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SPLIT-FIELD AND INTERNALLY FILTERED IMAGING POLARIMETER DEVELOPMENT AND TESTING

by

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A "split-field" infrared optical system has been designed and constructed to provide simultaneous image pairs in a single frame of an infrared (IR) imager, differing only in the direction of linear polarization. The optical train is afocal, allowing its use with a variety of infrared imaging devices. The system can operate in both long-wave IR (8-12 μm) and mid-wave IR (3-5 μm) with interchangeable polarizing splitter plates. Previous work at the Naval Academic Center for Infrared Technology (NACIT) at the Naval Postgraduate School has demonstrated that significant image improvement in infrared image contrast can be obtained by use of polarization filtering, especially for targets at sea through suppression of polarized sea background emission in the long wave, or of polarized reflection in the midwave. That work utilized digital subtraction of sequential image pairs with orthogonal polarizations, but suffered from inability to obtain simultaneous images and also from problems due to reflections from external polarization filters. Both of these problems are eliminated with the new split-field technique. Preliminary tests of this system with an AGA-780 imager were carried out in a field experiment using an Arleigh Burke DDG class ship as target at varying distances at sea. For comparison, images were also taken in successive pairs in time with the AGA-780 viewing the scene directly (without the split-field adjunct) with interchangeable internal polarizing filters in a rotatable filter wheel. Subjective and numerical analysis of the data from the field experiment demonstrated good image quality and contrast improvement, and potential for future utility.

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SPLIT-FIELD AND INTERNALLY FILTERED IMAGING POLORIMETER DEVELOPMENT AND TESTING

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ABSTRACT

A "split-field" infrared optical system has been designed and constructed to provide simultaneous image pairs in a single frame of an infrared (IR) imager, differing only in the direction of linear polarization. The optical train is afocal, allowing its use with a variety of infrared imaging devices. The system can operate in both long-wave IR (8-12 μm) and mid-wave IR (3-5 μm) with interchangeable polarizing splitter plates. Previous work at the Naval Academic Center for Infrared Technology (NACIT) at the Naval Postgraduate School has demonstrated that significant image improvement in infrared image contrast can be obtained by use of polarization filtering, especially for targets at sea through suppression of polarized sea background emission in the long wave, or of polarized reflection in the midwave. That work utilized digital subtraction of sequential image pairs with orthogonal polarizations, but suffered from inability to obtain simultaneous images and also from problems due to reflections from external polarization filters. Both of these problems are eliminated with the new split-field technique. Preliminary tests of this system with an AGA-780 imager were carried out in a field experiment using an Arleigh Burke DDG class ship as target at varying distances at sea. For comparison, images were also taken in successive pairs in time with the AGA-780 viewing the scene directly (without the split-field adjunct) with interchangeable internal polarizing filters in a rotatable filter wheel. Subjective and numerical analysis of the data from the field experiment demonstrated good image quality and contrast improvement, and potential for future utility.

TABLE OF CONTENTS

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I. INTRODUCTION

Previous work done at the Naval Postgraduate School has shown that infrared image contrast for sea targets can be improved by polarization filtering (Refs: 20,21,22). Unwanted background radiance which clutters the image can consist of emission and reflection components. At grazing angles an appreciable part of the water surface emission is linearly polarized with the electric vector vertical, while direct or indirect solar radiation reflected from the surface shows horizontal polarization. Other elements of the scene, such as the sky and man-made objects, often emit or reflect radiation that is unpolarized or polarized in a different direction from that of the sea surface. As a result, viewing the scene through a polarizing filter, or subtracting two otherwise identical images except for orthogonal polarization directions, can improve the target contrast against background.

Polarization filters for the infrared are only recently available. These consist of "wire-grid" structures deposited by photolithography and etching on transparent substrates. Such substrates also need to be antireflection coated to reduce unpolarized reflection by the dielectric substrate.

Special problems arise when dealing with IR as opposed to visible radiation. Because all materials emit radiation at temperatures above 0 degrees K, sensor background radiation often contaminates the final image. Very low temperatures must be used at all points from which radiation can enter the detector in order to reduce the amount of unwanted radiation entering below acceptable levels. Liquid Nitrogen and thermo-electrically cooled bodies are commonly utilized. Also, the 'narcissus effect' can occur in the final image when the cold detector 'sees' a reflection of itself from a flat or back-focussing optical surface (Ref. 23). Various methods to eliminate these problems are implemented in the techniques presented. These are key driving factors in the utilization of internal filtering and in the design of the Naval Postgraduate School Split-Field infrared polarized imaging system.

Important to the study of image improvement is the quantitative characterization of image intensity differences. In previous experiments done at the Naval Postgraduate School in which the orientation of the polarizer had to be changed manually between recording orthogonally polarized images, there were changes in the image in the time interval during this process

(Refs.1,21,22). Consequently it was impossible to have two identical images for comparison. To surmount this problem a Split-Image optical system was designed and built at NPS. In this system two orthogonally polarized images are recorded simultaneously. The images can then be digitized and mathematically subtracted to demonstrate the contrast improvement. Specific design, implementation, performance and image analysis will be explained and presented.

A description is also given of adaptation of the AGA imager with polarizing filters installed in the internal filter wheel. This system is useful in recording sequential images with orthogonal polarizations.

This thesis explores the phenomenon of infrared polarized radiation, background and target polarization characteristics, and experimental techniques for filtering and improving image quality.

II. BASIC INFRA-RED THEORY

To fully understand the phenomena associated with imaging of polarized infrared radiation it is necessary to understand the basic physics used to characterize infrared phenomena. This chapter deals with the laws of thermal radiation, radiation measurement metrics, and discussion of thermal imaging fundamentals. These short presentations attempt to give some insight into the selection of the infrared band and how it is used.

A. INFRA-RED TERMINOLOGY AND UNITS

In the study of radiation, the radiant power exchanged between the target, medium, and detector is of interest. A set of parameters is defined to describe the radiation at each point of interest. Table 2.1 shows some of the parameters and their units of measurement (Ref. 19). The last column in Table 2.1 denotes the units in the metric system. The entire content of this system of units will not be addressed, but some particular units need to be emphasized. Temperature is measured in Kelvins (K). The steradian (Sr) unit of solid angle is derived from defining the total solid angle around the center of a sphere as 4π steradians. Note that these quantities are commonly used in inconsistent units. This is done to match imaging system dimensions more closely for system performance calculations.

Symbol	Name	Description	Units (metric)
M	Radiant Flux Density (Exitance)	Radiant Flux leaving an element of a surface per unit area.	$Watts/cm^2$
E	Irradiance	Radiant power per unit area incident on a surface.	$Watts/cm^2$
I	Radiant Intensity	Radiant power leaving a point source per unit solid angle.	Watts/Sr
L	Radiance	Radiant power leaving or arriving at a surface at a point in a given direction per solid angle per area normal to that direction.	$Watts/cm^2Sr$

Table 2.1 Radiometric Units

All other physical parameters are measured in conventional units. Along the imaging path, *M* characterizes the power leaving the target surface per unit area. Some of this radiation is emitted by the target and some is reflected due to *Irradiance* from another source. The distant transport of the radiant energy from the target is described by the *Radiant Intensity,* I, which includes the geometrical spreading with range. *I* is the most useful parameter in calculating the maximum range of an imaging detector. When the radiation reaches the detector, the *Irradiance* at the receiver of the target radiation is converted into a signal for recording.

B. LAWS OF THERMAL RADIATION

In order to detect a target, it is necessary to characterize the radiation coming from the surface. Most infra-red detectors only operate efficiently in a small band of wavelengths, so the thermal radiation from a target must be known in that range. A set of well known radiation laws exists that describe the spectral emittance of thermal sources.

1. Black Body

A black body is known simply as an ideal emitter and absorber. By Kirchoff's Law, for a black-body the spectral absorptivity(α) = emissivity(ε) = 1, so the reflectance(ρ) and transmissivity (τ) must be = 0. For a black body this is true at all wavelengths. The spectral radiant emittance curve for a black body is shown by Fig. 1, and is described by Planck's Law.

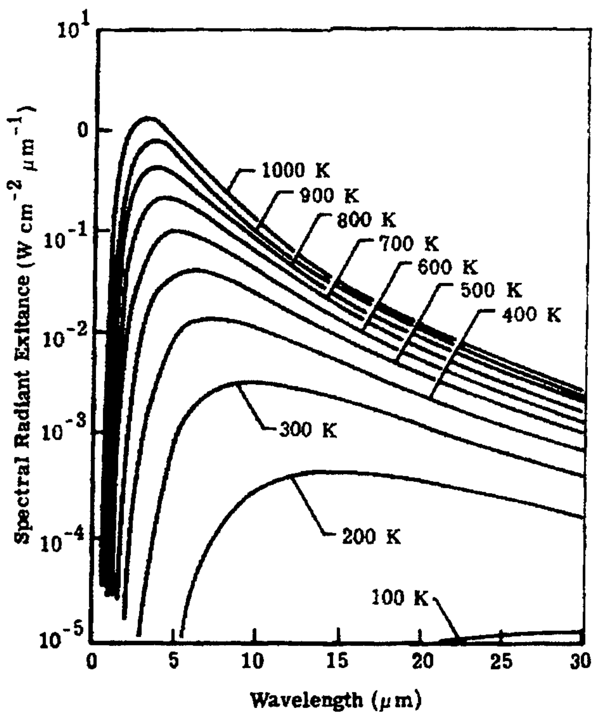


Figure 1. Black Body Radiance

2. Planck's Law

Planck's Law is the distribution shown in Fig. 1. It is given by

$$M_\lambda(T) = \frac{2\pi c^2 h/\lambda^5}{(e^{\frac{hc}{\lambda kT}} - 1)} \qquad (W/cm^2\mu m) \qquad (1)$$

where h is Planck's constant, and k is Boltzman's constant. The spectral radiance of the black body can be reproduced by the Planck distribution. For non-black body emitters, the radiant exitance is reduced by the emissivity(ε). The radiant exitance is then

$$M_{\lambda}=\epsilon_{\lambda}M_{\lambda black\text{-}body} \tag{2}$$

with $\varepsilon<1$ for all non-black bodies. Examples of emissivities

Material	Emissivity
Polished Al	.05 (373K)
Steel Oxidized	.79 (573K)
Water(frost/ice)	.98/.96 (263K)

Table 2.2 Emissivities of common materials

of practical materials are shown in Table 2.2 (Ref. 19) If $\varepsilon_{\lambda}(T)$ = constant independent of wavelength, then the body is called a grey body. For most surfaces this is not the case, and the spectral emissivity varies greatly with wavelength. Many materials behave as grey bodies over a limited range of wavelength.

3. Wien Displacement Law

In Fig. 1, a maximum radiant exitance occurs at a wavelength λ_{Mmax}. λ_{Mmax} can be found by differentiating the Planck distribution function and equating to zero. The result is the Wien Displacement Law.

$$\lambda_{max} T = 2898.78 \mu m K \quad (3)$$

Using Wien's Displacement Law, the wavelength with the highest spectral radiance is known with the surface temperature.

4. Stefan-Boltzman Law

If the radiant exitance is integrated over all wavelengths for a given temperature, the total power emitted per unit area can be found. The equation is found to be, for a black body

$$M(T) = \sigma T^4 \quad (4)$$

σ is the Stefan-Boltzman constant, $\sigma = 5.67 \times 10^{-12}$ W/cm^{2}K^4. For other bodies, application of the spectral emissivity must be done over all wavelengths.

C. ELECTROMAGNETIC BANDS AND ATMOSPHERIC WINDOWS

To understand why imaging is performed in the infra-red band, knowledge of the bands and the atmospheric attenuation 'windows' is necessary. All bodies radiate thermally at all wavelengths, so it would appear logical to detect the radiation at the peak wavelength defined by Wien's Displacement Law. This is not done in every case, due partially to atmospheric effects on the emitted radiation. A brief discussion of how the target and atmosphere interact follows.

1. Electromagnetic Radiation Bands

The infrared region of the electromagnetic spectrum lies between the radio (longer wavelength) and the visible (shorter wavelength) regions. Fig. 2 shows this region of the spectrum (Ref. 19). Its bandwidth is approximately .1µm to 1000µm. The longest wavelength of interest for conventional IR imaging is approximately 15µm since most targets and modern quantum detectors operate below this

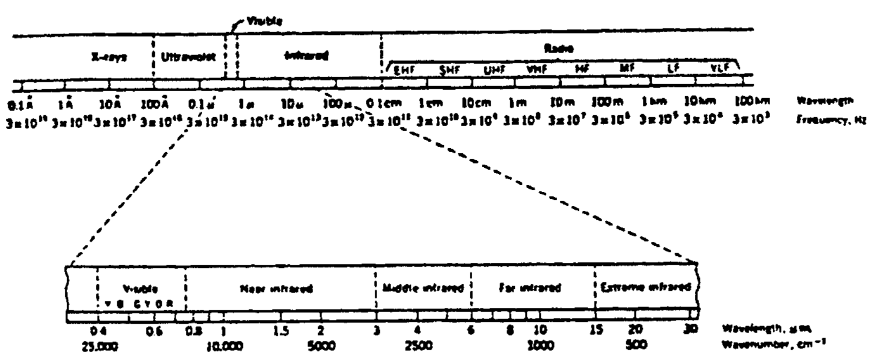


Figure 2. Partial Electromagnetic Spectrum

wavelength. termed the far infrared limit. The region nearest the visible is the near infrared. The "millimeter wave" band occurs around 1000µm.

2. Atmospheric 'Windows'

The processes that effect the radiation on its path through the atmosphere are extremely complex and will only be considered briefly. Attenuation affects the amount of radiant power incident on the optical system, which in turn affects the overall performance of the system. The attenuation mechanisms of primary concern are absorption and scattering of the radiation. Limiting or avoiding the amount of absorption and scattering in the target path is essential for any thermal imaging system because of the severity of the effects. Suspended aerosol particles are the primary contributors to scattering of the radiation in the IR. Aerosols include dust, fog, salt, ash, and many other airborne particles. Molecules such as H_2O and CO_2 are the predominant absorbing species in the atmosphere (Ref. 19) and define the windows in which IR radiation can pass through the atmosphere with any effectiveness. This is due to the structure of the molecules and the modes in which they can be excited and thus absorb energy. Figure 3 shows a plot of atmospheric transmittance versus wavelength over the near to far infra-red. This plot was generated by an atmospheric propagation modelling code, LOWTRAN 7. LOWTRAN 7 has resident atmospheric models for aerosol and humidity content in addition many other atmospheric characteristics.

The model used for the plot is for a Mid-Latitude Summer atmosphere, 5km path at sea-level. The 'Rural' designation is for the aerosol model describing an air mass over land with primary components being dust, sand, and hygroscopic particles [19].

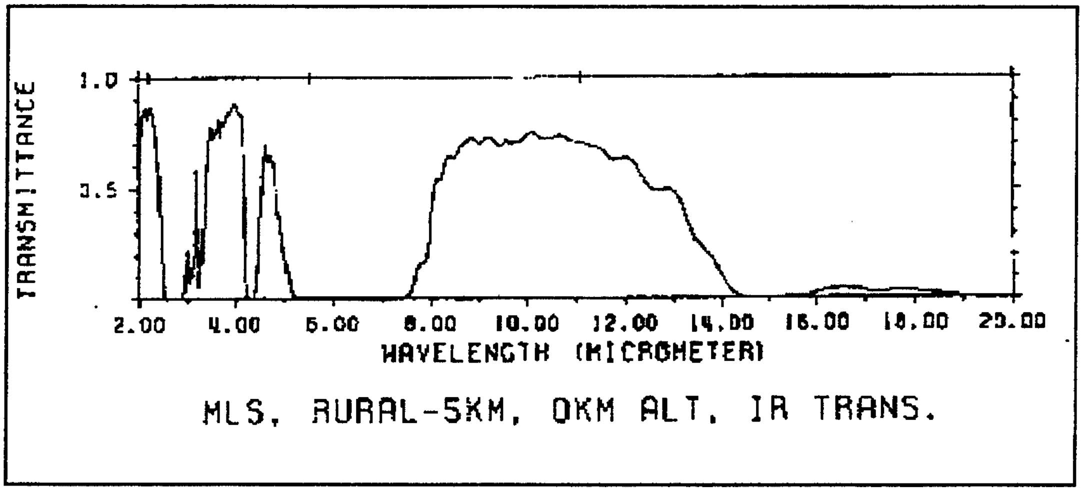


Figure 3. Atmospheric Windows

Transmission with no attenuation from the figure has a transmittance value of 1. The windows are depicted by the regions of maximum transmittance. It is clear that any imaging would need to take place for radiation found in these regions. Commonly used wavelengths for imaging military targets are around 4.0μm (short wave) for hot sources such as exhaust plumes and power plant components, and 8-12μm (long wave) for surfaces nearer to ambient temperatures. The relation of the temperature to desired wavelength band follows the Planck distribution for maximum radiated power. This correlation between radiated power wavelengths and propagation windows must be considered when using IR radiation for imaging is desired.

III. POLARIZATION PHYSICS

Polarization occurs in the reflected and emitted IR radiation of targets and backgrounds. For purposes of enhancing target contrast (as exemplified by ship targets at sea), it is necessary to determine the degree of polarization present and its orientation. Fundamental physical laws and polarization equations describe the important parameters of polarization of the target, and sea and sky background. Quantification of these parameters leads to expected increases in contrast and is necessary in designing and implementing polarizing imaging systems.

A. STOKES PARAMETERS

Sir George Gabriel Stokes (1852) discovered that the polarization state of any light source could be completely described by four observable quantities which have become known as the Stokes Parameters. This is done by taking the time average of the E field vector amplitude described by the polarization ellipse, thus yielding an observable intensity (Ref.17). The resultant four parameters are

$$\begin{aligned} I&=E_s^2+E_p^2 \\ M&=E_s^2-E_p^2 \\ C&=2E_sE_p\cos\delta \\ S&=2E_sE_p\sin\delta \end{aligned} \tag{5}$$

E_s and E_p are the normal and parallel components of the wave electric field, with respect to the plane of incidence. For a horizontasl surface the vertical component (p) lies in the plane of incidence, also referred to as parallel orientation. I denotes the total intensity of the light, M, the intensity of linear 's' or 'p' polarized light, C, the linear ±45 degree polarized light, and S, the circularly polarized intensity. δ is the phase difference between the s and p components of the E field. The degree of polarization is the ratio of the intensities of the polarized to the total intensity [3].

$$P=\frac{(M^2+C^2+S^2)^{1/2}}{I} \tag{6}$$

The polarization of the radiation to be filtered comes from effects due to emission and reflection. Specific laws have been developed to describe these phenomena and their contribution to the Stokes parameters will be shown.

B. EMISSION POLARIZATION

The target and background radiance produced by thermal emission from surfaces is inherently polarized [9]. Of specific interest for imaging targets at sea is the emission polarization of the sea and sky background since the primary contrast improvement will be obtained by filtering of the background.

1. **Sea Emission Polarization**

To find the emission polarization of the sea, the surface can be treated as an interface with coordinates shown in Figure 4 (Ref. 21).

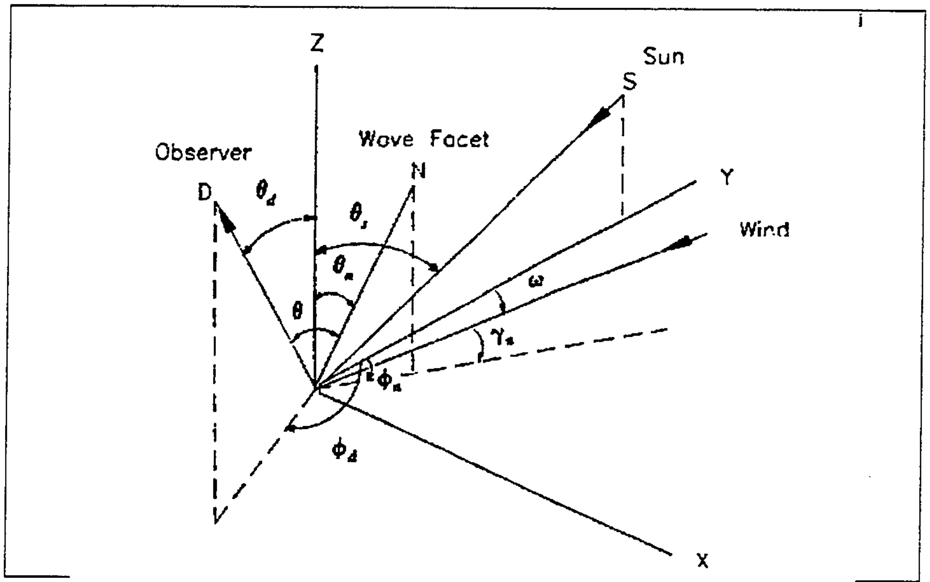


Figure 4. Coordinate System of Sea Surface

Y is the azimuthal direction of the sun. S and D are the directions of the sun and observer, respectively. N is the wave facet normal, θ and ϕ the zenith and azimuth angles for each vector. The light coming from the upper side of the interface (+z) consists of a reflected and an emitted component, such that the total radiance is given by

$$N(\Theta) = N_{\rho}(\Theta) + N_{\varepsilon}(\Theta) \tag{7}$$

The light emitted from the surface can be considered as radiation coming from the sea water side of the interface undergoing refraction at the surface. Behavior at the interface can be derived from the Fresnel equations and is discussed in this fashion by Sandus (Ref. 9) and Sidran (Ref. 11) following Reference 16. The emissivity of the surface is given by Reference 16.

$$\varepsilon = \frac{2}{(1+z_r)} \tag{8}$$

z_r is dependent on the orientation of the polarization (parallel or perpendicular) where:

$$z_{\perp}=\frac{s+\cos^2\Theta}{\sqrt{2}\cos\Theta[(s+a-\sin^2\Theta)^{1/2}]}$$

$$z_{\parallel}=\frac{s+(a^2+b^2)\cos^2\Theta}{\sqrt{2}\cos\Theta[s(a^2+b^2)+(a-\sin^2\Theta)(a^2-b^2)+(2ab^2)]^{1/2}} \tag{9}$$

$$a=Re(n^2)$$

$$b=Im(n^2)$$

$$s=\sqrt{(a-\sin^2\Theta)^2+b^2}$$

n is the complex index of refraction of the medium, Θ, the angle of emission. These equations hold true for any specular surface. Dependence on wavelength comes from the index of refraction (Ref. 11). This analysis indicates that both the emitted and reflected components of surface radiance will show polarization, predominately in orthogonal directions. Note that consideration is given only to the linearly polarized light. For most materials, there is only a small range of angles at which elliptical polarization occurs. Even in these cases the phase difference between orthogonal components is small enough (due to small dielectric constants) that an approximation of linearly polarized light at all angles is valid (Ref. 3). This theory has been applied to the sea surface and proven by Sidran (Ref. 11), Baesner and McCoyd (Ref. 8), and Gregoris, Yu, Cooper, and Milne (Ref. 20)..

