Inframetrics with the BOMEM spectrometer to be used to measure the spectral response of the Model 2100 during acceptance tests.

Performed Field of View uniformity and radiometric accuracy tests on the Model 2100.

B. Minirad Spectral Radiometer

Visited Minarad, Inc. on 3 November to review hardware and software progress on the CVF spectral radiometer development.

C. BOMEM FTIR Spectrometer

During 13-17 October, attended a specialized FTIR training course at BOMEM, Inc. in Vanier, Quebec.

Designed and fabricated a split cover for the optical head that will allow for quick access to the detectors and electronics.

Fabricated a short cable assembly for the spectrometer head that will allow the cables to be disconnected without removing the cover.

The beamsplitter assembly was originally installed incorrectly. In November, all beamsplitters were reinstalled correctly and the spectrometer was realigned.

April - June 1987

Conducted an in-depth review of the capabilities and deficiencies of the MINARAD CVF spectral radiometer.

July - September 1987

Worked with BOMEM personnel to (1) install new software on DEC 11/73 computer; (2) optically align the input collimator, detector output optics, beamsplitter assembly, laser optics and white light optics of the second interferometer sensor; and (3) check out all optics in the first sensor, finding that the focal mirror in the detector output optics was distorted.

7. Infrared Ship Signatures

October - December 1984

Conducted a preliminary survey of DOD and industrial facilities that potentially have capabilities to collect infrared signatures of ships during the initial experimental phase of the project.

January - March 1985

Attended several meetings during this reporting period to review the capabilities of agencies to collect infrared signatures of ships during the initial experimental phase of the project. Agencies visited with NRL representatives include the following:

Air Force Geophysics Laboratory Hanscom AFB, MA	10 JAN 85
Naval Metrology Engineering Center Pomona, CA	21 JAN 85
General Dynamics Pomona, CA	21 JAN 85
Naval Weapons Center China Lake, CA	22 JAN 85
Pacific Missile Test Center Point Mugu, CA	23 JAN 85
General Electric Utica, NY	28 FEB 85

Summaries of each meeting are detailed in separate memoranda to NRL. In addition, instrumentation capability information was received from Cincinnati Electronics Corporation and forwarded to NRL.

April - June 1985

Contacted and arranged a meeting with William Spicer (Code G74) of the Naval Surface Weapons Center (NSWC) to determine the present status of an electro-optical gyro stabilized pod. A meeting between NSWC, NRL and Mesa was held on 18 April to determine status of the LITE Pod and its availability to NRL.

NRL and Mesa personnel visited Eglin Air Force Base on 26 April to review their infrared measurement instrumentation capabilities

for possible use in Phase I of the infrared ship signature measurement program.

Prepared several sections of a draft document describing the infrared measurement instrumentation capabilities of several agencies that were evaluated for possible use in Phase I of the infrared ship signature measurement program.

July - September 1985

Assisted in the preparation of the infrared ship signature study document describing the infrared ship measurement instrumentation capabilities of several agencies that were evaluated for use in Phase I of the infrared ship signature.

October - December 1985

Assisted in the preparation of a document to evaluate current technical requirements within the U.S. Navy establishment for quantitative infrared ship signature measurements and the analytical and measurement capabilities of several groups that indicated interest in supporting these measurement efforts.

Contacted the PHM office in Key West to obtain information about obtaining drawings of the USS AQUILA (PHM-4) to be used for infrared signature studies. Drawings are available from the Naval Shipyard in Seattle, Washington after drawing numbers are known. After determining the drawings required they will be ordered.

Prepared instrumentation for a signature test of a PHM-class ship schedule for 17-23 October 1985, which was postponed to a later date.

January - March 1986

Obtained drawings of the USS AQUILA (PHM-4) in preparation for an upcoming infrared signature test.

April - June 1986

Attended meeting with NRL and Battelle Labs on 11 June. FOXTROT gimbal modification design was reviewed.

Attended a design review with NRL and Inframetrics in Boston on 6 June. Status of the Inframetrics Model 2100 was discussed.

July - September 1986

In preparation for planned airborne signature measurements of U.S. Navy ships, participated in meetings to determine a way to mount a TV camera and infrared radiometric imager to the inner gimbal of the selected pod, (c) decide on the design of an inner gimbal to motor interface, and (d) determine the design and interface of the gimbal electronics chassis.

October - December 1986

Attended a meeting with Battelle Labs and NRL personnel to discuss (a) the status of printed circuit boards, (b) the selection, and installation of components and (c) the mechanical and electrical backplane design.

January - March 1987

Participated in a detailed study to determine where to locate the airborne instrumentation suite for infrared ship signature data collection. Began mechanical design studies to integrate all sensors on a side-looking tracking mount that will look through an infrared window installed on the side of the NRL P-3 aircraft.