In dealing with the sea surface, wave structure alters the coordinates of interest in Fig. 4. The wave structure is considered to compose a distribution of emitting facets with unit direction toward the observer defined by the vector $\vec{s}$ (see Fig. 4), where

$$\vec{s}=s_1\hat{i}+s_2\hat{j}+s_3\hat{k} \tag{10}$$

The orientation of the normals to the facets with respect to the normal to the plane defined by $\vec{s}$ and the z axis is defined by the angle α. The effective emissivities of each facet referred to the vertical and horizontal directions, are given by

$$\begin{aligned}\varepsilon'_{\perp}&=\varepsilon_{\perp}\cos^2\alpha+\varepsilon_{\parallel}\sin^2\alpha\\ \varepsilon'_{\parallel}&=\varepsilon_{\perp}\sin^2\alpha+\varepsilon_{\parallel}\cos^2\alpha\end{aligned} \tag{11}$$

The prime symbol denotes the emissivity in the observer direction relative to the vertical to the plane containing the z axis and the observer direction $\underset{\sim}{s}$ (Ref. 8). The distribution of the slopes of the facets has been experimentally determined by Cox and Munk (Ref. 15). The Gram-Charlier equation with empirically derived constants adequately describes the distribution of wave slopes (Ref. 15). The resulting wave slope distributions are considered valid for wind speed ≤14m/sec and wave slope angle (β)≤23 degrees. Plots of the Cox and Munk distribution are shown in Fig. 5 from (Ref. 11). Because shadowing occurs on the back surfaces of the waves in the direction of the observer, a correction should be applied to the equations as used by Basener and McCoyd (Ref. 8) for percent polarization calculation. Saunders (Ref. 10) gives a correction to the Basener and McCoyd results. Figure 6 shows the polarization of emission for 1.0μm wavelength and 14m/s wind speed after Sidran (Ref. 11). The percent of polarization, Q is defined by

$$Q=100\bullet\frac{\varepsilon_{\shortmid}-\varepsilon_{\perp}}{\varepsilon_{\shortmid}+\varepsilon_{\perp}} \tag{12}$$

The results in Fig. 6 hold true for all wavelengths ≤ 10μm excluding the absorption bands (Ref. 11). Note that the largest polarization effects are seen at grazing incidence.

2. Sky Emission Polarization

The IR radiation from the sky is unpolarized (Ref. 2). Use of polarized filtering components will not contribute to the contrast improvement measurements when the sky is viewed directly. The sky emission in the image will be subject to attenuation by the polarizing filter to the degree of the unpolarized transmissivity of the filter. Fig. 7 (Ref. 10) shows the sky radiance as a function of zenith angle. Specific radiance characteristics can be seen in Fig. 7. When viewed toward the zenith, the sky emits less due to the fact that the atmosphere consists of water vapor and aerosols (absorbers) which also act as good emitters, but is less dense.

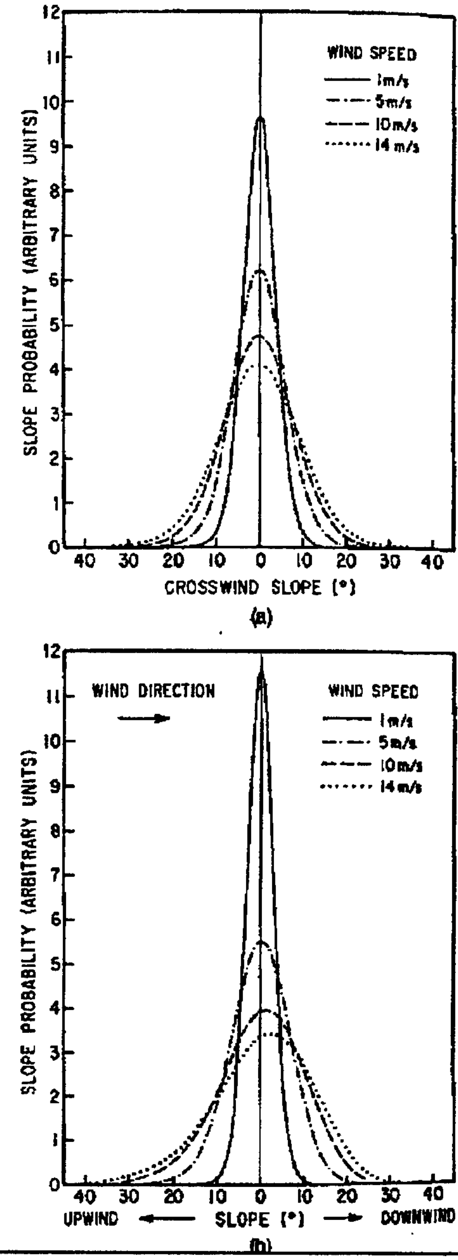


Figure 5. Facet slope angle distribution (a)crosswind, (b) upwind-downwind [11].

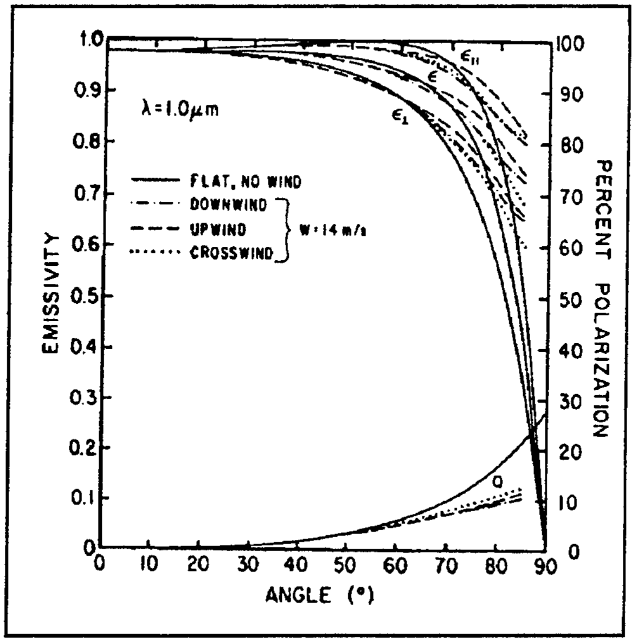
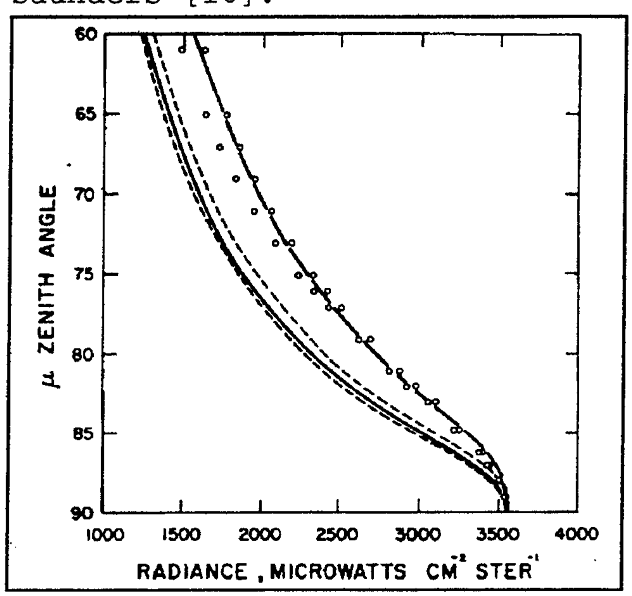


Figure 6. Percent Polarization for λ=1.0 μm

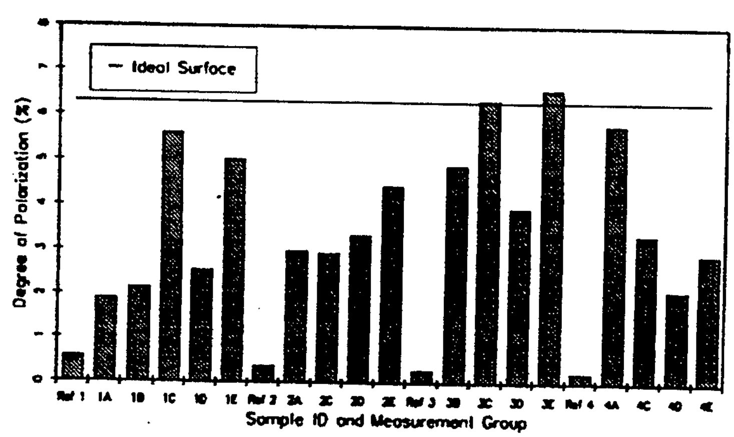
Figure 7. Sky Radiance as a function of zenith angle from Saunders [10].



Sky radiance increases with zenith angle toward the horizon to that of a black-body with atmospheric temperature. This is due to the maximum thickness of the atmosphere encountered at that angle and even the small emissivities of the absorbers combine (Ref. 10).

2. Target Emission Polarization

Although primary contrast improvement in the at-sea scenario will be gained by filtering of sea emission polarization, there is polarization due to emission from the target itself that must be considered. Painted surfaces such as are found on all types of vehicles and ships display emission polarization (Ref. 3,4). Figure 8 shows 21 measurements taken on various paint samples ranging from very smooth torough sand-paint mixtures (Ref. 4).



Measured polarized signature components in the 7.5-12 micron band for selected paint samples viewed at 45° from normal.

Figure 8. Ref [4]

The line for an ideal surface in Fig.8 denotes the amount of polarization that would be seen from a perfectly specular reflector. The rougher samples show less polarization than the smoother. The amount of polarization depends on the index of refraction of the paint and any degradation due to surface roughness.

C. REFLECTION POLARIZATION

For thermal radiation at a surface

$$\rho(\theta)+\alpha(\theta)+\tau(\theta)=1 \qquad \varepsilon(\theta)=\alpha(\theta) \tag{13}$$

As stated previously, the total amount of energy at a surface consists completely of the reflected, absorbed, and transmitted fractions. For a perfectly opaque body, therefore

$$\varepsilon(\theta)+\rho(\theta)=1 \tag{14}$$

The emissivity (ε) was treated in the previous section; the reflectance (ρ) of the sky, sea surface, and target must now be considered. Absorption will have an effect on the reflectance for each surface considered and will act to degrade the reflectance.

1. **Sea Reflection Polarization**

The application of the Fresnel Equations to a Cox-Munk sea surface slope distribution can be shown to predict polarization in reflectance as well as emittance with the following relations[11].

$$\varepsilon_{\perp} = 1 - \rho_{\perp} \qquad \varepsilon_{\parallel} = 1 - \rho_{\parallel}$$
$$\varepsilon = 1/2\,(\varepsilon_{\perp} + \varepsilon_{\parallel})$$
$$\rho = 1/2\,(\rho_{\perp} + \rho_{\parallel}) \qquad (15).$$
$$\varepsilon = 1 - \rho$$

The sea surface acts as an opaque body. Values of ε may be obtained as discussed in the previous section. The percentage polarization seen due to reflection is defined as [11]

$$P = 100 \cdot \frac{\rho_{\perp} - \rho_{\parallel}}{\rho_{\perp} + \rho_{\parallel}} \qquad (16).$$

2. **Sky Reflectance**

As stated in the emission section, the sky acts as a poor emitter near the zenith angle due to the low optical depth. Because of the high content of atmospheric water vapor and aerosols, it acts as an excellent absorber. By equation (13) it is therefore a poor reflector.

3. Target Reflectance

The characteristics of target reflectance follow the same behavior as the wave facet reflectance. The difference in the magnitude of the polarized components is a function of the index of refraction of the surface material of the target. As seen in previous cases, maximum polarization effects due to emission, and thus polarization will occur nearer to grazing incidence angles. The net polarization will be dependent on the balance between thermal emission and reflection of incident radiance, related through Eq. (15). For the purpose of the experiments performed to demonstrate the different polarizing imaging techniques, target distance and lack of detailed geometric orientation of surfaces precludes exact measurement of target surface polarization; however, qualitative effects will be shown.

IV. DATA ACQUISITION TECHNIQUES

To analyze the target radiance as it is affected by temperaturer, polarization, and other factors, it is necessary to employ thermal imaging equipment for recording. The split-field polarimeter and internal filters use the AGA-780 thermal imaging system for data acquisition. In the case of the internal filters which were designed to fit in only the AGA-780 Thermovision, the choice is necessary, but the split-field is made to adapt to a number of different sensors, particularly the AMBER 4128 focal plane array system. All the experimental data taken to be analyzed was taken with the AGA-780 Thermovision. Accompanying software necessary to digitize and display radiance data consisted of the AGA CATS software and Interactive Data Language (IDL) programs. The following is a brief discussion of the data collection devices.

A. AGA-780 THERMOVISION

The AGA-708 Thermovision consists of a two channel infrared scanning detector system. The AGA can operate in both the 2-5.6µm and 8-12µm bands using liquid nitrogen cooled InSb and HgCdTe detectors, respectively. Scanning is accomplished by two rotating prisms which scan the image across the detector, yielding 1.1 mrad geometric resolution.

The input lenses for the Long-wave infrared (LWIR) used for the experiments consist of anti-reflection coated Germanium. The LWIR band was used for all imaging. The optical system is f/1.87, with a 7x7 degree field of view. This f number was a key design input for the split system to match the aperture of the AGA. The AGA-780 is mounted on a common plate with the split-field system with a sliding mount to facilitate easy changing between the LWIR and MWIR band detectors. Figure 11 in chap. 7 shows the arrangement used with the split system.

B. AGA CATS SOFTWARE PACKAGE

The analog data provided by the scanning detector is digitized for display and measurement by the AGA CATS software. The CATS software uses an 8 bit A/D converter to convert detector intensity into a 16 color display for real-time viewing on a computer screen. Many different functions are available to the user such as storing frozen image data, image manipulation, temperature readout and emmissivity compensation. When using the CATS program to provide temperature readings of a target, it is necessary to calibrate the system to match target radiance with temperature. This is accomplished by recording the thermal level seen by the A/D conversion and fitting a curve to the data through a least-squares method. The curve is reproduced by the equation [Ref 18]

$$ThermalLevel = \frac{A}{C\ e^{B/T} - 1} - OS \tag{17}$$

A, B, and C are determined by the curve fitting, OS is the offset correction up or down, and T is the temperature (ordinate) of the plot. Thermal Level value range determines the abscissa. Plots for system calibration for the internal filters and with the split-image system added are shown in Appendix D.

The most important feature of CATS is the ability to store frozen image data for later analysis. To make detailed measurements and perform data manipulation, further software is required with greater flexibility.

C. INTERACTIVE DATA LANGUAGE (IDL) SOFTWARE

In order to process the image data to a level comensurate with the accuracy in measurement desired, a software package is required that provides flexibility, digital resolution, and data manipulation capability. IDL allows the user all of these functions and is required to give the data processing power needed. It is produced by Research Systems Incorporated, Boulder, CO. Data that is stored by the CATS program is read into IDL in array format where numerical analysis is performed with the data displayed in an image format. Routines are written to perform a number of functions and will be discussed in the analysis chapter.

V. POLARIZATION FILTERING TECHNIQUES

Use of polarization signature and background features for target discrimination implies the employment of polarization filters. The technology for large aperture polarizers in the IR is relatively new. Most methods commonly used in the visible range are not available in the IR.

A. POLARIZING FILTERS

Polarizing filters have traditionally been constructed using anisotropic crystals or wire grids. Of these methods, the wire grid technique has been applied in recent years using lithographic techniques. This consists of a conducting grid deposited on a transparent substrate. Placed in the optical path of the incoming radiation, the filter will pass the component of the radiation with the electric field orthogonal to the orientation of the grid. The grid behaves like a dielectric sheet in this case. The component of the radiation with the electric vector parallel to the wire grid induces currents in the wires and is reflected. Fig. 9 shows a schematic of this process. A restrictions on the grid is that the line spacing must be of the order of the wavelength of the incident radiation (Ref.6). Such filters for the infrared are available with clear apertures up to 45mm. Typical transparent substrates in the infra-red are materials such as Germanium, Silicon, and KRS-5.

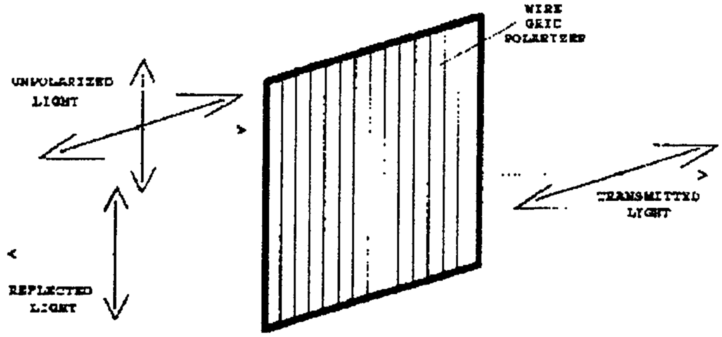


Figure 9. Wire Grid Polarizer

1. External Filters

The location of the filter in the optical path has a large impact on image attributes. If a flat reflecting surface is placed in front of the collimated lens, it is possible for the cold detector to 'see' itself in the image. This is referred to as the 'Narcissus Effect' (Ref.23), which perturbs the image greatly. Tilting the polarizer may alleviate this problem but will reflect radiation into the image from outside the field of view. Another drawback to using an external filter is the size required to cover the aperture defined by the input lenses. It is necessary to cover the entire aperture which is a function of the system f number and focal length. Benefits of using an external filter are ease of insertion/removal and grid orientation changing.

The large external filter was used in the MAPTIP experiment in October 1993. The large external polarizer provided excellent data for the determination of the degree of polarization of the targets and backgrounds and of contrast improvement (Ref.1). Conclusions showed percent polarization of vertical sea-water emission up to 83% in the long-wave IR band. Contrast improvement from emission polarization filtering was as high as 36.3%. Large improvements such as this justify the utility of the external polarizers and show their effectiveness.

2. Internal Filters

Filters can also be placed inside the AGA-780 imaging system between the main input lenses and the detector. This allows hands-off operation and smaller filter size. In systems which are configured to use filters in the optical path for other types of filtering, small polarizing filters can be substituted. These filters will typically be designed into non-imaging locations. 'Narcissus' spots, filter mounting and alignment problems, and other complications can thus be avoided with this method. Implementation can be accomplished with minor system modification and cost.

Installation in an existing filter wheel requires a polarizer for each polarizer orientation to be used, adding to system expense. Internal filtering is a highly desirable option and experimental use will be discussed in more detail later.

An alternative method of internal polarizing applicable to focal plane array systems is placing an independent filter closely against each element of the focal plane array[6]. Each element of the array can then have any preselected orientation of linear polarization built into the focal plane mask. An added benefit over rotating polarizers is the simultaneous recording of all the selected polarizations without manipulating a filter selector. Disadvantages are the pixel offset of the image for each polarization, and the inherent loss of resolution. The practicality of this technique for the 3-5µm band has been demonstrated in a NASA-supported program (Ref. 6).

B. SPLIT FIELD OPTICS

A method of polarization in which the polarizer is internal to an optical system but external to the imaging system itself is the technique of Split-Field polarization filtering. The concept of the split field system is that orthogonally polarized images can be extracted from the field-of-view simultaneously with one polarizing filter and presented in adjacent sections of the final image field of view. This is accomplished by splitting the beam with a polarizer. The Environmental Research Institute of Michigan (ERIM) has developed such a system which uses Brewster angle reflection to separate one plane polarized component from the beam, extracting the orthogonal component from the transmitted component through the Brewster plate (Ref. 5). Since the Brewster plate is tilted, a reference is needed to keep uncalibrated background from contaminating the image, as in the NPS system. Commonality exists between the ERIM system and the NPS system. However, the NPS system defines the apertures of the two channels and brings them to adjacent halves of the final image plane. The ERIM system focusses the two channels onto separated areas on a single integrated focal plane array.

The Naval Postgraduate School, Naval Academic Center for Infrared Technology (NACIT) has constructed and begun testing a split-field system. Polarization is attained through a wire grid polarizer tilted to the incoming radiation with polarization orientation obstained from grid transmission and grid reflection. When considering options for selecting an imaging system for the split-field optics, the scanning AGA was chosen. The only focal plane array available for use at this time operates in the 3-5 μm band.

Because of the nature of the targets and environments where the split system will be used most, it was decided to first build the system to operate in the 8-12 μm region. The existing hardware and familiarity using the AGA coupled with IDL software and established data analysis techniques made it a good choice for examining the new system. The trade to go to the AGA is in reduced frame sampling rate and resolution. A detailed explanation of the split-field technique employed, a system description, and polarizing characteristics of the system will follow later.

VI. INTERNAL POLARIZING FILTERING WITH THE AGA-780

Internal filtering of the radiation after it passes through the imaging system input lenses can be accomplished with the AGA-780 Thermovision Scanning Imaging system by using an existing filter wheel. The original purpose of the filter wheel was to hold various accessory spectral filters in the optical path before the radiation reached the detector. Fig. 10 shows the internal layout of the AGA-780. One of seven positions of the wheel is selected by rotating the knob on the front face of the unit. Care must be taken

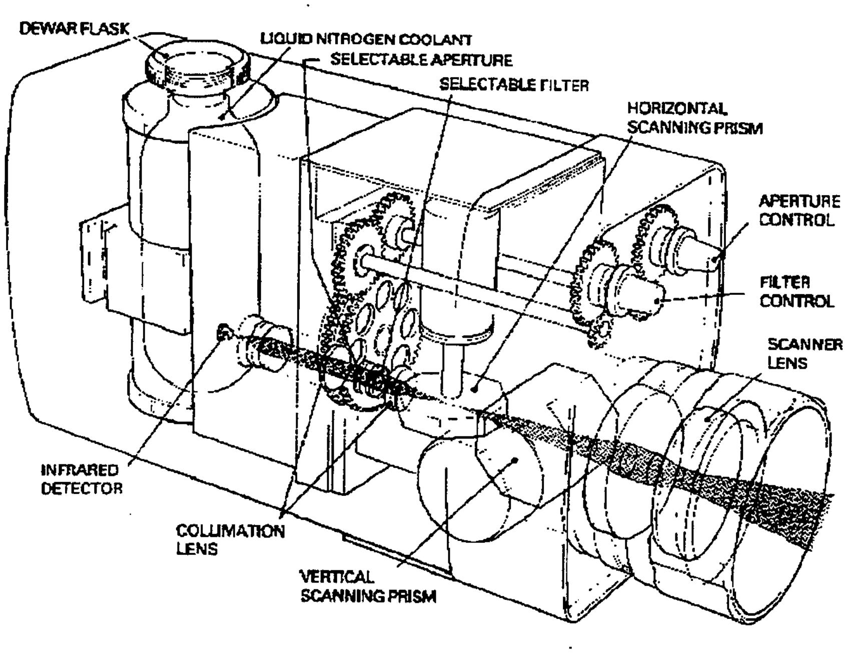


Figure 10. Internal Layout of the AGA Thermovision (model with only one IR Band).

to ensure that no internal circuitry compensates for an assumed filter present at the position of the polarizer. Polarization measurements with this system require sequential images with alternate filter wheel positions inserting vertically and horizontally polarized filters. This necessarily involves time delays.

A. ALUMINUM/KRS-5 FILTERS

The filters used consisted of an aluminum grid superimposed on a 9.5mm diameter x 3mm thick round KRS-5 substrate manufactured by Graseby-Specac; Suffolk, England. The performance specifications provided with the filters are nearly identical for both and will be treated as such for explanation. Appendix A shows the performance curves for the two filters. The various traces numbered 1-3 represent power transmitted with the grid vertical, horizontal, and with the grids from two filters crossed, relative to the electric vector of the incoming radiation. The determination of the perpendicular and parallel transmittances for the filter involves use of a spectrometer which itself includes internal polarizing reflections. Thus it must be accomplished by measuring the transmittance twice, with the grid in two orthogonal orientations. These two measured transmittances are designated E_v and E_h. The corresponding instrument transmittance is measured without the grid in place as E_0, and the transmittance for two crossed grids as E_1. From these quantities the grid transmittances are derived as

$$K_1=\frac{E_h+E_v}{E_0} \qquad K_2=\frac{E_1}{E_h+E_v} \tag{18}$$

These quantities are specified by the manufacturer for each filter. The expressions are approximate values derived by Young, et al. (Ref. 13).

B. FILTER INSTALLATION IN THE AGA-780

Figure 10 shows the internal layout of the AGA-780. To install the filters, the appropriate holes in the wheel were enlarged approximately 0.5mm in diameter. Two filters were then installed in filter positions 4 and 5, carefully oriented with passage axis vertical and horizontal, respectively. The filter wheel was then installed in accordance with the manual. Extreme care was taken to select positions in the filter wheel which have no electronic filter compensation in the system. The manual denotes which positions these are. Once the system modification was complete, new calibration constants were computed and installed in the CATS system. Calibration constants are listed in Appendix D.

VII. THE NPS-NACIT SPLIT-FIELD POLARIMETER

The split-field system approach possesses many advantages over external and internal filter placement normal to the path of the radiation, particularly in elimination of time lags and registration problems between orthogonal polarizations. The Naval Academic Center for Infrared Technology (NACIT) at the Naval Postgraduate School (NPS) has constructed and tested a split-field front end optical system for input to thermal imaging systems, specifically matched to the AGA-780 and the AMBER Engineering-4128. The Split-Field Polarimeter is the result of a conceptual design by Professor Alfred W. Cooper. The actual construction and design optimization was performed by Professor Eugene C. Crittenden and LT Peter H. Heisey, USN, as assistant. The general features of the NPS-NACIT Split-Field Polarimeter are:

1. Simultaneous display and recording of orthogonally polarized images.
2. Utilization of entire field-of-view for display.
3. Adaptability to different imaging systems.
4. Dual-band (8-12μm and 3-5μm) operation using interchangeable filters.
5. F/1.87, 99mm focal length optics.

As mentioned in Chapt. IV for other systems with split-field optics, the 'Narcissus spot' is avoided by having the filter tilted relative to the path of the radiation. A background plate is also needed to give a uniform reflected radiation source into the images. The specifics of the system and its components and design will be discussed.

A. SYSTEM DESIGN

The split-field optical system consists of input and output compound lenses, polarizing splitter, and front-surface aperture limiting mirrors. The components are arranged in a vertical plane with respect to the ground. The system takes the collimated input radiation, focuses it down as it is split into two orthogonally polarized components, and folds and recombines the two split halves of the image while recollimating the light for processing by the thermal imaging system. In this process, the optical aperture is redefined so that only the scan lines of the central half of of each image are retained. The remaining 3.5 x 7 degree halves are combined in adjacent halves of an intermediate 7 x 7 degree image plane. The 7 x 7 degree field of view of the optical system is thus split into two channels with orthogonal polarizations. Each channel is aperture limited into a 7x3.5 degree field to compose half of the final image. The original radiant flux in the image is preserved in this way. An overall picture of the system in use with the AGA-780 Thermal Imaging System is shown in Fig. 11. In this setup, the entire imaging system is mounted on one lightweight mounting plate. Fig. 12 shows the inside of the box with all components exposed. Aluminum was used for all mountings and plates because of low weight, corrosion resistance, and easy machining.

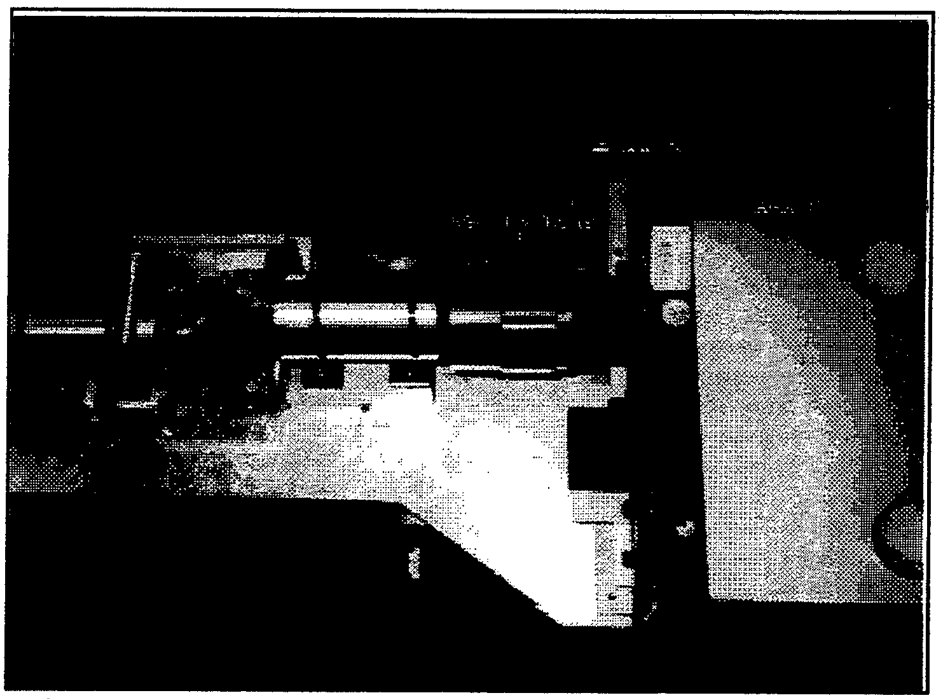


Figure 11. Top View of AGA with Split-System.

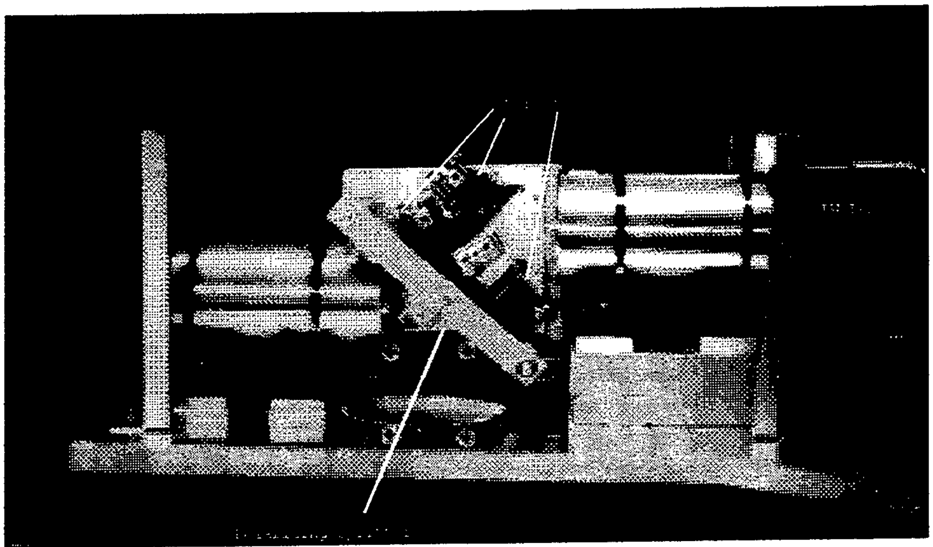


Figure 12. Side View of AGA with Split-System.

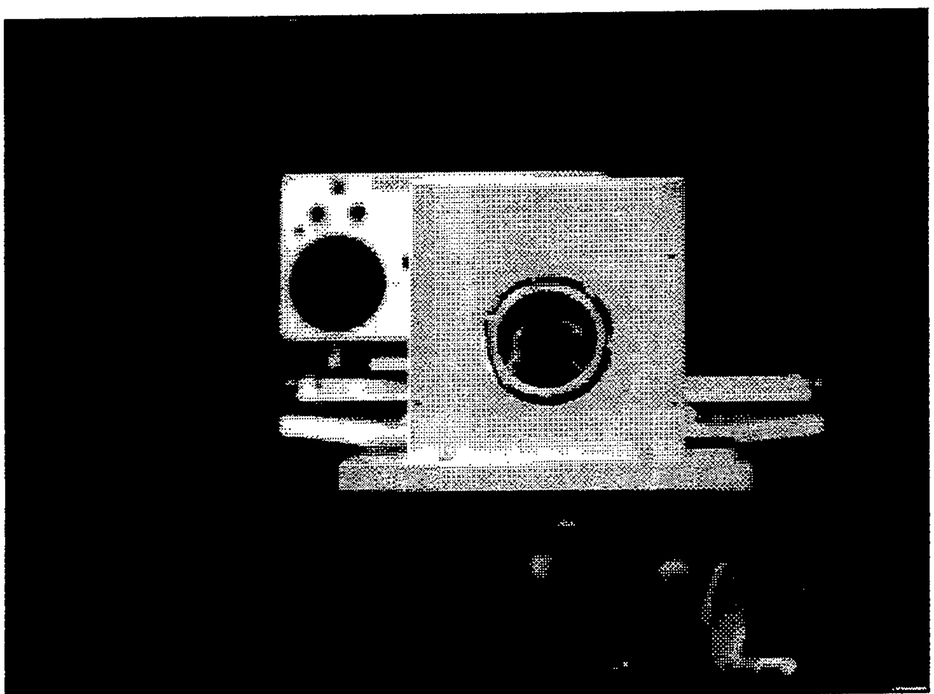


Figure 13. Front View of Split-Field input lenses with AGA in background.

availability, corrosion resistance, and easy machining. The front view in Fig. 13 shows the exposed input lens. The long wave input lens for the AGA system is hidden by the backside of the system. The short wave lens not being used by the AGA is to the side and may be slid into place behind the optics when a short-wave polarizer is installed. Figure 14 shows the image orientation and focal plane within the split-field optics.

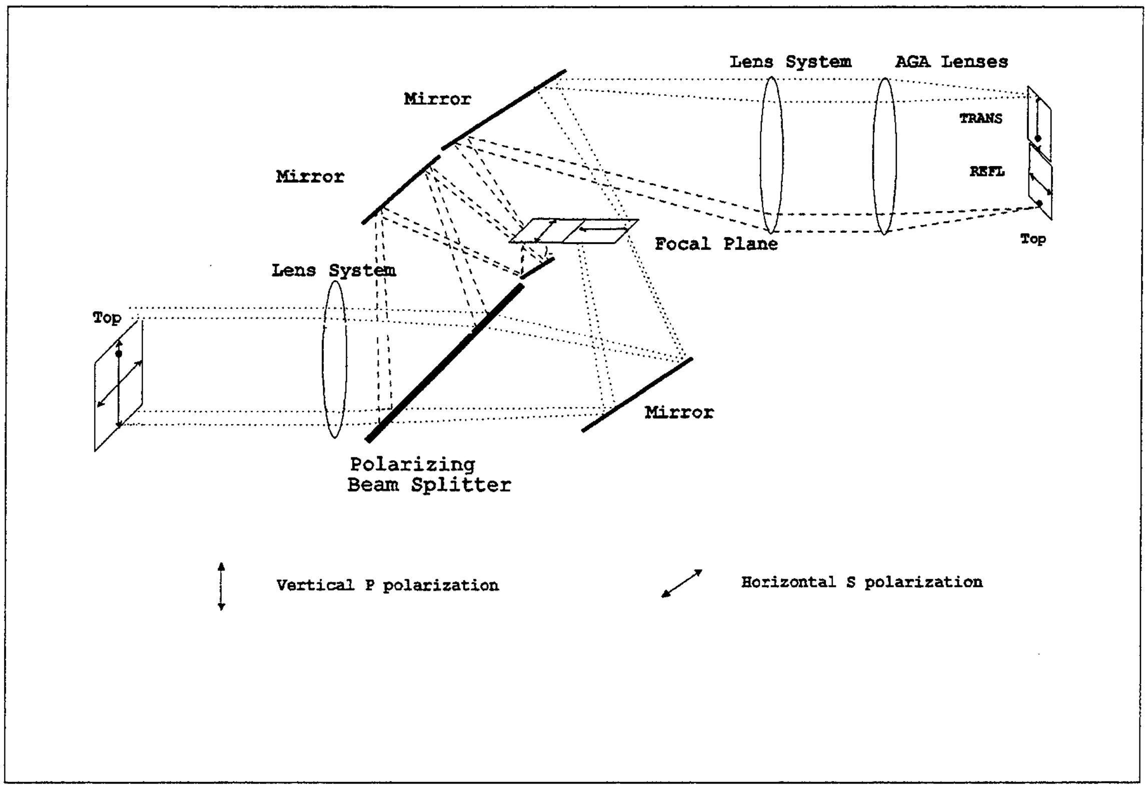


Figure 14. Schematic of Ray Paths in Split Optical System

The incoming rays encounter two Germanium lenses (labeled lens system) and are refracted to a focal plane. In the process, the polarizing splitter splits the beam into two paths with one beam vertically polarized with respect to the ground (transmitted beam) and the other reflected with horizontal polarization. The transmitted beam is reflected to a focal plane at the edge of a small mirror used by the reflected beam to be turned in the same direction (Fig. 14). At this point, both beams have been recombined in a single focal plane. The beams then diverge and are reflected by the last mirror into two lenses identical to the first lens system (labeled lens system). The radiation emerges afocally so that the AGA imager, positioned immediately behind the system can process the image for display.

B. SPLIT-FIELD OPTICAL COMPONENTS

The split-field system consists of 3 major components as stated in the previous chapter. The specific characteristics and operation of these components will now be addressed.

1. Lenses

The lenses used by the system to generate the split image for input to the thermal imaging system consist of two identical assemblies each containing two germanium anti-reflection coated lenses. One assembly is used for the input and the other for the output side. The output assembly is reversed, end for end, relative to the input assembly.

The inner surface of the first lens of the input assembly and the inner surface of the last lens of the output assembly are aspheric. This reduces aberrations and provides a minimum spot size of 1.1 mrad, within the resolution of the AGA imager. The lens surfaces are coated for antireflection in both the 4μm and 12μm wave bands. This is necessary because the high index of refraction of germanium (4.0) would produce large reflection losses and scattered radiation if the surfaces were left uncoated. The overall focal length of each of the two lens assemblies is 99.2mm with an f number of 1.87

2. **Polarizing Splitter**

The most important component of the split system from the polarizing standpoint is the Al/Ge polarizing splitter. The custom designed splitter consists of a germanium substrate with an aluminum grid deposited on one side. The grid consists of .25μm wide aluminum strips separated by .40μm for an overall period of .65μm. The substrate is a round disc, 50mm in diameter x 2mm thick. Both sides of the splitter areanti-reflection coated for the 8-12μm band. It is necessary to replace the splitter for the short-wave IR band, since the vendor found it impossible to coat the element for both bands. The same analysis done for the KRS-5 polarizers in Chapt. V was performed for the Ge splitter.

Data provided by the manufacturer (Graseby-Specac) is valid for normal incidence of the optical beam on the splitter. Values for K_1, K_2, and P are .81, 0.0, and 1.0, respectively at 10μm. This means the splitter passes 81% of the linearly polarized light perpendicular to the grid orientation and is ~100% polarized. The manufacturers performance curves are provided in Appendix A. Extensive analysis was done to verify operation of the splitter; this will be addressed in section C. Results showed that there is a wavelength dependency of the radiation fraction that is reflected and transmitted. It is found that wavelengths between 7μm and 9μm favor reflection and the opposite is true above 9μm. This is due to inefficiencies in the polarizing grid and anti-reflection coating. Results obtained by system calibration show this and will be discussed later.

3. Gold Mirrors

The folding operation of the optical system is performed by four gold first-surface 'protected' mirrors. The mirrors were purchased from Edmund Scientific Co. and are advertised to be 1/10 λ flat at .5μm. Gold was chosen because of its high reflectivity, and thus, low emissivity. Figure 15 shows a plot of the emissivities at 9.92 μm for gold at a range of incidence angles.

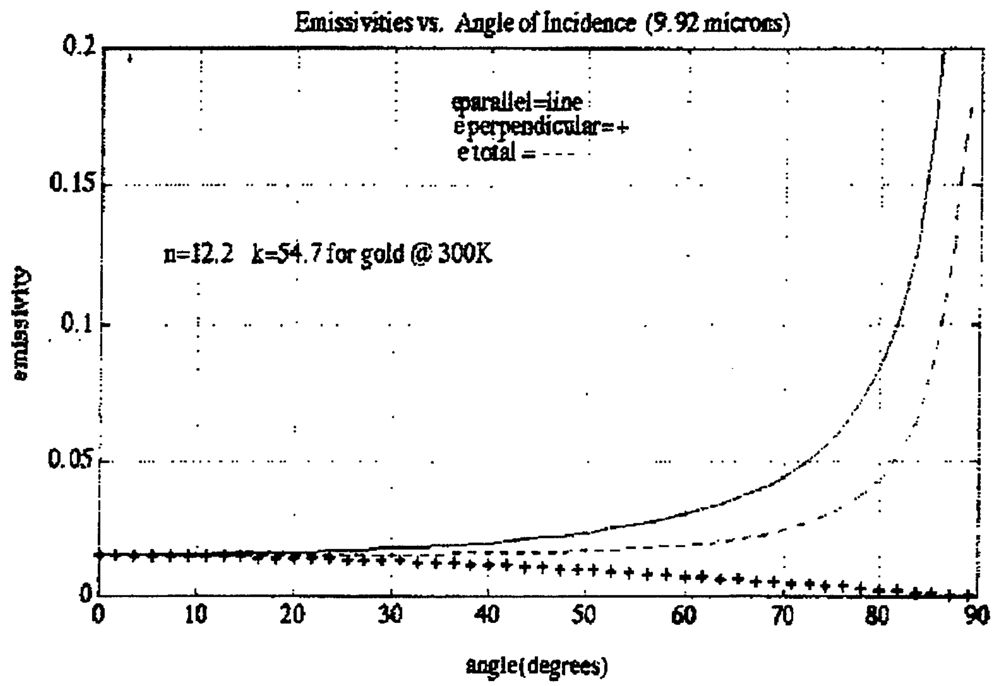


Figure 15. Emissivity of Gold from eq.(9).

As expected, significant polarization effects occur only at angles close to grazing incidence. Most reflecting angles of the mirrors are near 45 degrees, so these effects are small (<1%), but must be considered.

C. SYSTEM CHARACTERISTICS

The combined effects of the presence of the components in the optical path and mechanisms by which they perform their functions must be quantified to predict overall system performance. Irregularities in refracting and reflecting surfaces, polarized reflection and emission, and system background radiance are effects which influence the measured radiance and resolution of the target. Experiments have been performed to characterize these effects to assist in predicting final image quality.

1. Resolution

To obtain the full resolution possible by the AGA-780 when used with the split-field system, effects induced by imperfections in the optics of the split-system must be minimized. Upon delivery of the splitter, visual resolution was tested using a standard bar chart. Reflection of the bar chart off the surfaces of the splitter showed no loss in resolution from direct viewing of the chart. It follows that imperfections in the surfaces would induce less effect in the longer wavelengths and would not be considered.

A test was also done on the combined AGA-split system to discern if resolution was degraded by the presence of the split-field system. A sharp edged (cold) plate was placed in front of a black-body thermal source. Using the AGA optics alone, measurements were taken of the number of pixels in the image that were required to resolve the sharp edge between hot and cold surfaces. Along the direction of image raster scan, the resolution is about 2-3 pixels. Perpemdicular to the raster scan the resolution is slightly better. Parallel to the raster scan the resolution is apparently limited by the frequency band pass of the amplifier electronics and the response time of the detector. In the direction perpendicular to the raster scan, the resolution is slightly higher because the response times of the detector and amplifier are not involved. In both parallel and perpendicular scan directions, no loss of resolution occurred in the image when the split-field optics were added.

2. MTF

Modulation transfer function tests were performed for the AGA system with and without the split-field. The cutoff frequency for the AGA in the direction of raster scan is .3-.5 cycles/mrad which gives a resolution of 2-3mrad. The AGA system manual gives a system resolution of 1.1mrad. This is apparently the geometrical resolution of the AGA optical system. The MTF data show that the overall system has a 2-3 mrad resolution. There was no loss in spatial resolution with the split-field system;

3. System Polarization Performance

The main driver in the performance of the system is the polarizing splitter. Establishing numerical values for transmissivity, reflectivity, and absorption of the splitter for polarized and unpolarized target radiation requires measurement of all radiance sources throughout the image and split-field system.

a. *Spectral Polarizer Performance*

The manufacturer of the polarizer provided spectral transmittance data for the polarizer at normal incidence to a reference beam. For use in the split system, it is necessary to know the spectral transmittance and reflection for 45 degree incidence.

To measure the transmittance, the polarizer was placed at 45 degrees to the incoming beam in a Perkin-Elmer Model 337 Infrared Grating Spectrophotometer. The photometer measures the characteristics in the same manner as the spectrophotometer used by the manufacturer. Because of polarization induced in the beam by the grating, the method described by Young et al.(Ref 13), is used to compute the transmittance. This is the approach outlined in Chapt. VI. Appendix B shows the plots generated by the polarizer at normal and 45 degree incidence. Agreement with the manufacturers values are within 3% for normal incidence. For wavelengths less than 10.5µm, the transmissivity is higher than at normal incidence. This is probably due to the fact that the effective grid spacing is reduced by cos(45), when the grid is perpendicular to the plane of incidence of the beam, thus moving the curve left to shorter wavelengths. It is necessary to mention that placing the filter in such a manner as to reflect ambient radiation into the detector does not contaminate the readings. The intensity radiated by a typical room temperature object compared to that of the IR source in the device is on the order of 0.001.

Obtaining performance for reflection polarization required altering the conventional configuration of the polarizer to the beam to utilize the front surface as the effective transmitter. Figure 16 shows the arrangement used to obtain this.