April - June 1987

Continued the mechanical design to integrate the infrared signature sensor system to a side-looking tracking mount that will look through an infrared window installed on the side of the NRL P-3 aircraft. The design of various mechanical components were submitted to the NRL machine shop for fabrication.

Designed an enclosure for the Electronics Control Assembly (ECA). The physical locations of each component in the ECA enclosure were determined and a block diagram was generated to detail the layout. The status of mechanical and electrical components was determined and critical items were identified. The electrical wiring list was obtained from Battelle Labs and converted to a schematic diagram for ease of fabrication and troubleshooting. A new printed circuit board was designed for the synchro-to-DC converters. On 8 June 1987 traveled to Battelle Labs for a status review of the improved FOXTROT gimbal interface.

July - September 1987

Fabrication and documentation of the mechanical design continued.

Specified and ordered electronic components for the gimbal electronics control assembly (ECA). Coordinated the final design and assembly of the ECA. Also attended design review meetings with NRL and Battelle personnel.

Participated in a ship signature test at Fort Story, VA during 6-14 August 1987. Operated the BOMEM interferometer spectrometer.

Participated in a ship signature test at the Naval Coastal Systems Center in Panama City, FL, during 7-11 September 1987. Operated the BOMEM interferometer spectrometer. Reduced data from all ship tests and corrected spectral data for specific spectral bands using the LOWTRAN VI atmospheric model.

8. FOXTROT Simulator Pod

April - June 1985

Gathered present FOXTROT servo loop data and future performance requirements of the FOXTROT gimbal system. This data was forwarded to Larry Stockum of Battelle Labs for evaluation.

July - September 1985

Attended meetings to determine the LITE pod and FOXTROT modifications for installing an Inframetrics Mode 2100 Thermal Imager.

Submitted a Technical Report prepared by Mesa subcontractor Dr. Larry Stockum entitled Evaluation of NRL Gimbal Assemblies and Control System, dated 13 August 1985. The report addresses three subjects:

1. LITE POD/Inframetrics Sensor Integration
2. Evaluation of the FOXTROT Pod/Gimbal and Control System for a Side Looking Application
3. FOXTROT Platform and Control System Evaluation

Obtained a LITE pod drawing package from Aeronutronic-Ford.

October - December 1985

Provided information on FOXTROT gimbal system for Battelle Labs. On 30 October 1985, attended a meeting at NRL with Dr. Larry Stockum of Battelle Labs. Discussion included modification of

the FOXTROT gimbal electronic control system and an alternate seeker head for VICTOR.

January - March 1986

On 22 January 1986 traveled to Battelle Labs in Columbus, Ohio to meet with Dr. Larry Stockum to discuss modifications to the present Foxtrot gimbal system.

9. Dynamic Simulator

July - September 1985

Designed and fabricated a two-axis infrared dynamic simulator. Developed modifications to the simulator in preparation for later acceptance tests at NRL.

October - December 1985

Designed and have under construction two dynamic simulators for VICTOR testing at NRL in early 1986. One unit has a single point source and one can be attached to an X-Y recorder platen to provide two-axis controlled motion. The second unit is a larger version containing ten point sources at known intervals.

January - March 1986

Repaired mirrors and the controller, and setup galvanometers for evaluating the dynamic capabilities of the VICTOR simulator.

10. E-Chaff

October - December 1985

Set up ISI A-to-D converter for E-Chaff data reduction. Digitized video tape imagery and produced radiant intensity vs. time plots.

11. TORCH Decoy

October - December 1985

Made supertape of 16 September 1985 PIP/TORCH Test using ISI system. Included title insertions and alphanumerics for visual annotation.

Set up, checked out, calibrated and, on 8 October 1985, operated the Block interferometer during a PIP TORCH test at the Naval Surface Weapons Center in Dahlgren, VA.

January - March 1986

Provided support for a series of TORCH and Product Improvement Program (PIP) Torch tests at CBD during the week of 3 February 1986. Assisted in the setup, calibration and operation of Block interferometer, Inframetrics infrared imagers and the Mesa banded radiometer.

April - June 1986

Participated in Special Function Infrared TORCH decoy tests on 29 April thru 1 May and 16-18 June at CBD. Delivered, setup, calibrated and operated the following equipment: Mesa Model 1034 banded radiometer, Minarad Model SA-200 spectral radiometer, Barnes PRT-5 radiometers and Inframetrics Model 210 infrared imager. Data from the Model 1034 was reduced using LOTUS 1-2-3. Data from the Model SA-200 spectral radiometer was reduced and graphically output after each test run.

July - September 1986

Participated in TORCH tests at Chesapeake Bay Detachment on 27-29 August and 8 September.

Used the BOMEM spectrometer to interrogate a TORCH simulator. Various emission spectra were collected and reduced.

Set up and operated the BOMEM spectrometer in Code: 5740 laboratory facilities to evaluate spectral characteristics of candidate decoy chemical emissions.