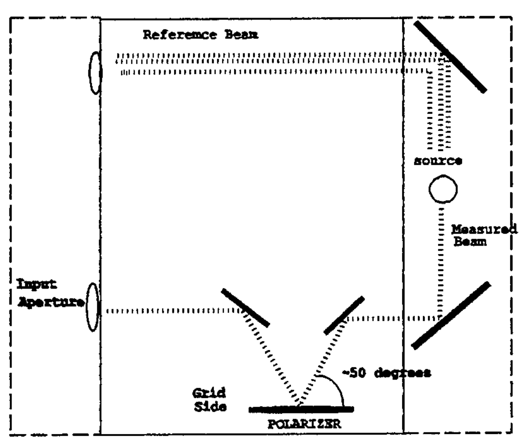


Figure 16. Configuration for polarization reflection measurement using the Perkin-Elmer M337 Infrared Grating Spectrophotometer.

Data for the linear polarization reflection efficiency is provided in Appendix B. Reference 13 provides a derivation of the measurement technique to obtain the transmittance of a polarizing grid. The difference in finding the efficiency here is that reflection is substituted for transmission in the equations. The radiant intensity with the polarizer removed was obtained by placing an aluminum mirror in place of the polarizer and resetting the 100% transmission indicator. The performance plot in appendix B shows this trace across the top of the graph. The designation for the reflected efficiency is K_{1R}. The equations are analogous to those described in chapter VI. It was not possible to measure K_{2R} (orthogonal polarization reflection) because of the unique arrangement and nonavailability of another similar polarizer.

The degree of reflected polarization perpendicular to the grid, can be described as follows. Any radiation impinging on the grid with E vector perpendicular that is not transmitted must be reflected due to fact that the grid width is small compared to the wavelength, precluding current generation. This reflected component is the complement to the transmitted fraction of the radiation. This theory will be demonstrated in the following section.

b. Polarizer Performance Utilizing Radiance Analysis

(1) Theoretical Representation

An alternative method for measuring the fraction of polarized radiation transmitted and reflected by the polarizing splitter is to take radiance readings of the radiation passed with a known source polarization orientation. However, complications arise with this method when target temperature is near the temperature of the optical system, because the background irradiance that enters the detector is of the order of the target irradiance. To discriminate the target irradiance from the background, a mathematical description of the background effect is required.

For the case of unpolarized radiation incident on the optical system, the following equations apply:

$$\begin{aligned} I_{T_{UNPOL}} &= f_{T_\parallel} I_\parallel + f_{T_\perp} I_\perp + \varepsilon_{T_B} \\ I_{R_{UNPOL}} &= f_{R_\parallel} I_\parallel + f_{R_\perp} I_\perp + \varepsilon_{R_B} \end{aligned} \qquad (19)$$

where

$\varepsilon_{T_B}, \varepsilon_{R_B}$ = *the respective background emittances measured for each channel, independent of target irradiance*

$$\varepsilon_{T_B}, \varepsilon_{R_B} = \varepsilon_{lenses} + \varepsilon_{mirrors} + \varepsilon_{splitter} + \varepsilon_{background\ plate}$$

$I_{\perp}$ and $I_{\parallel}$ represent the components of target irradiance perpendicular and parallel to plane of incidence of the polarizing splitter. These are what is actually measured by the thermal imaging system. For the entire analysis the convention used is that the polarizing splitter grid lines are perpendicular to the plane of incidence. The $\boldsymbol{\varepsilon}_{TB,RB}$ terms represent the radiant exitance of all the components of the system when the incident intensity into the system ~0. This is simulated by directing the optics at a pool of liquid nitrogen. The subscripts T and R designate the transmitted and reflected channel through the split-field optical system. T denotes the radiance fraction which passes through the polarizing splitter and is displayed as the top half of the split image; R denotes the other channel reflected by the splitter. The perpendicular and parallel subscripts describe the orientation of the E vector for the irradiance relative to the plane of incidence of the splitter. For example, unpolarized radiation is commonly represented by

$$I_{total}=(I_{total}/2)_{\perp}+(I_{total}/2)_{\parallel} \tag{20}$$

To eliminate unknown terms in Eq. (19), measuring a purely linearly polarized source in two orthogonal orientations yields a simpler set of equations. For the first case of purely polarized target irradiance perpendicular to the plane of incidence (perpendicular to the grid),

$$\begin{aligned} I_{T_{\parallel}}&=f_{T_{\parallel}}I_{\parallel}+\varepsilon_{T_B}+\varepsilon_{F_{T_{\parallel}}} \\ I_{R_{\parallel}}&=f_{R_{\parallel}}I_{\parallel}+\varepsilon_{R_B}+\varepsilon_{F_{R_{\parallel}}} \end{aligned} \tag{21}$$

The $f_{T,R}$ terms denote that fraction which goes into the respective channels from splitter reflection and transmission performance. The target consisted of a polarizing filter in front of a black body source; therefore, there is some filter emittance that must be considered. The added ε_F terms represent the emittance of the polarizing source for each channel, for each orientation of the target producing filter. It can be seen that there is a fractional contribution to each channel to be measured, T and R. This is because it is known that the transmittance of the grid is not 1.0. For the case where the target radiance is plane polarized perpendicular to the plane of incidence (parallel to the grid),

$$I_{T_\perp}=\varepsilon_{T_B}+\varepsilon_{F_{T_\perp}}$$
$$I_{R_\perp}=f_{R_\perp}I_\perp+\varepsilon_{R_B}+\varepsilon_{F_{R_\perp}} \tag{22}$$

There are few terms seen in the T channel because it is known from the spectral performance curves that the transmitted E components are ~100% polarized. Equation 21 shows the intensities seen in the two channels with a vertically, parallel (p) linearly polarized source and eq. 22 with 90 degree rotation of the target E vector, s polarized.

(2) Experimental Radiance Measurement

To compute the performance of the system using the equations in the previous section, it is necessary to take careful radiance measurements of each term in the equations with a linearly polarized target. Appendix C contains the values obtained in the laboratory for these measurements.

To compare the performance of the polarizing splitter channels, the values in Appendix C are plugged into eqns. (21) and (22) and then subtract the equations from each other. The relationships obtained are

$$(f_{T_\parallel}-f_{R_\parallel})I_\parallel=21.9$$

$$f_{R_\perp}I_\perp=22.4$$

Measurements showed that there is no dependency of target intensity on polarization orientation, so $I_\parallel=I_\perp$. Therefore,

$$\frac{(f_{T_\parallel}-f_{R_\parallel})}{f_{R_\perp}}=0.98 \qquad (23)$$

This equation allows calculation of the reflected fraction of the incident radiation which is normally passed through by the grid. The implications of Eq. (23) are that the transmittance of linearly polarized irradiance perpendicular to the grid is always greater than the reflection efficiency of the orthogonal component from the grid front. This is seen with the performance curves in appendix B. It also allows correlation of splitter performance using the radiance method with that seen in the spectral performance curves. To compare the radiance method, it will be assumed that the non-transmitted E vector perpendicular to the grid undergoes Snell reflection and $f_T+f_R=1$. The spectrophotometer data measured in the previous section shows that at 9.52μm, the above expression = 0.97. Agreement is seen between the two methods at that wavelength, but the ratio varies strongly at other wavelengths. Schematic representation of what happens at the splitter within the optical system is shown in Figs. 17-19. Figure 17 indicates the fractional performance in the LWIR for unpolarized input. For this case, 58% of the background is reflected into the transmitted (T) channel and

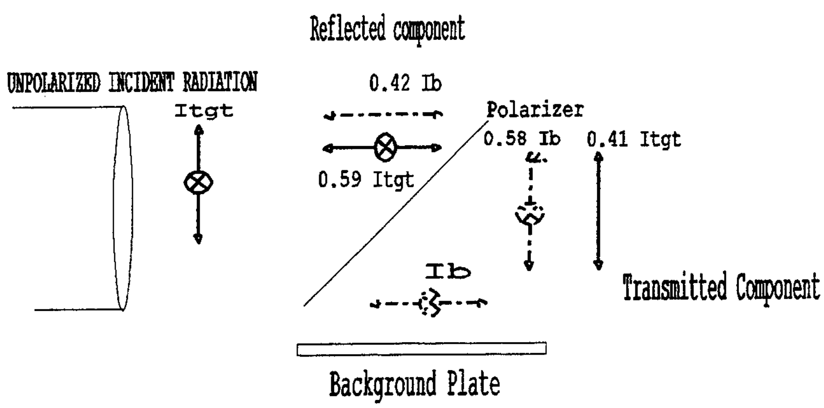


Figure 17. Schematic of polarizing splitter for unpolarized incident radiation. Grid perpendicular to plane of incidence.

combined with 41% of the target irradiance. The reflected (R) channel combines 42% of the background with 59% of the target irradiance. Figure 18 indicates the fractional

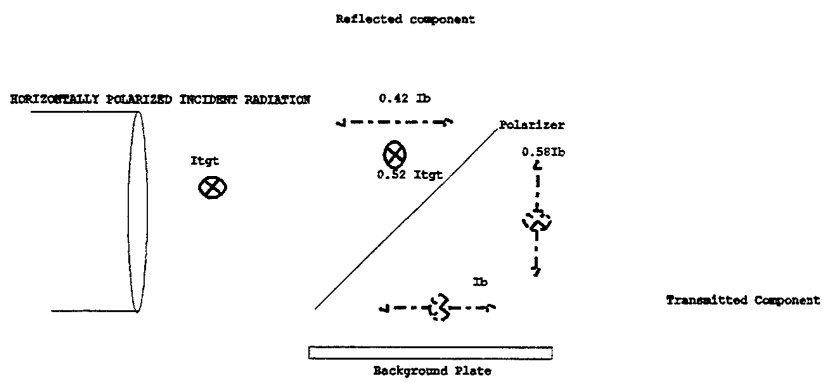


Figure 18. Schematic of polarizing splitter for horizontally polarized incident radiation. Grid perpendicular to plane of incidence.

performance in the LWIR for horizontally polarized input. For this case the transmitted beam contains 58% of the irradiance from the background plate and essentially no target radiation. Figure 19 shows the equivalent situation for vertically polarized input, which shows 83% of the target irradiance with 58% of the background irradiance in the transmitted (T) beam, and 17% of the target irradiance

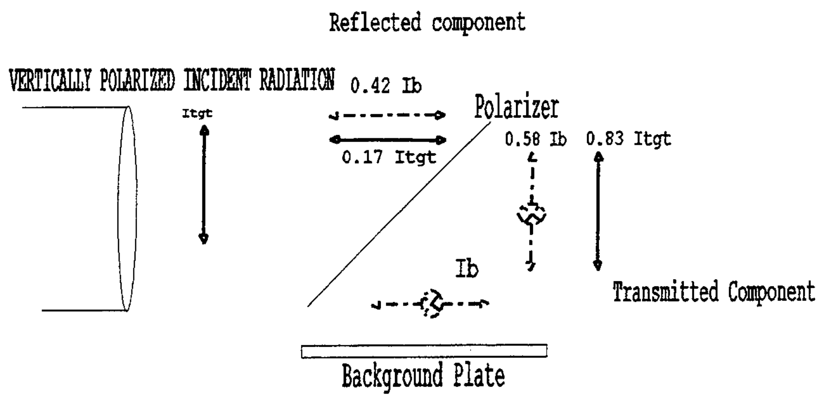


Figure 19. Schematic of polarizing splitter for vertically polarized incident radiation. Grid perpendicular to plane of incidence.

with 42% of the background plate irradiance in the reflected (R) beam.

The radiance analysis of the polarizing splitter performance provides a gross analysis and verification of the data provided by the manufacturer and by the grating spectrophotometer. This representation of transmittted and reflected target irradiance must be considered when processing split-field images.

VIII. IMAGE ANALYSIS

To prove the concepts presented and to demonstrate the effects of polarized filtering on image contrast, it is necessary to perform a preliminary image analysis on images recorded with the thermal imaging system in two configurations; internal polarizing and split-image optical system polarizing. Two separate experiments were conducted to demonstrate system performance.

In March 1995, 1338 images were taken during a field experiment with the R/V POINT SUR from the Monterey Bay Aquarium Research Institute marine operations building at Moss Landing, CA. All of the polarization filtering was done internally. In August of the same year, images were recorded using the NACIT Split-field Polarimeter from the Naval Postgraduate School beach property of the USS John McCain, an Arleigh Burke Class DDG. The images recorded show contrast improvement effects from polarization filtering.

A. DEFINITION OF CONTRAST AND TARGET-BACKGROUND RADIANCE DIFFERENCE

When an observer views an image, the critical parameter for detecting and recognizing the target amidst the background is target contrast. Numerous definitions are currently used to define contrast. Common examples of these are [23]

$$Contrast=\frac{N_{target}-N_{background}}{N_{background}}; \quad Contrast=\frac{N_{target}-N_{background}}{N_{target}+N_{background}} \tag{24}$$

Here N represents radiance. It is desirable to compare the contrast of images which may be separated in time. In this case, changes in system gain cause the apparent digitized image values to change for similar viewing conditions. Also, changing instrument settings changes N for every image when the controls are altered. Therefore, when target and background conditions vary little between images, the difference in N may be a more accurate indicator of contrast. Differences in filter transmittance cause the conventional contrast equations to be in error so that any artificial thermal level changes induced by this are ignored for filters with the same calibration curve slope. This is the case for the internal filters (Appendix E). To accommodate this, the analysis will only consider differences in the apparent radiances of the target and background. The contrast parameter to be measured is termed Target-Background Radiance Difference (TBRD). This is the numerator of both contrast equations in Eq. (24).

$$TBRD = \Delta N = \langle N_{target} \rangle - \langle N_{background} \rangle \tag{25}$$

The average values of N are used because of the varying composition of the image with target distance, system noise, and measurement points in the image. If the image radiation is polarization filtered, the resultant TBRD is a function of the amount of filtering only if all optical components and scene characteristics remain constant. It has been shown that many different components of an image can display different degrees of polarization. If background irradiance is suitably filtered more than target irradiance, TBRD will increase.

When comparing two images, it is useful to quantify the increase in image contrast improvement. The TBRD improvement factor is defined by

$$TBRD_{improvement} = \Delta N_{imp} = \frac{\Delta N_1}{\Delta N_2} \tag{26}$$

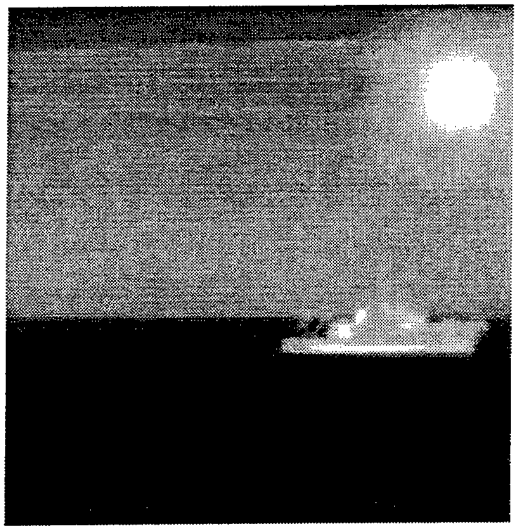
B. FIELD MEASUREMENTS WITH INTERNAL FILTERS

From May 16-23, 1995, polarized thermal imaging experiments were conducted from the Monterey Bay Aquarium Research Institute using the R/V POINT SUR as target.

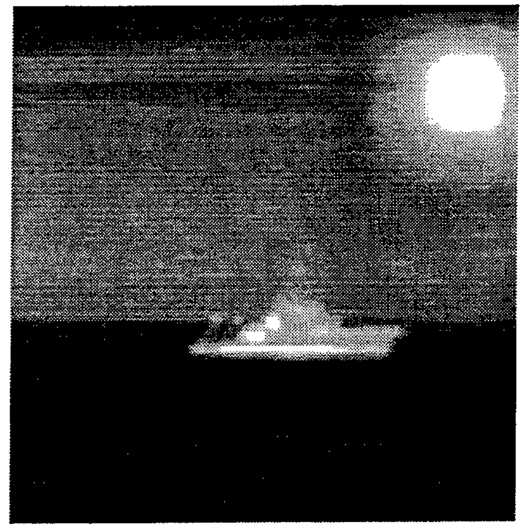
1338 images were recorded using internally filtered and unfiltered images in the 8-12μm wave band. The ship presented all aspects with ranges varying from .25 nmi to the range limit of the day. Appendix E carries a complete listing of the images and a small picture of each with the filename shown on the bottom of each image. Vertically and horizontally polarized images will be compared for target-background radiance difference.

1. Visual Image Comparison

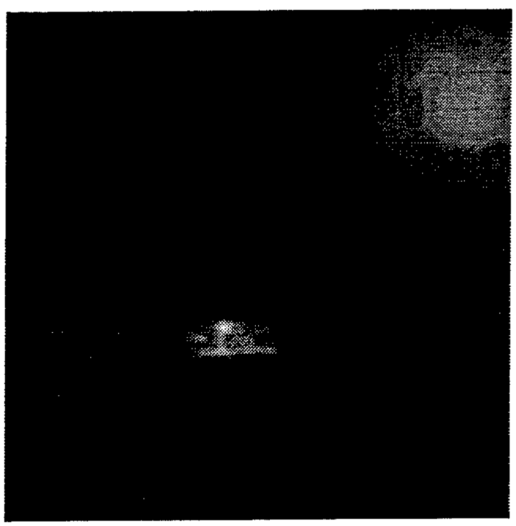
Selected pairs of images demonstrate the visual TBRD and contrast improvement between vertically and horizontally polarized images. Unpolarized images were not considered for this comparison because of the nature of the data analysis process, and the change in system settings necessary to obtain useable images due to the changing of system gain and altering the byte level of the images significantly. The definition of TBRD would not be valid for comparison to the polarized images and further compensation to TBRD would be necessary. The images are selected from the compilation listing in Appendix E. The contrast between the two orthogonally polarized members of each pair of images in Fig. 20a and 20b shows the lower apparent radiance of the sea water background in the horizontal polarization. It is necessary to mention that the images were printed on a Hewlett-Packard LaserJet 4M 600dpi printer. Differences in the images are more easily seen in a grayscale color table on an SVGA monitor. The bright area seen in the top right corner of each image is a constant temperature source created by inserting a mirror in the field of view, reflecting a calibrated black body source. This provides an unpolarized reference in each image to compare filter transmittance and provide temperature calibration confirmation. The source is not discussed in this analysis.



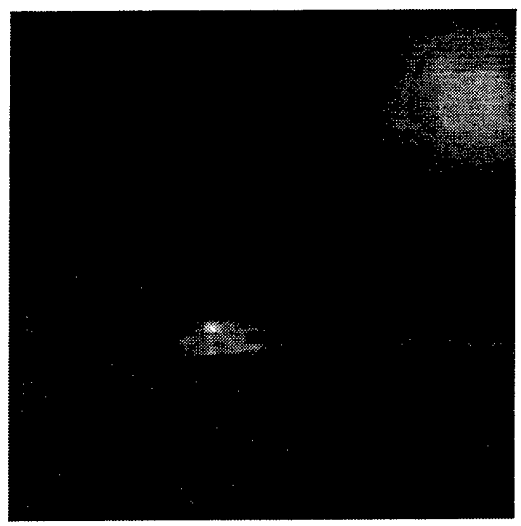
M5L16051 16May95
Polarization: Horizontal
TBRD=108.5



M5L16052 16May95
Polarization: Vertical
TBRD=73.2
$TBRD_{imp}$=1.48

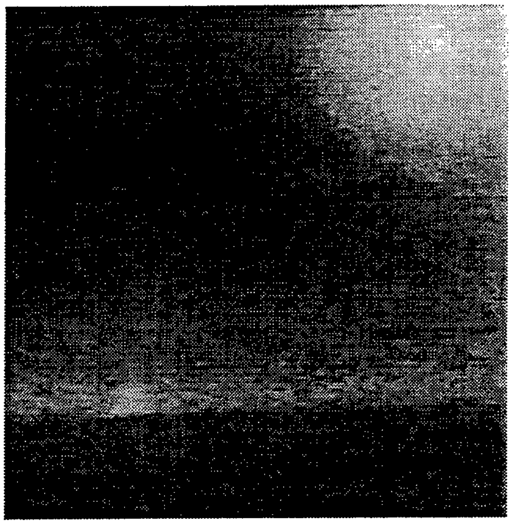


M5L17195 17May95
Polarization: Horizontal
TBRD=58.3

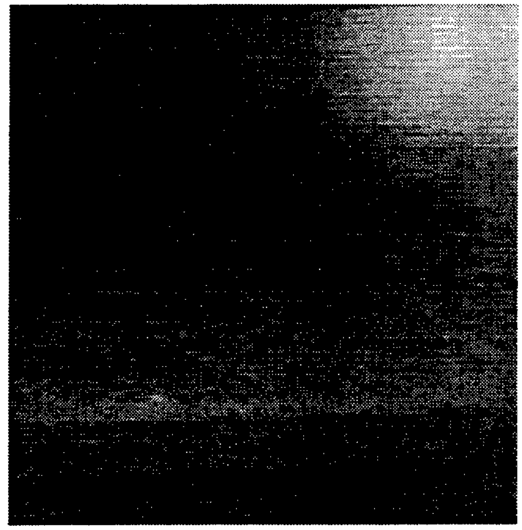


M5L17196 17May95
Polarization: Vertical
TBRD=44.0
$TBRD_{imp}$=1.33

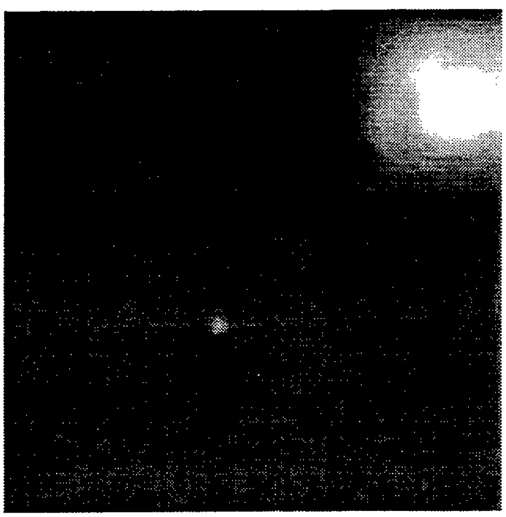
Figure 20a. Comparison of vertically and horizontally polarized LWIR Band (8-12μm) images of RV POINT SUR.



M5L23014 23May95
Polarization: Horizontal
TBRD=22.8



M5L23015 23May95
Polarization: Vertical
TBRD=10.2
TBRDimp=2.24



M5L17136 17May95
Polarization: Horizontal
TBRD=38.4

M5L17137 17May95
Polarization: Vertical
TBRD=32.4
$TBRD_{imp}$=1.18

Figure 20b. Comparison of vertically and horizontally polarized LWIR Band (8-12µm) images of R/V POINT SUR

2. **Numerical TBRD Measurement.**

The images presented in Fig. 20 were extracted groups of images with the same aspects, ranges, and path conditions. The average radiances are calculated by averaging over the target and background areas within an area around the ship. Appendix F contains the IDL code to perform this operation. To compare the TBRD for a number of images, the images must be taken with target and background conditions as constant as possible for trends in the data to appear. Figures 21-23 show TBRD measurements made on different sets of images grouped by ship range and aspect. The vertical axis gives the TBRD in dimensionless units. The 8 bit A/D converter sets the maximum thermal level reading based on system gain to 255. This irradiance reading is independent of system calibration settings and measures the raw data from the detector with no compensation for temperature accuracy. The horizontal axis gives range computed from ship image height measured in pixels. Smaller targets appear to the right side of the plot, which shows TBRD as a function of range. The general trend of TBRD reduction with target size is due to increased path attenuation and path radiance with range. The legend on the plots denotes the polarization and whether TBRD is calculated above or below the horizon. The average TBRD

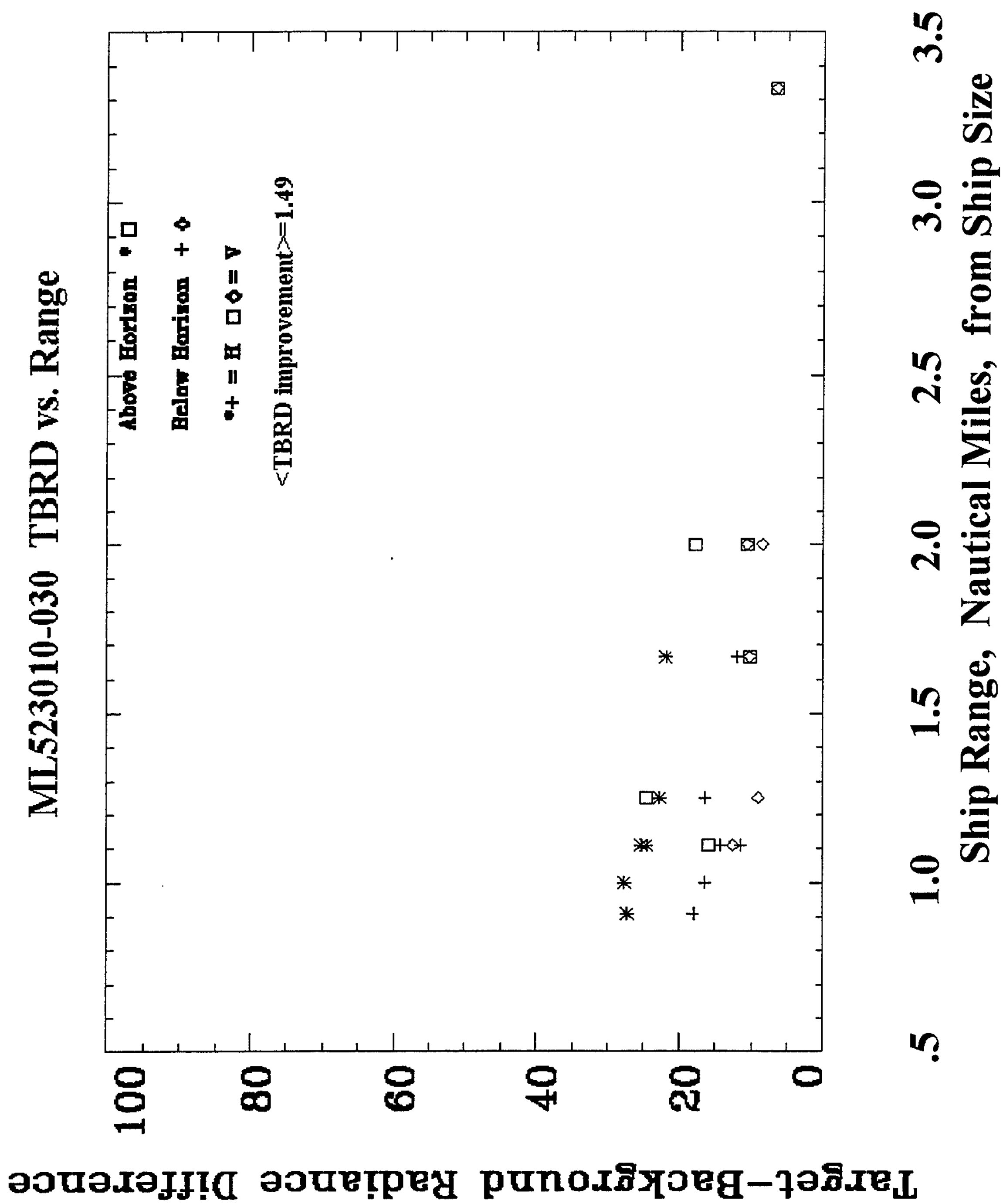


Figure 21. TBRD Improvement-Starboard Aspect

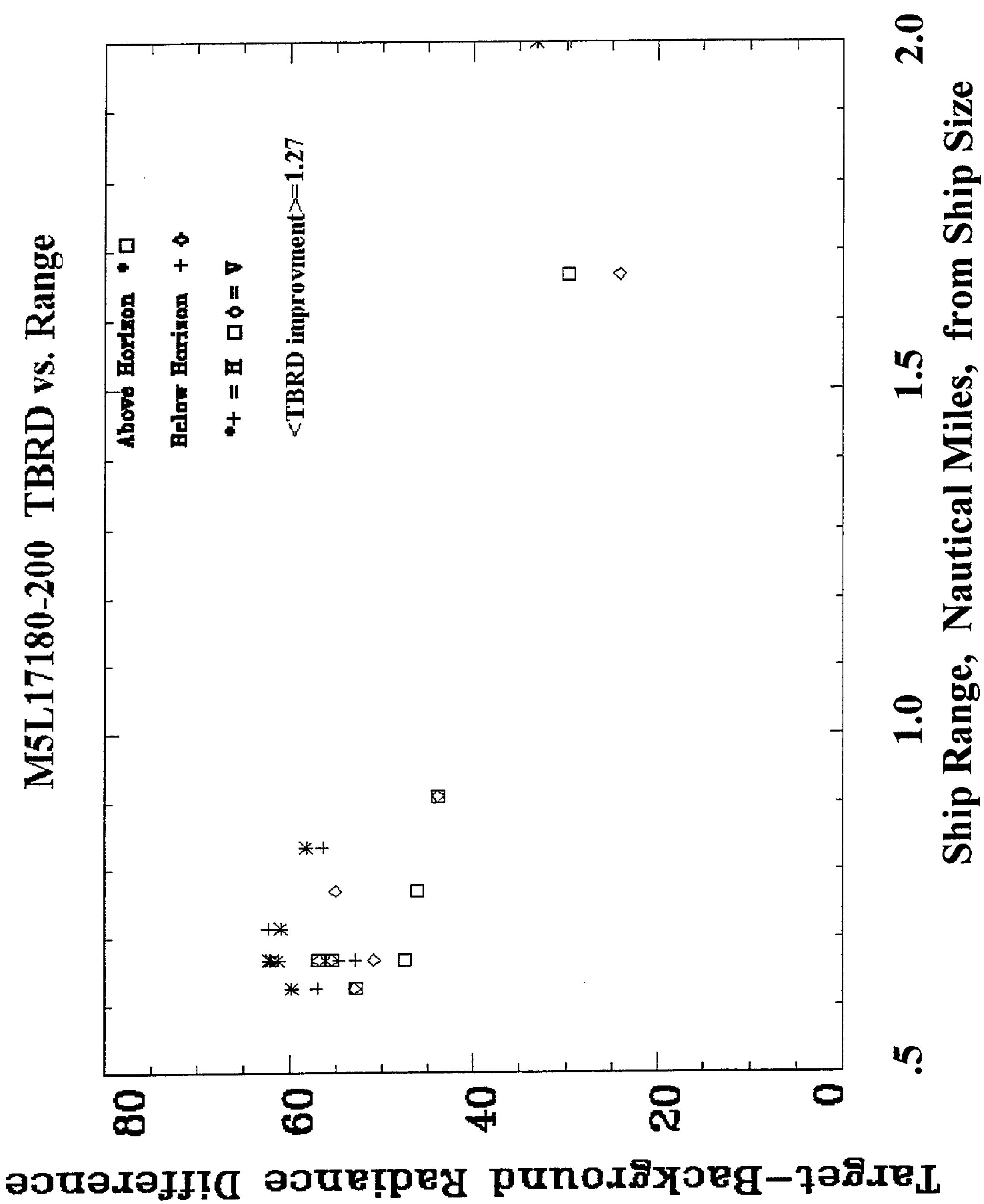


Figure 22. TBRD Improvement-Port and Stb Aspect

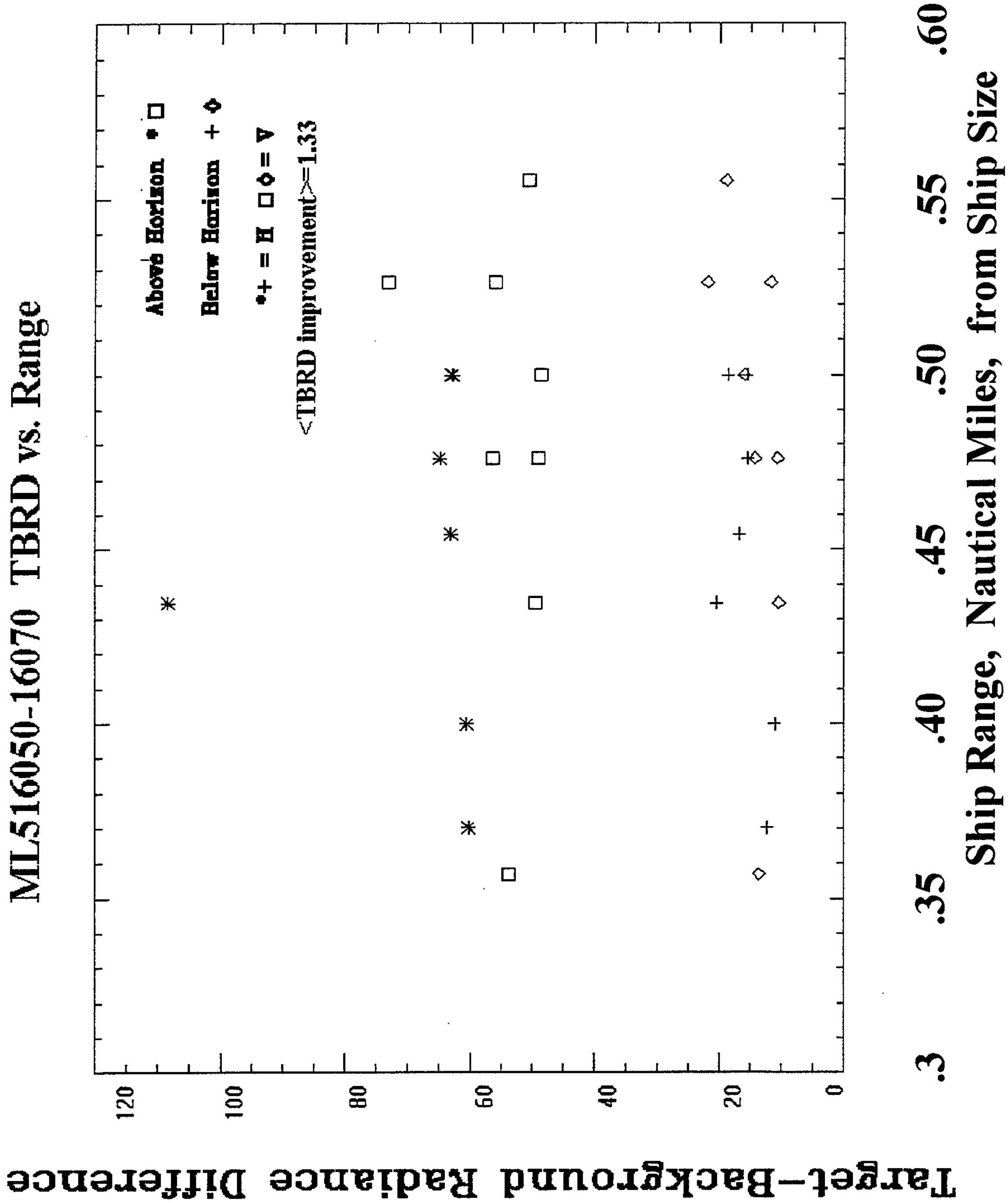


Figure 23. TBRD Improvement-Bow Aspect

improvemement on each plot is calculated only for the below horizon case against the sea water background. It is expected that TBRD against the sky should be nearly the same in both polarizations. This data does not contain any meteorological, target temperature, or detailed ship position data which is available for analysis improvement.

Very general trends are seen for TBRD improvement, but are not as apparent as the average improvement calculation numbers in the plot. Ship size varies greatly in the plots due to variation in the numbers of pixels recorded in the vertical direction and is most pronounced in the images taken in the near ranges. It is seen that there is some polarization effect in the above horizon TBRD. This is probably due to horizon selecton in the image and possible polarization of atmospheric radiance close to the horizon. Analysis was not performed on the polarization of the sky.

C. FIELD MEASUREMENTS WITH SPLIT-FIELD POLARIMETER

Preliminary test and evaluation imaging was done on 3 August, 1995 with the split-field polarimeter optical system. The target is the USS John McCain, an Arleigh Burke class destroyer present in Monterey Bay for a port visit at the Naval Postgraduate School. Thirteen split-field and 10 test images were taken of the ship and black-body calibration sources. The target was at a stationary range of 1.85km, determined by target geometrical size. All images are port aspect. All of the images taken are listed by filename in Appendix G. Because of the similarity in image composition, only one image will be analyzed in depth. Figure 24 shows the image chosen which is optimized for focus, level gain setting, and system adjustment. Images are recorded inverted by the AGA and this image has been artificially flipped upright for viewing. The top image is the reflected component of the polarizing splitter, horizontally (s) polarized, and the bottom is the transmitted vertically (p) polarized image. Consistent with results seen for the internally polarized images is the increase in contrast of the top image. Discussion of specific composition of each channel is in Chapter VII.

Figure 25 shows a vertical profile taken of the image through the hot stack. From the known geometry of the ship, no significant polarization is expected for the stack which is just aft of the large notch in the top of the superstructure. Polarization of emission could exist in the ship panels on the bow as they slant outward toward the horizontal with height. The bottom of the profile corresponds to the bottom of Fig. 24. The x-axis denotes

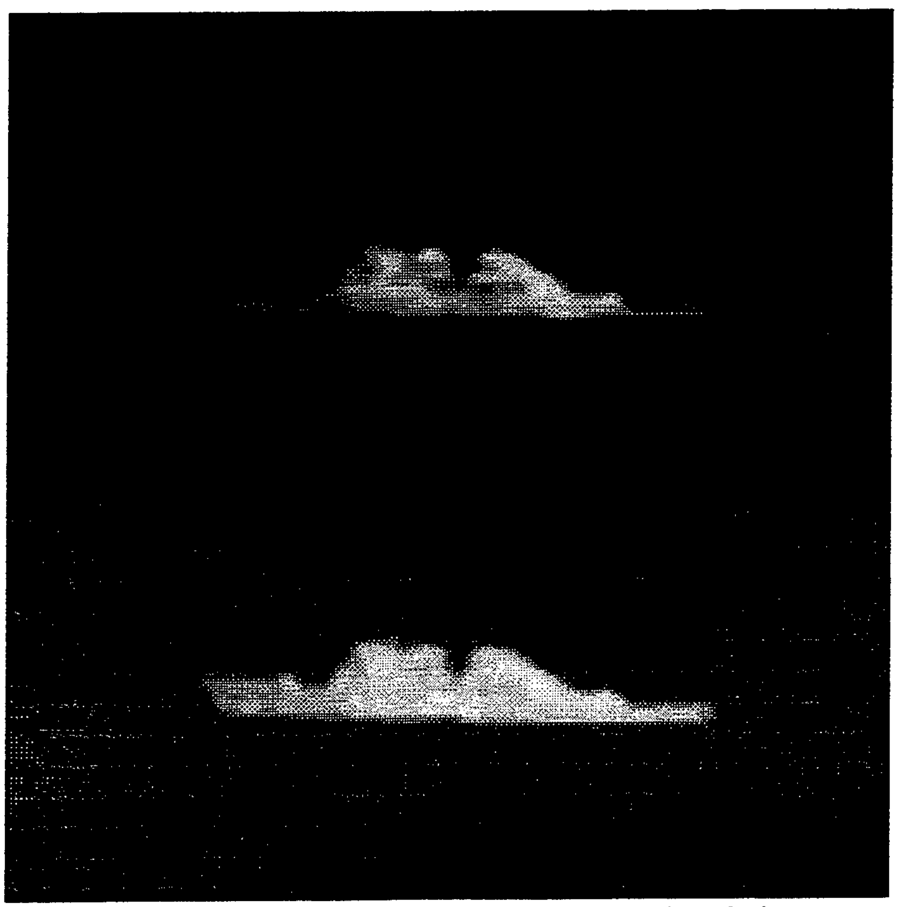


Figure 24. NACIT Split-field polarized image, USS John McCain, 3Aug95
Top-Vertically Polarized TBRD=168
Bottom-Horizontally Polarized TBRD=200

the 8 bit digitized value of radiant intensity. TBRD for the top image is 200 and 168 for the bottom. This gives a TBRD improvement factor = 1.19. This is with reference to the average value of the sea water background taken in the foreground along the azimuth of the stack in the middle. The fog above the image is assumed unpolarized. There is an overall increase in image intensity in the vertically polarized image due to the behavior of the splitter and the background plate (Ch 7).

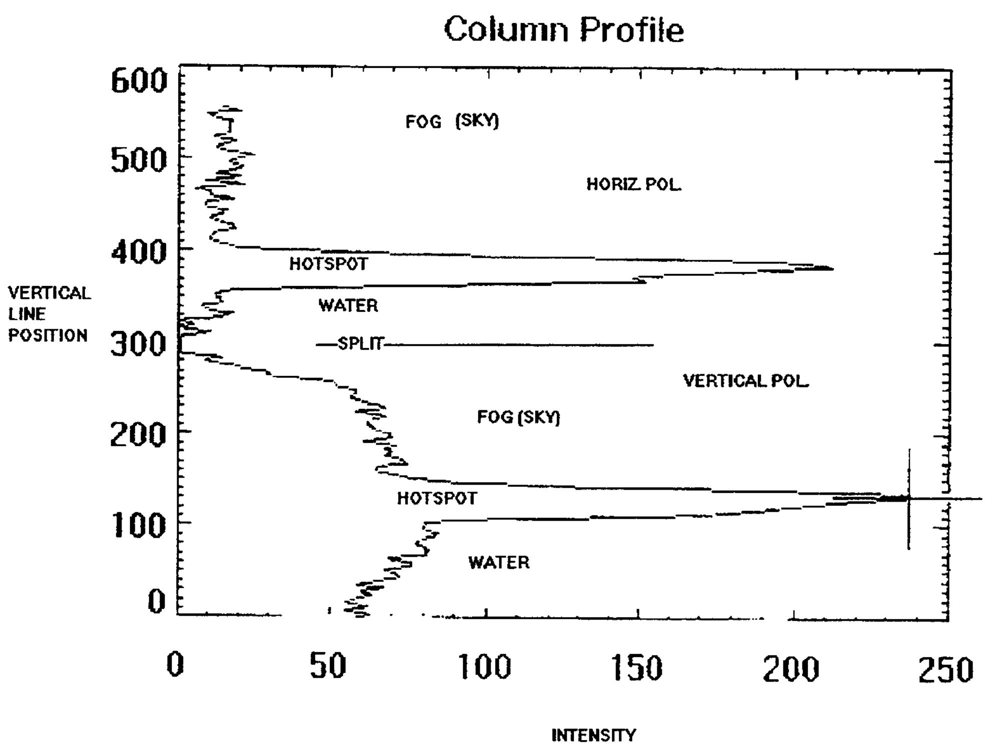


Figure 25. Vertical Profile of Split Image, M0803011

The added reflectance from the back of the splitter raises the overall level of the vertically polarized image. This is another justification for using TBRD to compare image contrast differences.

1. Digital Image Subtraction

The goal of the split system is to provide simultaneous images of the two polarizations which allows digital subtraction of the images to visually represent TBRD improvement. An IDL program was written to accomplish a pixel by pixel overlay of the images of the ships (Appendix F). The program finds the 'hottest' pixel in the image and aligns the pixel addresses in the top and bottom while subtracting the values. The resulting image displays a value of 0 (black) where the images had the same intensity. The areas in the image where polarization effects occur are the brightest. Figure 26 is an image of the top channel minus the bottom channel compensated for background contribution to the bottom image. This was done by adjusting the threshold of intensity for the bottom image. This essentially removes any polarization effects seen on the ship because of their small effects.