September - December 1986

Participated in scaled down TORCH laboratory tests at NRL in September and October. Investigated the infrared emission spectra of various fuels being considered for the TORCH decoy. Spectra was collected, radiometrically reduced and plotted.

Participated in TORCH tests at Chesapeake Bay Detachment on 19 November 1986. Used the BOMEM spectrometer to interrogate a TORCH simulator. Spectra were collected, reduced and plotted. The Kazuko eye-safe laser was used to determine range to the decoy.

April - June 1987

On 8 May 1987, used the MINARAD CVF spectral radiometer to measure the infrared radiation from special TORCH decoy rounds fired at CBD.

July - September 1987

Operated BOMEM interferometer spectrometer for data collection and reduction of modified TORCH tests at CBD on 1 July and 24 August 1987.

12. **LOWTRAN**

October - December 1985

On 6-7 November 1985, attended a workshop held by AFGL at Wright-Patterson Air Force Base in Dayton, OH to learn latest improvements and additions to the LOWTRAN atmospheric transmission model.

13. **Activated Metals**

January - March 1986

Performed data reduction of infrared imagery from an activated metals test conducted on 20 August 1985. The data reduction was done utilizing the ISI Image Processing System.

14. **NATO Infrared Decoy Comparative Tests**

July - September 1986

Began preparation for decoy tests scheduled for December.

September - December 1986

Worked with NRL: 5750 personnel to develop a comprehensive test plan for a comparative test series scheduled for 8-19 December 1986 and 27 February through 6 March 1987. Also assisted in the coordination of test preparations, supporting such efforts as identifying test instrumentation, selecting test sites, establishing test geometries and developing test sequences. Attended numerous planning meetings with personnel in the Tactical Electronic Warfare, Optical Science and Chesapeake Bay Divisions.

Mesa also provided support to prepare the sensor instrumentation, integrate sensors to mounts and revamp the NRL instrumentation van. Among the tasks were to select a land-based tracking mount; design and fabricate mechanical mounts to integrate sensors to the mount; layout the instrumentation van; install new electrical wiring, instrumentation racks and new video cabling; and checkout all sensors, recorders and other equipment. Electrical and mechanical drawings and test data sheets were developed.

January - March 1987

The bulk of Mesa's efforts in the reporting period were spent preparing for this major test series. The test plan was revised and updated, sensors were checked out, and the sensors, tracking mount and instrumentation van were integrated into a dynamic field unit. The land-based instrumentation suite was set up near Building 5 at the Chesapeake Bay Detachment (CBD) and a second set of instrumentation was installed on the LCM-8. The actual testing began on 23 March and continued through the end of the reporting period into the next quarter, with Mesa personnel operating infrared and electro-optical sensors.

April - June 1987

A substantial portion of Mesa's efforts in the reporting period were spent in support of the NATO Infrared Decoy Comparative Test Series. The tests began on 23 March, and continued through 10 April 1987. During the testing period, Mesa personnel calibrated, operated, repaired and maintained several infrared and electro-optical sensors. After the testing was complete, Mesa personnel supported NRL in an intense data review and reduction process to determine the potential usefulness of each decoy tested. Thermal imagery video tapes were reviewed to determine the spatial configuration and time duration of each decoy, and to select specific rounds that appeared reasonable for radiometric analysis; spectral data from the BOMEM FT-IR spectrometer was carefully reviewed, instrument corrected and radiometrically reduced; and spectral data from the MINARAD CVF spectrometer was carefully reviewed for reasonableness. Mesa also coordinated the preparation of a preliminary test report that was required thirty days after the test. After completion of the preliminary report, specific decoy rounds were further reviewed and reduced radiometrically, as requested. Also, provided banded atmospheric transmission data from the LOWTRAN VI atmospheric model and used this data to correct selected target signatures for atmospheric losses.

15. STIR Radiometer

September - December 1986

Interfaced with Optical Sciences Division to specify hardware components.

Interfaced with the Naval Surface Weapons Center to formalize design and upgrade drawings.

April - June 1987

Began to coordinate efforts to finalize the optical design of the STIR radiometer. Have interfaced with Naval Surface Weapons Center engineers to investigate aerodynamic, mechanical and optical considerations of the sensor. Determined that the originally proposed scanning motor was deficient for this application and found a satisfactory alternative motor. Concentrated on the selection of the optical dome. Performed various trade-offs, including infrared transmittance, mechanical sturdiness, aerodynamics, delivery schedule, cost and manufacturer availability, to recommend a set of dome specifications to NRL.

On 20 June 1987 visited II-VI in Saxonburg, PA to discuss optical domes.

July - September 1987

Conducted the design and specifications development of the STIR radiometer which included the following areas:

1. Inner gimbal support ring
2. Optical specifications and design review
3. Mechanical specifications and design review
4. Detector and filter specifications and vendor selection
5. Dome specifications, material selection, vendor selection and ordering
6. Mechanical drawing package reviews and modifications