It is clearly seen that the water shows the largest amount of difsference in the image. Irregularities in

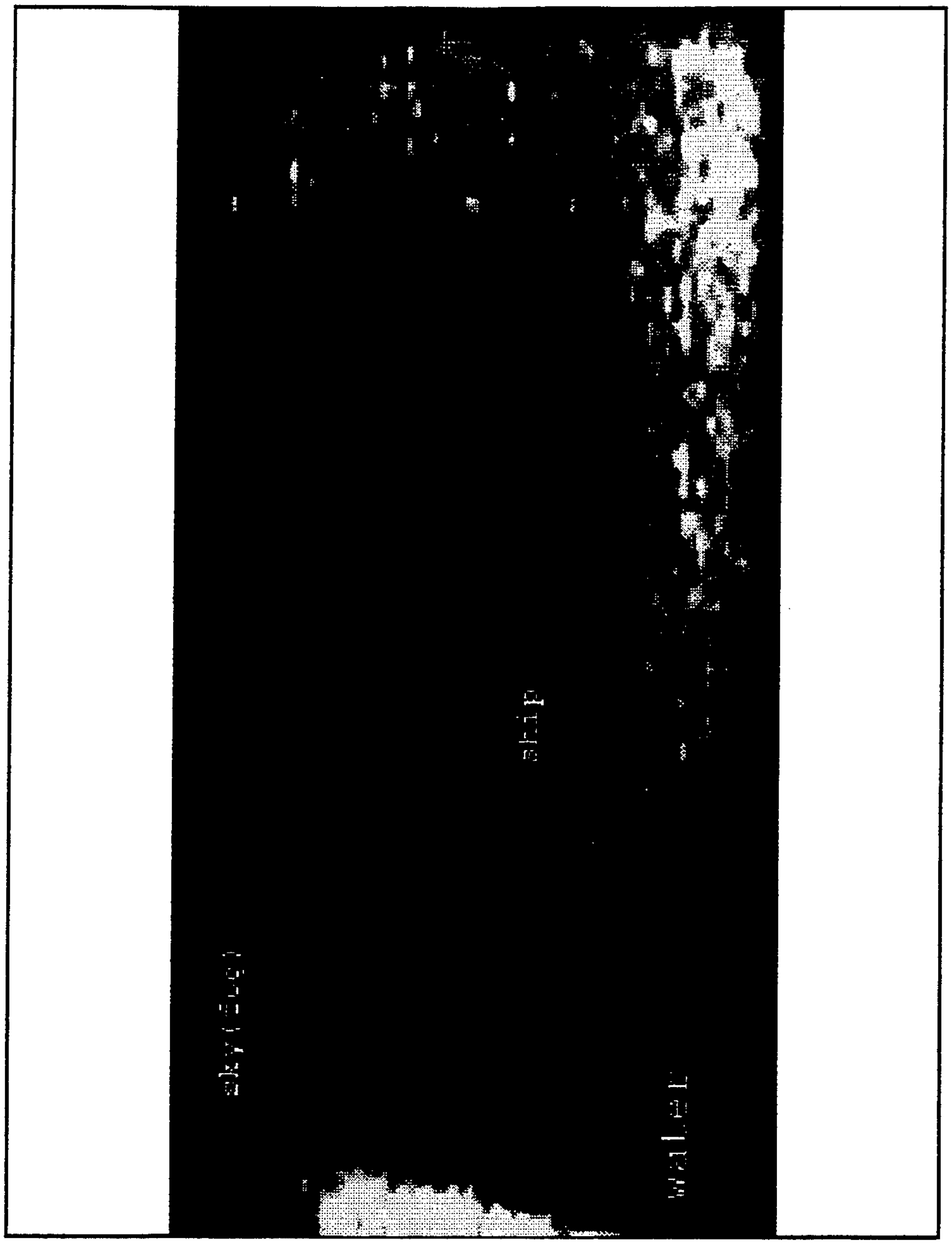


Figure 26. Digitally Subtracted top and bottom split image channels. M0803011, 3Aug95.

in the image plane show on both sides of the subtracted image. Techniques are under development to balance the intensity of the two images, remove background irregularites, and improve alignment of the two images, but these techniques were not available at the time these images were processed. The images are shown here to illustrate the general utility and feasibility.

IX. DISCUSSION AND CONCLUSIONS

The split-field polarizing system designed and constructed in this work, demonstrates the utility of *simultaneous* image storing for processing, while preserving image resolution.

Subjective and numerical analysis of the data from images taken with the split-field system demonstrated excellent performance in image quality, contrast improvement, and utility. Polarization filtering performance for a sea water background, for both the split-field system and for direct viewing with interchangeable filters in the AGEMA imager, gave results comparable to those obtained in the MAPTIP experiments where an external BaFl substrate polarizer was used. This was determined by comparing contrast calculated in terms of TBRD from previous measurements with values from the split-field and internal filtering systems. Both the split-field and internally filtered direct viewing systems eliminated the narcissus effects that degrade the use of external filters.

Observations of the target scenes show quantitatively that:

1. Digital subtraction of *simultaneously* recorded split-field images is a viable technique for contrast improvement.

2. In the 8-12 μm region, vertical polarization emission of the sea surface is the predominant component for filtering.

3. Split-field polarized filtering gives preliminary TBRD improvement of contrast of 1.19. This is driven by the splitter performance and background plate effects.

4. Direct viewing with internal polarization filtering is capable of 1.2-1.5 TBRD improvement of contrast for sea-water emission, but digital subtraction is not possible because of time delay between acquisition of the orthogonally polarized images.

5. Both the split-field and direct viewing internal filtering techniques provide contrast improvement on the order of that seen in the MAPTIP experiments.

6. The combined system designed and constructed for this project provides dual use of the AGA-780 with the split-field system and as a direct-view internally-filtered system. This provides two highly effective polarizing systems for use in one location with flexibility in system selection.

X. RECOMMENDATIONS FOR FUTURE WORK

Further work needs to be performed in all aspects of polarized imaging using the split system and internal polarizing systems. In March, 1996 an Electro-Optical Propagation Assessment in the Coastal Environment (EOPACE) experiment phase will take place near San Diego CA. In-depth demonstration and field implementation of both techniques will take place at that time. Specific concentration areas for both systems in the intermediate time frame include:

Internal Polarizers:

-Quantify the spectral transmissivity experimentally for each polarizing filter to verify percent polarization performance.

-Re-calibrate the AGA system with the filters installed prior to use to give level equalization for both filters.

Split-image Polarimeter:

-Conduct laboratory experiments to explore and remedy system induced gradient across the field-of-view.

-Realign Split-field optics to eliminate any vignetting, focussing differences between the two channels, and edge effects due to optical surface misalignment.

-Install a temperature control system on the background plate to maintain constant radiance contribution to the image for varying environmental conditions.

-Insert a small temperature source in the intermediate focal plane of the split-field optics to give a constant calibration source for real time split channel comparison.

Overall AGA-780 Thermal Imaging System:

-Install the new NEC VERSA P/75 75MHz Pentium Laptop computer as the display and file storage server to replace the current CATS 386 computer.

-Install the new 12 bit A/D converter for increasing system dynamic range and allowing higher data resolution for analysis.

APPENDIX A.

PERFORMANCE CURVES FOR THE POLARIZING FILTERS

This appendix contains the performance curves for the polarizing filters used in the internal and split image configuration. The interpretation of the data is included in the text of the appropriate chapters.

The data were provided by the manufacturer of the polarizers, Graseby-Specac. The measurements were taken with a spectrometer using the actual filter shipped. Where two filters were required for the crossed-grid measurement (trace 3), another polarizer nearly identical to the one shipped is used.

Trace 1- transmittance with grid perpendicular to the E vector of incident radiation.

Trace 2- transmittance with grid parallel to the E vector of incident radiation.

Trace 3- transmittance of two filters with grids crossed.

Vertical Axis- wavenumber/wavelength

Horizontal Axis- transmittance

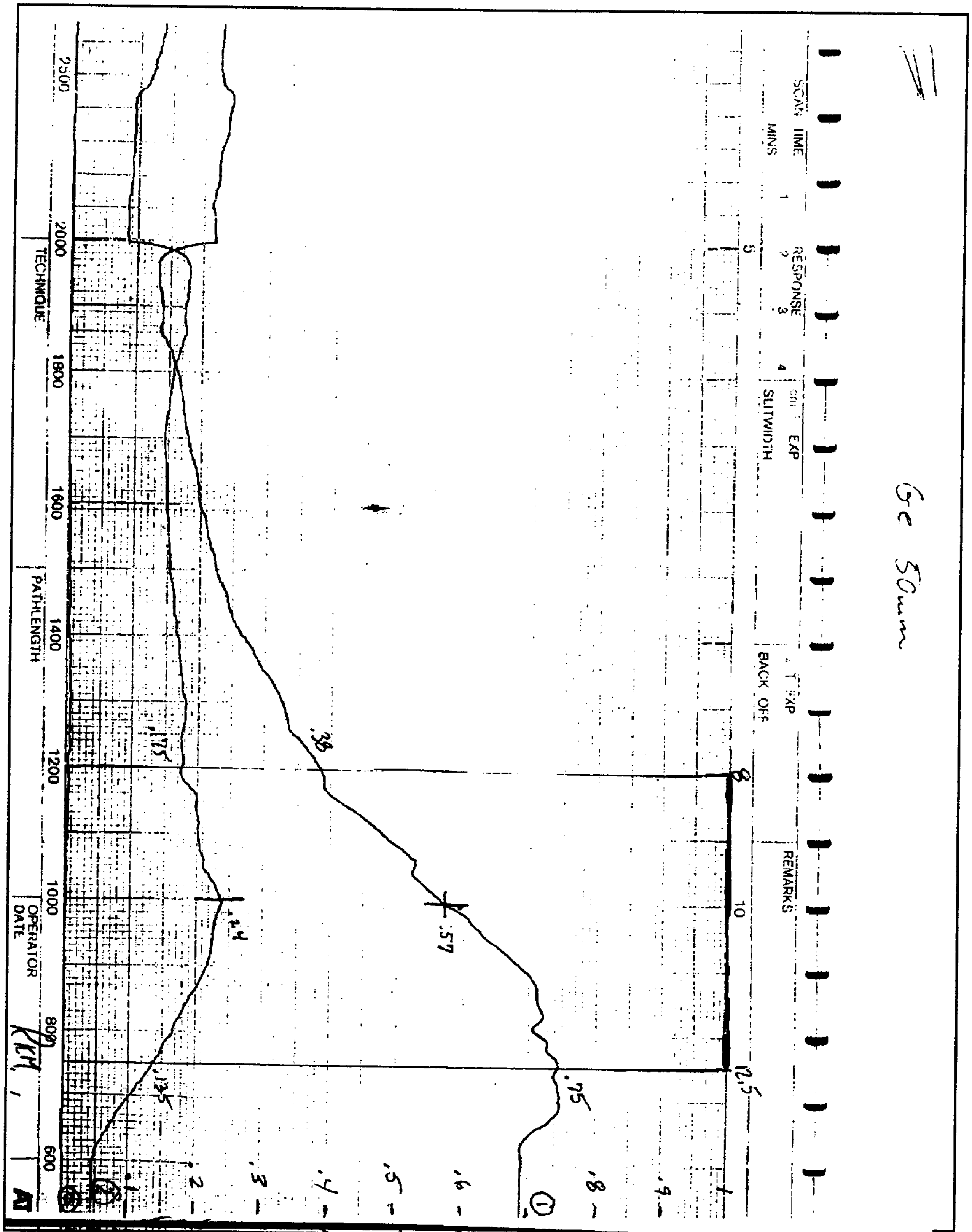


Figure A1. Performance curves for 50mm Ge Splitter.

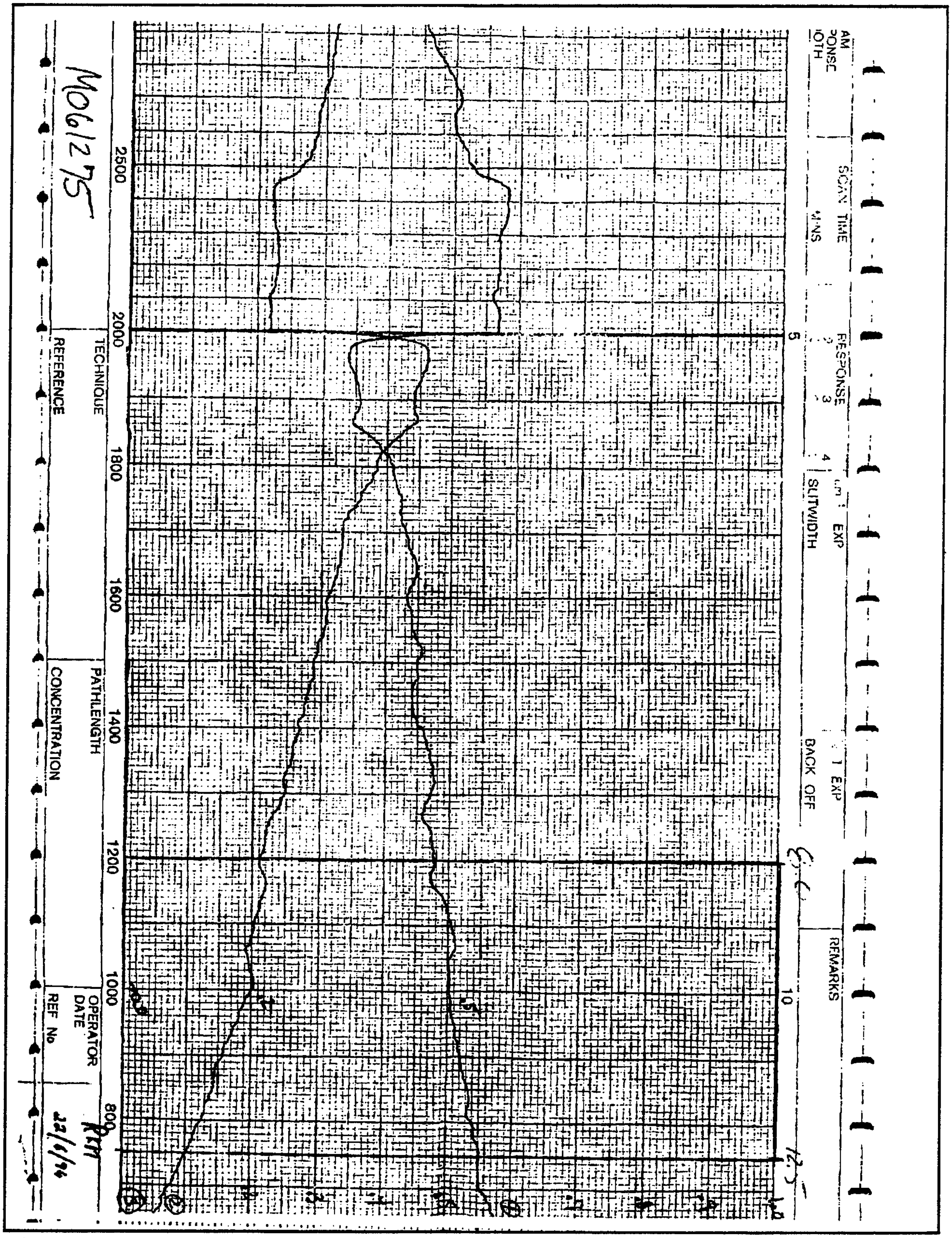


Figure A2. Performance curves for KRS-5 9.5mm polarizer (#75)

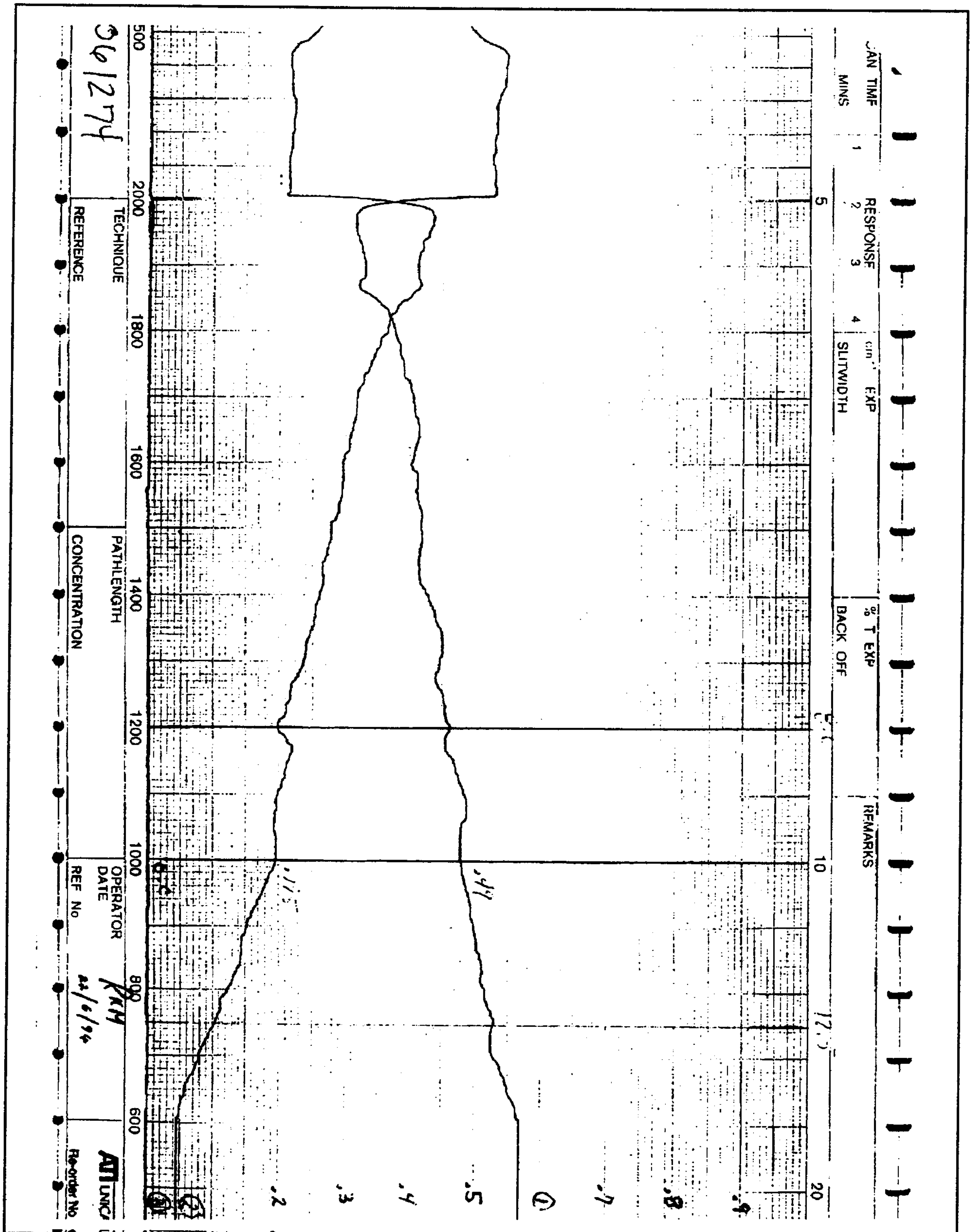


Figure A3. Performance curves for KRS-5 9.5mm polarizer (#74)

APPENDIX B.
SPECTRAL TRANSMITTANCE/REFLECTANCE OF THE 50 MM POLARIZER

This appendix contains the Perkin-Elmer spectophotometer traces for the 50mm polarizing splitter. In Fig. B1, the traces with the x designation are for the polarizer oriented 45 degrees to the incoming beam. The K_{1N} trace is the combination of the traces and gives the overall transmittance of the splitter normal to the incoming beam. The x symbols along the K_{1N} trace are the overall transmittance of the splitter at 45 degrees to the incoming beam. It is seen that the peak occurs at a slightly shorter wavelength than at normal incidence.

In Fig.B2, K_{1R} is the overall reflection efficiency in the configuration described in Chapt. VI.

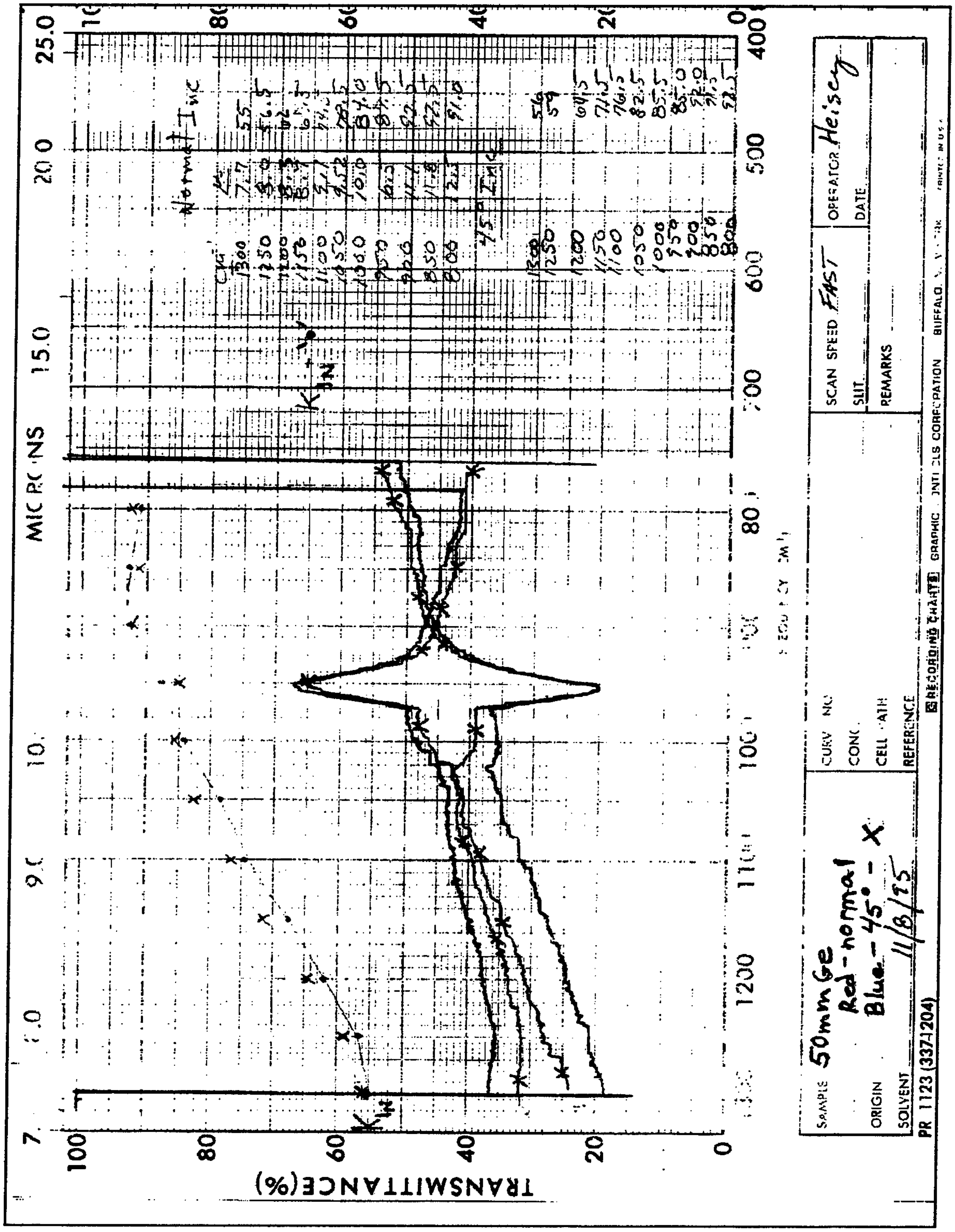


Figure B1. Polarization Transmittance of 50mm Polarizer.

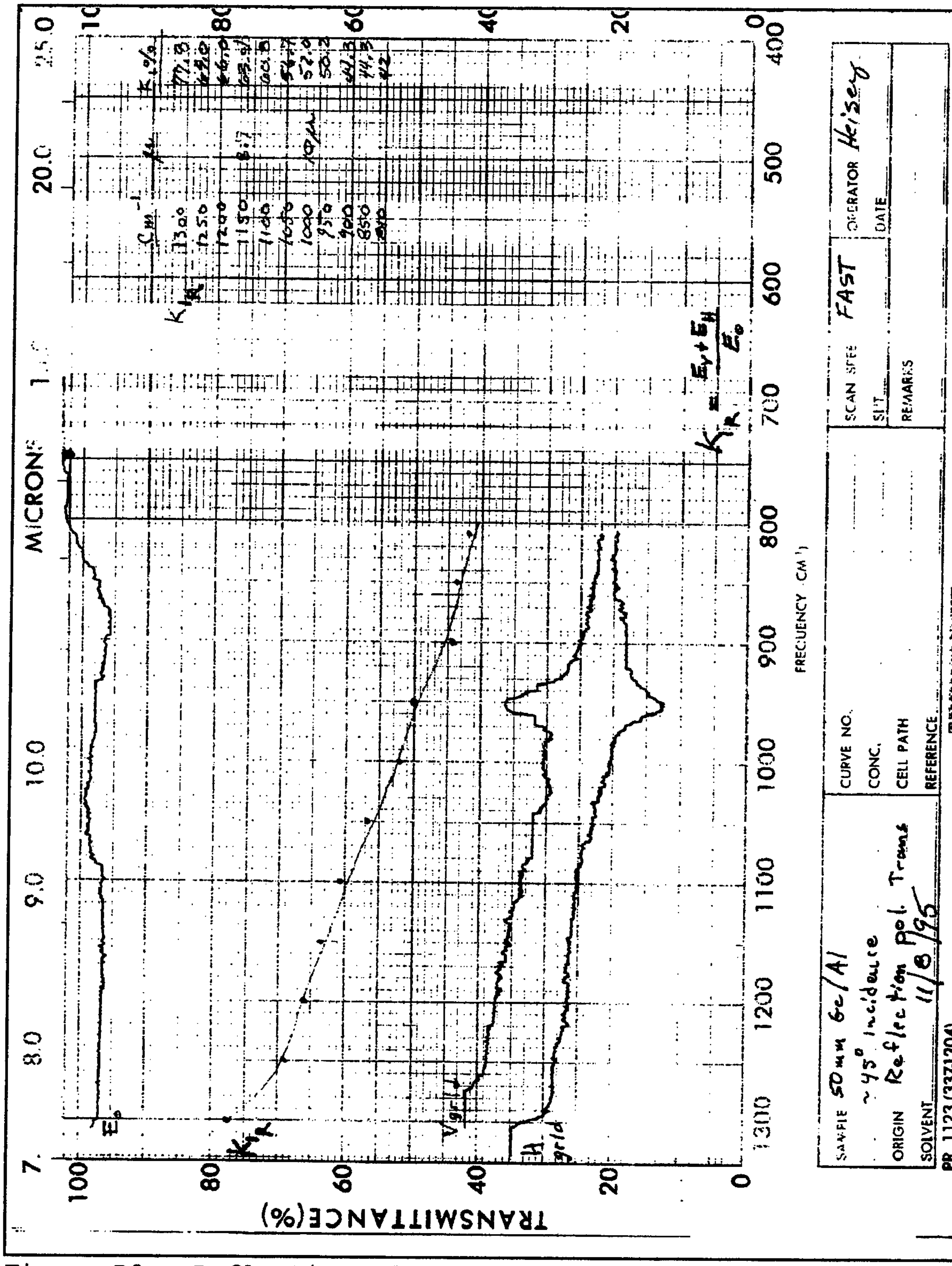


Figure B2. Reflection of Polarized Radiation by the Grid. Transmittance axis denotes Reflectance (%).

APPENDIX C.

MEASURED RADIANCE VALUES FOR THE NPS-NACIT SPLIT-FIELD POLARIMETER

The following data were taken as input to the radiance analysis of polarizing splitter performance.

Lab Conditions:

Room Temp 17C,
Source-Agema Black-Body @60C
Polarized Source-BaFl IR Polarizer Pol%~99%
Sensor-AGA 780 LW Band, f/1.87, Range 2
Background Plate Temp- ~0C (heavy frost surface)

$\varepsilon_{T_B}=21.7 \quad \varepsilon_{R_B}=23.2$

$\varepsilon_{F_{T_\parallel}}=4.2 \quad \varepsilon_{F_{R_\parallel}}=11.2$

$\varepsilon_{F_{T_\perp}}=8.6 \quad \varepsilon_{F_{R_\perp}}=5.4$

$I_{T_\perp}=34.7 \quad I_{R_\perp}=51.0$

$I_{T_\parallel}=50.3 \quad I_{R_\parallel}=36.9$

APPENDIX D.

CALIBRATION CURVES FOR FILTERED AND UNFILTERED AGA-780

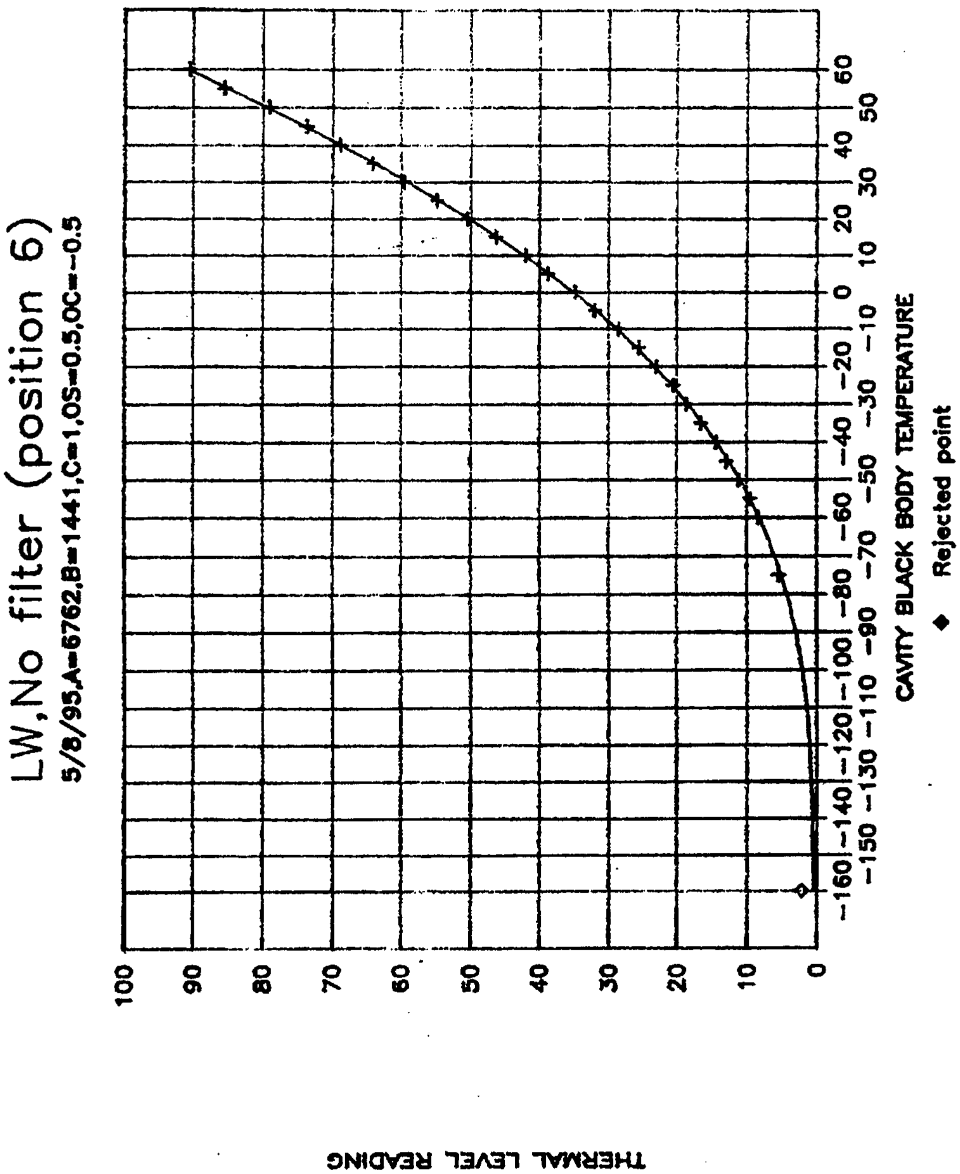


Figure D-1. Calibration for the AGA with no filters present.

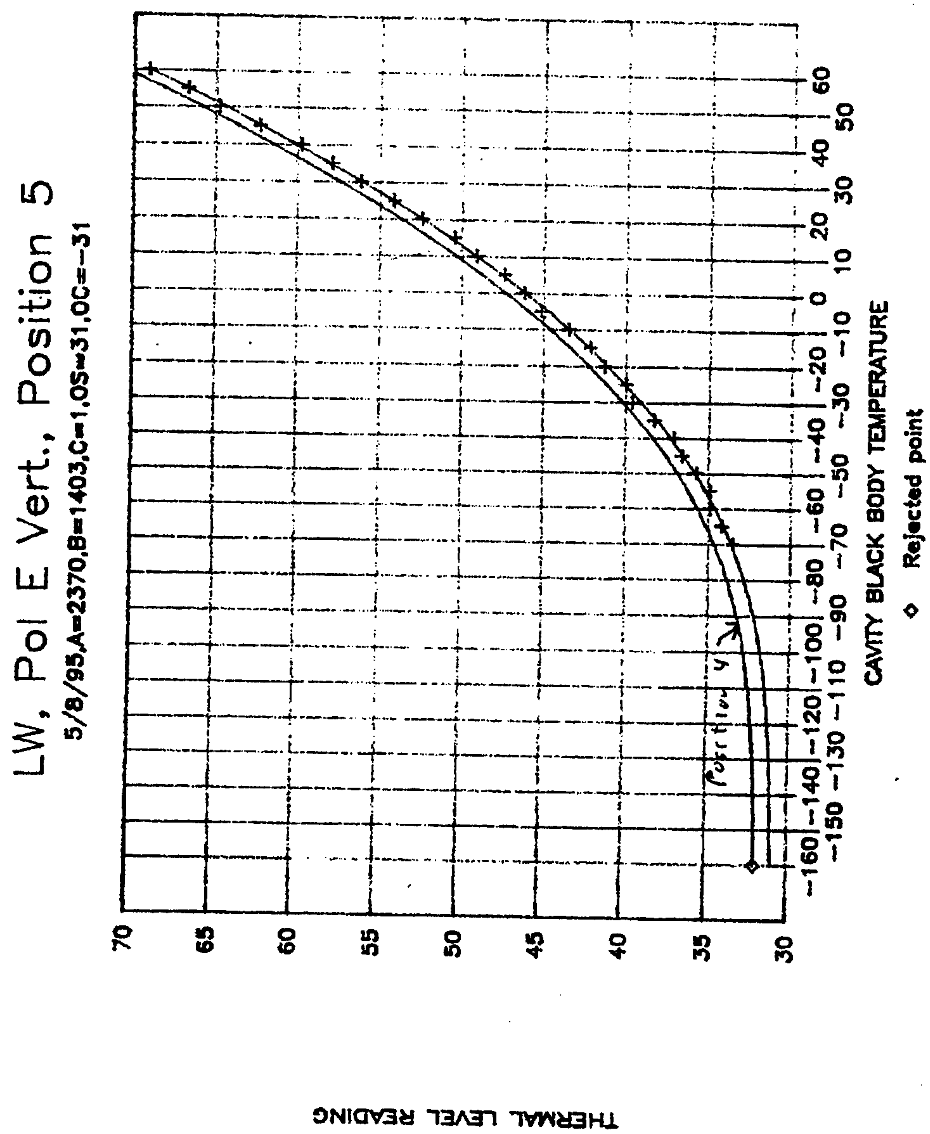


Figure D2. Calibration Data for AGA with internal filter. Pos 5 denotes one of the small internal filters located in position 5 of the AGA filter wheel. Position 4 is the other with orthogonal filter orientation. A small difference is seen in thermal level with temperature between the two filters.

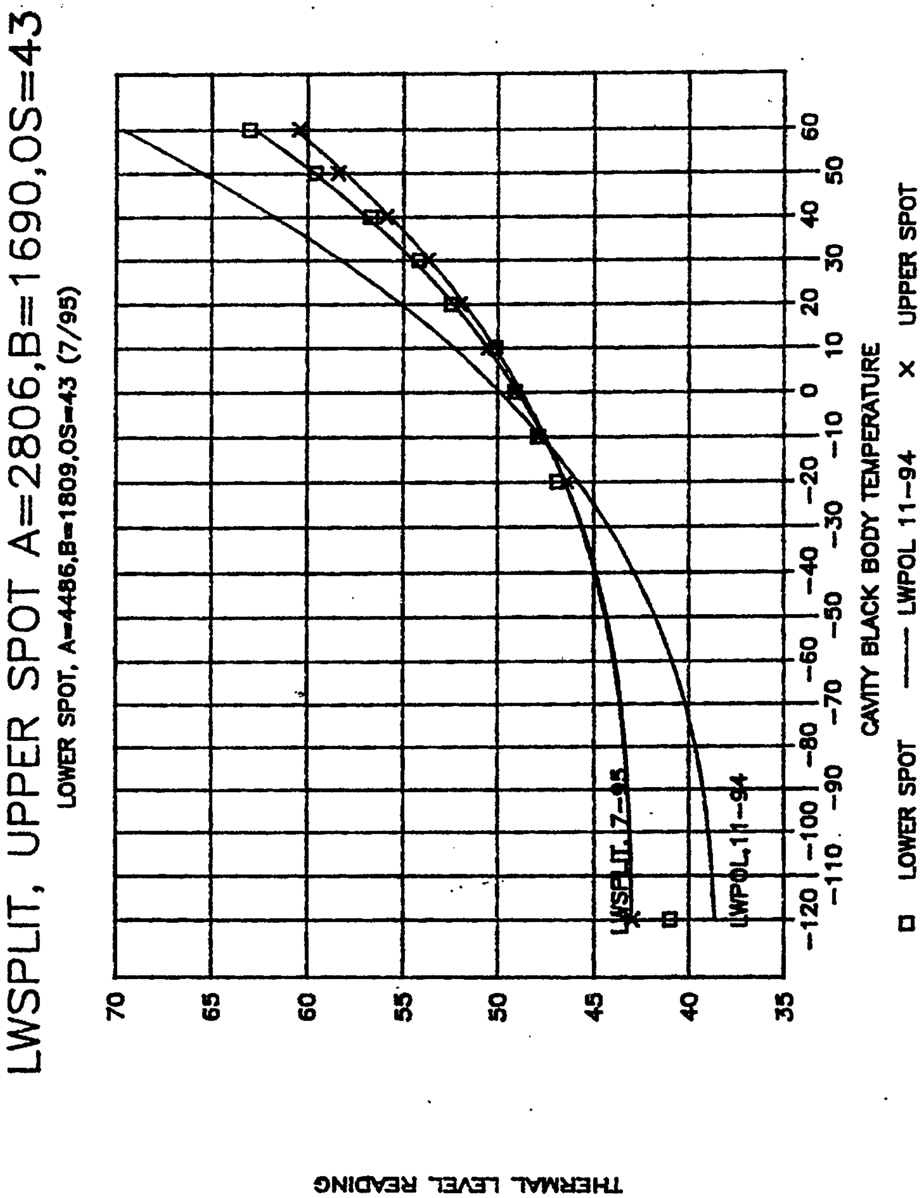


Figure D3. Calibration curve for the Split-field Polarimeter. This shows level reading with temperature for the two channels of the split-field polarimeter. LWPOL is for the large BaFl external polarizer for comparison. Upper spot denotes the splitter transmitted channel imaged by the AGA.

APPENDIX E.
COMPILATION OF MOSS LANDING IMAGES
MAY, 1995

The following is a complete image compilation of the entire Moss Landing experiment. The data tabulated is incomplete and only shows what is necessary for preliminary TBRD comparison of images. A sheet depicting a number of representitive images is appended to this list. Images corresponding to each of the table entries are available in digital form on hard disk at the NACIT laboratory.

The title header gives data about each of the images taken.
Pol-polarization orientation of the image. h,v-horiz,vert. x-image not analyzable for one reason (see image). u-unpolarized image.
Level-thermal level setting of the AGA control knob.
Range-thermal level range setting of the AGA control.
Offset-Offset of the calibration constant for image temperature compensation.
Ovrflw, Undrflw-number of pixels in the image with radiance values above or below the 0-255 range.

Filename	date	time	pol	level	range	offset	ovrflw	undrflw
M5L17001.IMG	5/16/95	12:43:06	x	44.70	20.	2.	0.	0.
M5L17002.IMG	5/16/95	12:43:44	x	44.70	20.	2.	0.	0.
M5L17003.IMG	5/16/95	12:45:09	x	44.70	20.	2.	0.	0.
M5L17004.IMG	5/16/95	12:45:20	x	44.70	20.	2.	0.	0.
M5L17005.IMG	5/17/95	9:11:07	h	46.90	2.	0.	246.	0.
M5L17006.IMG	5/17/95	9:11:20	v	46.90	2.	0.	294.	0.
M5L17007.IMG	5/17/95	9:11:59	u	44.40	5.	0.	202.	0.
M5L17008.IMG	5/17/95	9:12:20	u	46.40	5.	0.	4.	16482.
M5L17009.IMG	5/17/95	9:13:09	h	46.60	2.	0.	297.	0.
M5L17010.IMG	5/17/95	9:13:20	v	46.60	2.	0.	410.	0.
M5L17011.IMG	5/17/95	9:13:51	v	47.40	2.	0.	210.	0.
M5L17012.IMG	5/17/95	9:14:15	u	44.40	5.	0.	280.	0.
M5L17013.IMG	5/17/95	9:15:07	u	46.60	5.	0.	3.	18368.
M5L17014.IMG	5/17/95	9:17:06	h	46.90	2.	0.	252.	0.
M5L17015.IMG	5/17/95	9:17:16	v	46.90	2.	0.	391.	0.
M5L17016.IMG	5/17/95	9:17:33	u	45.40	5.	0.	100.	3916.
M5L17017.IMG	5/17/95	9:17:52	u	47.40	5.	0.	2.	18902.
M5L17018.IMG	5/17/95	9:21:06	h	46.90	2.	0.	210.	0.
M5L17019.IMG	5/17/95	9:21:16	v	46.90	2.	0.	305.	0.
M5L17020.IMG	5/17/95	9:21:38	u	44.90	5.	0.	169.	0.
M5L17021.IMG	5/17/95	9:21:57	u	47.40	10.	0.	0.	0.
M5L17022.IMG	5/17/95	9:22:55	h	47.40	2.	0.	77.	978.
M5L17023.IMG	5/17/95	9:23:04	v	47.40	2.	0.	178.	0.
M5L17024.IMG	5/17/95	9:23:21	u	44.90	5.	0.	186.	0.
M5L17025.IMG	5/17/95	9:23:39	u	48.10	10.	0.	0.	8703.
M5L17026.IMG	5/17/95	9:25:13	h	47.10	2.	0.	161.	0.
M5L17027.IMG	5/17/95	9:25:23	v	47.10	2.	0.	264.	0.
M5L17028.IMG	5/17/95	9:25:43	u	45.20	5.	0.	117.	1705.
M5L17029.IMG	5/17/95	9:25:59	u	48.60	10.	0.	0.	9494.
M5L17030.IMG	5/17/95	9:27:01	h	46.60	2.	0.	256.	0.
M5L17031.IMG	5/17/95	9:27:09	v	46.60	2.	0.	343.	0.
M5L17032.IMG	5/17/95	9:27:28	u	44.90	5.	0.	154.	1.
M5L17033.IMG	5/17/95	9:27:42	u	48.60	10.	0.	0.	16600.
M5L17034.IMG	5/17/95	9:34:30	h	47.10	2.	0.	192.	0.
M5L17035.IMG	5/17/95	9:34:38	v	47.10	2.	0.	300.	0.
M5L17036.IMG	5/17/95	9:34:53	u	44.90	5.	0.	178.	0.
M5L17037.IMG	5/17/95	9:35:06	u	48.10	10.	0.	0.	7669.
M5L17038.IMG	5/17/95	9:35:39	h	47.10	2.	0.	175.	0.
M5L17039.IMG	5/17/95	9:35:44	v	47.10	2.	0.	276.	0.
M5L17040.IMG	5/17/95	9:36:05	u	45.40	5.	0.	60.	5958.
M5L17041.IMG	5/17/95	9:36:21	u	47.90	10.	0.	0.	5703.
M5L17042.IMG	5/17/95	9:37:06	h	47.10	2.	0.	31.	4495.
M5L17043.IMG	5/17/95	9:37:14	v	47.10	2.	0.	163.	249.
M5L17044.IMG	5/17/95	9:37:28	u	45.20	5.	0.	51.	6364.
M5L17045.IMG	5/17/95	9:37:42	u	47.90	10.	0.	0.	7616.
M5L17046.IMG	5/17/95	9:42:58	h	46.40	2.	0.	277.	0.
M5L17047.IMG	5/17/95	9:43:07	v	46.40	2.	0.	398.	0.
M5L17048.IMG	5/17/95	9:43:19	u	44.70	5.	0.	176.	19.
M5L17049.IMG	5/17/95	9:43:33	u	48.10	10.	0.	0.	7633.
M5L17050.IMG	5/17/95	9:44:16	h	46.40	2.	0.	305.	0.

M5L17051.IMG	5/17/95	9:44:25	v	46.40	2.	0.	435.	0.
M5L17052.IMG	5/17/95	9:44:41	u	44.90	5.	0.	157.	322.
M5L17053.IMG	5/17/95	9:44:54	u	48.10	10.	0.	0.	9403.
M5L17054.IMG	5/17/95	9:45:28	h	46.90	2.	0.	189.	0.
M5L17055.IMG	5/17/95	9:45:36	v	46.90	2.	0.	304.	0.
M5L17056.IMG	5/17/95	9:45:51	u	44.20	5.	0.	254.	0.
M5L17057.IMG	5/17/95	9:46:03	u	48.10	10.	0.	0.	8709.
M5L17058.IMG	5/17/95	9:47:34	h	46.90	2.	0.	222.	0.
M5L17059.IMG	5/17/95	9:47:43	v	46.90	2.	0.	343.	0.
M5L17060.IMG	5/17/95	9:48:00	u	44.70	5.	0.	207.	0.
M5L17061.IMG	5/17/95	9:48:16	u	48.10	10.	0.	0.	9469.
M5L17062.IMG	5/17/95	9:49:00	h	47.10	2.	0.	73.	1898.
M5L17063.IMG	5/17/95	9:49:08	v	47.10	2.	0.	238.	0.
M5L17064.IMG	5/17/95	9:49:21	u	44.70	5.	0.	240.	0.
M5L17065.IMG	5/17/95	9:49:37	u	48.40	10.	0.	0.	8762.
M5L17066.IMG	5/17/95	9:53:32	h	46.90	2.	0.	370.	0.
M5L17067.IMG	5/17/95	9:53:41	v	46.90	2.	0.	522.	0.
M5L17068.IMG	5/17/95	9:53:57	u	44.90	5.	0.	211.	0.
M5L17069.IMG	5/17/95	9:54:11	u	48.60	10.	0.	0.	12991.
M5L17070.IMG	5/17/95	9:54:35	h	47.40	2.	0.	254.	0.
M5L17071.IMG	5/17/95	9:54:44	v	47.40	2.	0.	300.	0.
M5L17072.IMG	5/17/95	9:55:02	u	44.90	5.	0.	192.	100.
M5L17073.IMG	5/17/95	9:55:15	u	48.60	10.	0.	0.	17985.
M5L17074.IMG	5/17/95	9:57:35	h	47.40	2.	0.	182.	0.
M5L17075.IMG	5/17/95	9:57:46	v	47.40	2.	0.	307.	0.
M5L17076.IMG	5/17/95	9:58:01	u	45.20	5.	0.	196.	0.
M5L17077.IMG	5/17/95	9:58:14	u	48.40	10.	0.	0.	10557.
M5L17078.IMG	5/17/95	9:58:37	h	47.10	2.	0.	444.	0.
M5L17079.IMG	5/17/95	9:58:47	v	47.10	2.	0.	655.	0.
M5L17080.IMG	5/17/95	9:59:08	u	44.70	5.	0.	191.	122.
M5L17081.IMG	5/17/95	9:59:27	u	47.40	10.	0.	0.	5246.
M5L17082.IMG	5/17/95	10:07:29	h	47.40	2.	0.	268.	0.
M5L17083.IMG	5/17/95	10:09:43	h	47.90	2.	0.	356.	0.
M5L17084.IMG	5/17/95	10:10:02	v	47.90	2.	0.	630.	0.
M5L17085.IMG	5/17/95	10:10:19	u	44.40	5.	0.	288.	0.
M5L17086.IMG	5/17/95	10:10:35	u	48.10	10.	0.	0.	6029.
M5L17087.IMG	5/17/95	10:11:16	h	47.60	2.	0.	704.	0.
M5L17088.IMG	5/17/95	10:11:35	v	48.10	2.	0.	517.	0.
M5L17089.IMG	5/17/95	10:12:01	u	44.40	5.	0.	316.	0.
M5L17090.IMG	5/17/95	10:12:18	u	47.90	10.	0.	0.	6477.
M5L17091.IMG	5/17/95	10:14:11	h	47.90	2.	0.	447.	0.
M5L17092.IMG	5/17/95	10:14:19	v	47.90	2.	0.	724.	0.
M5L17093.IMG	5/17/95	10:14:47	u	44.70	5.	0.	290.	0.
M5L17094.IMG	5/17/95	10:15:20	u	47.90	10.	0.	0.	6163.
M5L17095.IMG	5/17/95	10:15:57	h	47.90	2.	0.	461.	0.
M5L17096.IMG	5/17/95	10:16:09	v	47.90	2.	0.	617.	0.
M5L17097.IMG	5/17/95	10:16:29	u	45.20	5.	0.	202.	3449.
M5L17098.IMG	5/17/95	10:16:44	u	48.40	10.	0.	0.	8100.
M5L17099.IMG	5/17/95	10:21:54	h	48.60	2.	0.	354.	0.
M5L17100.IMG	5/17/95	10:22:04	v	48.60	2.	0.	618.	0.
M5L17101.IMG	5/17/95	10:22:20	u	45.20	5.	0.	414.	0.
M5L17102.IMG	5/17/95	10:22:37	u	48.10	10.	0.	0.	6539.
M5L17103.IMG	5/17/95	10:22:54	h	48.60	2.	0.	629.	0.
M5L17104.IMG	5/17/95	10:23:02	v	48.60	2.	0.	885.	0.
M5L17105.IMG	5/17/95	10:23:17	u	44.70	5.	0.	504.	0.
M5L17106.IMG	5/17/95	10:23:35	u	48.80	10.	0.	0.	17517.
M5L17107.IMG	5/17/95	10:26:59	h	48.60	2.	0.	991.	0.
M5L17108.IMG	5/17/95	10:27:22	v	48.60	2.	0.	913.	0.
M5L17109.IMG	5/17/95	10:27:41	u	44.00	5.	0.	879.	0.
M5L17110.IMG	5/17/95	10:28:01	u	48.60	10.	0.	0.	9649.
M5L17111.IMG	5/17/95	10:28:34	h	48.40	2.	0.	1023.	0.
M5L17112.IMG	5/17/95	10:28:45	v	48.40	2.	0.	1278.	0.

M5L17113.IMG	5/17/95	10:29:02	u	44.90	5.	0.	530.	56.
M5L17114.IMG	5/17/95	10:29:17	u	48.80	10.	0.	0.	14237.
M5L17115.IMG	5/17/95	10:35:34	h	50.50	10.	0.	0.	0.
M5L17116.IMG	5/17/95	10:36:05	h	49.60	2.	0.	363.	27.
M5L17117.IMG	5/17/95	10:36:17	v	49.60	2.	0.	689.	0.
M5L17118.IMG	5/17/95	10:36:50	u	45.70	5.	0.	351.	2914.
M5L17119.IMG	5/17/95	10:37:14	u	49.30	10.	0.	0.	15942.
M5L17120.IMG	5/17/95	10:38:46	h	49.10	2.	0.	646.	0.
M5L17121.IMG	5/17/95	10:38:56	v	49.10	2.	0.	859.	0.
M5L17122.IMG	5/17/95	10:39:17	u	45.20	5.	0.	501.	0.
M5L17123.IMG	5/17/95	10:39:43	u	49.10	10.	0.	0.	15431.
M5L17124.IMG	5/17/95	10:40:20	h	49.10	2.	0.	525.	0.
M5L17125.IMG	5/17/95	10:40:40	v	49.60	2.	0.	595.	0.
M5L17126.IMG	5/17/95	10:40:59	u	45.70	5.	0.	408.	767.
M5L17127.IMG	5/17/95	10:41:41	u	45.20	10.	0.	0.	0.
M5L17128.IMG	5/17/95	10:44:21	h	49.30	2.	0.	592.	0.
M5L17129.IMG	5/17/95	10:44:27	v	49.30	2.	0.	858.	0.
M5L17130.IMG	5/17/95	10:44:37	u	47.40	10.	0.	0.	0.
M5L17131.IMG	5/17/95	10:44:49	u	49.30	10.	0.	0.	10491.
M5L17132.IMG	5/17/95	10:47:02	h	49.60	2.	0.	448.	0.
M5L17133.IMG	5/17/95	10:47:09	v	49.60	2.	0.	731.	0.
M5L17134.IMG	5/17/95	10:47:25	u	46.20	5.	0.	228.	5097.
M5L17135.IMG	5/17/95	10:47:39	u	45.20	10.	0.	0.	0.
M5L17136.IMG	5/17/95	10:47:52	h	49.30	2.	0.	354.	0.
M5L17137.IMG	5/17/95	10:47:57	v	49.30	2.	0.	621.	0.
M5L17138.IMG	5/17/95	10:48:07	u	45.90	5.	0.	297.	665.
M5L17139.IMG	5/17/95	10:48:16	u	45.20	10.	0.	0.	0.
M5L17140.IMG	5/17/95	10:50:53	h	49.30	2.	0.	337.	0.
M5L17141.IMG	5/17/95	10:50:59	v	49.30	2.	0.	895.	0.
M5L17142.IMG	5/17/95	10:51:14	u	45.90	5.	0.	294.	1770.
M5L17143.IMG	5/17/95	10:51:25	u	45.20	10.	0.	0.	0.
M5L17144.IMG	5/17/95	10:55:29	h	49.60	2.	0.	608.	0.
M5L17145.IMG	5/17/95	10:55:37	v	49.60	2.	0.	876.	0.
M5L17146.IMG	5/17/95	10:55:50	u	45.20	5.	0.	586.	0.
M5L17147.IMG	5/17/95	10:55:58	u	45.20	10.	0.	0.	0.
M5L17148.IMG	5/17/95	10:57:46	h	49.60	2.	0.	542.	0.
M5L17149.IMG	5/17/95	10:58:06	v	50.10	2.	0.	705.	0.
M5L17150.IMG	5/17/95	10:58:19	u	45.40	5.	0.	419.	0.
M5L17151.IMG	5/17/95	10:58:28	u	45.20	10.	0.	0.	0.
M5L17152.IMG	5/17/95	11:00:33	h	49.80	2.	0.	490.	0.
M5L17153.IMG	5/17/95	11:00:46	v	50.30	2.	0.	543.	0.
M5L17154.IMG	5/17/95	11:01:00	u	45.90	5.	0.	310.	130.
M5L17155.IMG	5/17/95	11:01:08	u	45.20	10.	0.	0.	0.
M5L17156.IMG	5/17/95	11:02:55	h	49.80	2.	0.	246.	262.
M5L17157.IMG	5/17/95	11:03:05	v	49.80	2.	0.	600.	0.
M5L17158.IMG	5/17/95	11:03:20	u	45.90	5.	0.	254.	2944.
M5L17159.IMG	5/17/95	11:03:39	u	44.70	10.	0.	0.	0.
M5L17160.IMG	5/17/95	11:04:22	h	50.30	2.	0.	325.	0.
M5L17161.IMG	5/17/95	11:04:36	v	50.30	2.	0.	546.	0.
M5L17162.IMG	5/17/95	11:04:58	u	45.40	5.	0.	332.	175.
M5L17163.IMG	5/17/95	11:05:11	u	45.20	10.	0.	0.	0.
M5L17164.IMG	5/17/95	11:06:34	h	49.80	2.	0.	505.	0.
M5L17165.IMG	5/17/95	11:06:44	v	50.30	2.	0.	318.	2077.
M5L17166.IMG	5/17/95	11:06:56	u	45.90	5.	0.	247.	4721.
M5L17167.IMG	5/17/95	11:07:07	u	45.20	10.	0.	0.	0.
M5L17168.IMG	5/17/95	11:12:00	h	49.80	5.	0.	0.	0.
M5L17169.IMG	5/17/95	11:12:25	v	50.30	5.	0.	0.	0.
M5L17170.IMG	5/17/95	11:12:47	u	45.70	10.	0.	0.	0.
M5L17171.IMG	5/17/95	11:13:29	h	49.60	5.	0.	0.	0.
M5L17172.IMG	5/17/95	11:13:47	v	49.80	5.	0.	0.	0.
M5L17173.IMG	5/17/95	11:14:02	u	45.90	10.	0.	0.	0.
M5L17174.IMG	5/17/95	11:15:50	h	49.60	5.	0.	0.	0.

M5L17175.IMG	5/17/95	11:16:04	v	50.30	5.	0.	0.	0.
M5L17176.IMG	5/17/95	11:16:16	u	46.60	10.	0.	0.	0.
M5L17177.IMG	5/17/95	11:16:42	h	50.30	5.	0.	0.	0.
M5L17178.IMG	5/17/95	11:16:52	v	50.30	5.	0.	0.	0.
M5L17179.IMG	5/17/95	11:17:07	u	47.10	10.	0.	0.	0.
M5L17180.IMG	5/17/95	11:19:53	h	50.80	5.	0.	0.	0.
M5L17181.IMG	5/17/95	11:20:10	v	50.80	5.	0.	0.	0.
M5L17182.IMG	5/17/95	11:20:29	u	47.10	10.	0.	0.	0.
M5L17183.IMG	5/17/95	11:21:18	h	50.80	5.	0.	2.	0.
M5L17184.IMG	5/17/95	11:21:33	v	51.30	5.	0.	0.	0.
M5L17185.IMG	5/17/95	11:21:51	u	47.90	10.	0.	2.	1121.
M5L17186.IMG	5/17/95	11:23:32	h	51.30	5.	0.	1.	0.
M5L17187.IMG	5/17/95	11:23:38	v	51.30	5.	0.	0.	0.
M5L17188.IMG	5/17/95	11:23:46	u	48.10	10.	0.	2.	1117.
M5L17189.IMG	5/17/95	11:24:21	h	51.50	5.	0.	5.	0.
M5L17190.IMG	5/17/95	11:24:28	v	51.50	5.	0.	2.	0.
M5L17191.IMG	5/17/95	11:24:41	u	48.10	10.	0.	5.	20.
M5L17192.IMG	5/17/95	11:25:03	h	50.80	5.	0.	2.	0.
M5L17193.IMG	5/17/95	11:25:11	v	50.80	5.	0.	1.	0.
M5L17194.IMG	5/17/95	11:25:27	u	47.60	10.	0.	4.	1.
M5L17195.IMG	5/17/95	11:25:54	h	50.80	5.	0.	1.	0.
M5L17196.IMG	5/17/95	11:26:09	v	50.80	5.	0.	1.	0.
M5L17197.IMG	5/17/95	11:26:26	u	46.20	10.	0.	4.	0.
M5L17198.IMG	5/17/95	11:33:02	h	49.30	5.	0.	0.	0.
M5L17199.IMG	5/17/95	11:33:10	v	49.30	5.	0.	180.	0.
M5L17200.IMG	5/17/95	11:33:26	u	46.20	10.	0.	0.	0.
M5L17201.IMG	5/17/95	11:36:57	h	48.60	5.	0.	369.	0.
M5L17202.IMG	5/17/95	11:37:05	v	48.60	5.	0.	650.	0.
M5L17203.IMG	5/17/95	11:37:27	h	44.90	10.	0.	0.	0.
M5L17204.IMG	5/17/95	11:37:40	h	45.90	10.	0.	0.	0.
M5L1900.IMG	5/19/95	8:27:03	x	43.20	2.	0.	17955.	0.
M5L19001.IMG	5/19/95	8:28:15	x	43.20	2.	0.	15080.	2195.
M5L19002.IMG	5/19/95	8:29:38	x	44.20	2.	0.	630.	16819.
M5L19003.IMG	5/19/95	8:29:56	x	44.20	2.	0.	8562.	8675.
M5L19004.IMG	5/19/95	8:30:00	x	44.20	2.	0.	75.	17151.
M5L19005.IMG	5/19/95	8:42:18	u	45.20	5.	0.	56.	0.
M5L19006.IMG	5/19/95	8:42:57	u	44.00	2.	0.	721.	0.
M5L19007.IMG	5/19/95	8:43:19	x	48.10	2.	0.	0.	19449.
M5L19008.IMG	5/19/95	8:43:32	u	43.70	2.	0.	891.	0.
M5L19009.IMG	5/19/95	8:43:51	u	44.20	2.	0.	692.	6.
M5L1901.IMG	5/19/95	8:27:12	x	43.20	2.	0.	3233.	0.
M5L19010.IMG	5/19/95	8:44:26	u	43.70	2.	0.	888.	0.
M5L19011.IMG	5/19/95	8:44:41	u	43.70	2.	0.	747.	0.
M5L19012.IMG	5/19/95	8:45:33	u	43.00	5.	0.	517.	0.
M5L19013.IMG	5/19/95	8:49:03	h	47.60	5.	0.	0.	0.
M5L19014.IMG	5/19/95	8:49:09	v	47.60	5.	0.	0.	0.
M5L19015.IMG	5/19/95	8:49:26	u	45.20	10.	0.	0.	0.
M5L19016.IMG	5/19/95	8:49:46	u	45.40	10.	0.	1.	0.
M5L19017.IMG	5/19/95	8:52:16	h	47.60	2.	0.	131.	0.
M5L19018.IMG	5/19/95	8:52:21	v	47.60	2.	0.	283.	0.
M5L19019.IMG	5/19/95	8:52:49	u	43.50	2.	0.	951.	0.
M5L1902.IMG	5/19/95	8:27:44	x	43.20	2.	0.	11223.	0.
M5L19020.IMG	5/19/95	8:54:36	u	44.20	2.	0.	781.	4.
M5L19021.IMG	5/19/95	8:56:58	h	47.40	2.	0.	280.	0.
M5L19022.IMG	5/19/95	8:57:01	v	47.40	2.	0.	286.	0.
M5L19023.IMG	5/19/95	8:57:08	u	43.70	2.	0.	984.	0.
M5L19024.IMG	5/19/95	8:57:32	h	47.60	5.	0.	0.	0.
M5L19025.IMG	5/19/95	8:57:36	v	47.60	5.	0.	0.	0.
M5L19026.IMG	5/19/95	8:57:41	u	45.20	5.	0.	87.	0.
M5L19027.IMG	5/19/95	8:57:57	h	48.40	10.	0.	0.	0.
M5L19028.IMG	5/19/95	8:58:02	v	48.40	10.	0.	0.	0.
M5L19029.IMG	5/19/95	8:58:09	u	46.40	10.	0.	0.	0.

M5L19030.IMG	5/19/95	9:01:18	h	47.60	2.	0.	144.	0.
M5L19031.IMG	5/19/95	9:01:22	v	47.60	2.	0.	353.	0.
M5L19032.IMG	5/19/95	9:01:29	u	43.50	2.	0.	1652.	0.
M5L19033.IMG	5/19/95	9:02:15	h	48.10	5.	0.	0.	0.
M5L19034.IMG	5/19/95	9:02:20	v	48.10	5.	0.	0.	0.
M5L19035.IMG	5/19/95	9:02:29	u	44.00	5.	0.	254.	0.
M5L19036.IMG	5/19/95	9:02:39	u	46.40	5.	0.	6.	12076.
M5L19037.IMG	5/19/95	9:03:23	h	48.10	5.	0.	0.	0.
M5L19038.IMG	5/19/95	9:03:29	v	48.10	5.	0.	0.	0.
M5L19039.IMG	5/19/95	9:03:37	u	44.70	5.	0.	134.	0.
M5L19040.IMG	5/19/95	9:03:45	u	46.40	5.	0.	3.	12593.
M5L19041.IMG	5/19/95	9:05:17	h	47.60	2.	0.	345.	0.
M5L19042.IMG	5/19/95	9:05:21	v	47.60	2.	0.	331.	0.
M5L19043.IMG	5/19/95	9:05:28	u	44.20	2.	0.	736.	16.
M5L19044.IMG	5/19/95	9:05:50	h	47.90	5.	0.	0.	0.
M5L19045.IMG	5/19/95	9:05:54	v	47.90	5.	0.	0.	0.
M5L19046.IMG	5/19/95	9:06:01	u	45.40	5.	0.	55.	0.
M5L19047.IMG	5/19/95	9:07:18	u	47.60	2.	0.	7.	19411.
M5L19048.IMG	5/19/95	9:07:26	u	47.90	5.	0.	3.	18991.
M5L19049.IMG	5/19/95	9:08:07	h	47.10	2.	0.	202.	0.
M5L19050.IMG	5/19/95	9:08:10	v	47.10	2.	0.	312.	0.
M5L19051.IMG	5/19/95	9:08:18	u	44.40	2.	0.	642.	6591.
M5L19052.IMG	5/19/95	9:09:06	h	47.90	5.	0.	0.	0.
M5L19053.IMG	5/19/95	9:09:09	v	47.90	5.	0.	0.	0.
M5L19054.IMG	5/19/95	9:09:20	u	44.90	5.	0.	108.	0.
M5L19055.IMG	5/19/95	9:09:39	h	49.10	10.	0.	0.	0.
M5L19056.IMG	5/19/95	9:09:43	v	49.10	10.	0.	0.	0.
M5L19057.IMG	5/19/95	9:09:57	u	45.90	10.	0.	1.	0.
M5L19058.IMG	5/19/95	9:11:31	h	47.10	2.	0.	118.	0.
M5L19059.IMG	5/19/95	9:11:40	v	47.10	2.	0.	313.	0.
M5L19060.IMG	5/19/95	9:11:50	u	44.00	2.	0.	810.	0.
M5L19061.IMG	5/19/95	9:12:12	h	47.40	5.	0.	0.	0.
M5L19062.IMG	5/19/95	9:12:15	v	47.40	5.	0.	0.	0.
M5L19063.IMG	5/19/95	9:12:23	u	44.40	5.	0.	163.	0.
M5L19064.IMG	5/19/95	9:12:30	u	48.40	5.	0.	0.	19155.
M5L19065.IMG	5/19/95	9:14:19	h	46.90	2.	0.	144.	0.
M5L19066.IMG	5/19/95	9:14:22	v	46.90	2.	0.	336.	0.
M5L19067.IMG	5/19/95	9:14:29	u	44.00	2.	0.	786.	0.
M5L19068.IMG	5/19/95	9:14:57	h	47.40	5.	0.	0.	0.
M5L19069.IMG	5/19/95	9:15:00	v	47.40	5.	0.	0.	0.
M5L19070.IMG	5/19/95	9:15:07	u	44.20	5.	0.	130.	0.
M5L19071.IMG	5/19/95	9:17:50	h	46.60	2.	0.	307.	0.
M5L19072.IMG	5/19/95	9:17:55	v	46.60	2.	0.	470.	0.
M5L19073.IMG	5/19/95	9:18:04	u	44.00	2.	0.	650.	1638.
M5L19074.IMG	5/19/95	9:18:38	h	47.10	5.	0.	0.	0.
M5L19075.IMG	5/19/95	9:18:42	v	47.10	5.	0.	0.	0.
M5L19076.IMG	5/19/95	9:18:48	u	44.20	5.	0.	158.	0.
M5L19077.IMG	5/19/95	9:21:11	h	47.10	2.	0.	332.	0.
M5L19078.IMG	5/19/95	9:21:14	v	47.10	2.	0.	450.	0.
M5L19079.IMG	5/19/95	9:21:21	u	44.20	2.	0.	877.	4.
M5L19080.IMG	5/19/95	9:21:40	h	47.90	5.	0.	0.	0.
M5L19081.IMG	5/19/95	9:21:44	v	47.90	5.	0.	0.	0.
M5L19082.IMG	5/19/95	9:21:52	u	44.90	5.	0.	79.	0.
M5L19083.IMG	5/19/95	9:22:16	h	47.60	10.	0.	0.	0.
M5L19084.IMG	5/19/95	9:22:20	v	47.60	10.	0.	0.	0.
M5L19085.IMG	5/19/95	9:22:30	u	46.60	10.	0.	1.	0.
M5L19086.IMG	5/19/95	9:33:01	h	47.10	2.	0.	293.	0.
M5L19087.IMG	5/19/95	9:33:05	v	47.10	2.	0.	450.	0.
M5L19088.IMG	5/19/95	9:33:13	u	43.50	2.	0.	3115.	0.
M5L19089.IMG	5/19/95	9:33:21	u	47.60	2.	0.	0.	19352.
M5L19090.IMG	5/19/95	9:33:51	h	47.60	5.	0.	0.	0.
M5L19091.IMG	5/19/95	9:33:55	v	47.60	5.	0.	0.	0.

M5L19092.IMG	5/19/95	9:34:03	u	44.00	5.	0.	259.	0.
M5L19093.IMG	5/19/95	9:35:44	h	47.10	2.	0.	353.	0.
M5L19094.IMG	5/19/95	9:35:49	v	47.10	2.	0.	597.	0.
M5L19095.IMG	5/19/95	9:36:02	u	44.20	2.	0.	748.	0.
M5L19096.IMG	5/19/95	9:36:44	h	48.60	5.	0.	0.	0.
M5L19097.IMG	5/19/95	9:36:56	v	48.10	5.	0.	0.	0.
M5L19098.IMG	5/19/95	9:37:04	u	43.70	5.	0.	245.	0.
M5L19099.IMG	5/19/95	9:41:49	h	46.90	2.	0.	191.	0.
M5L19100.IMG	5/19/95	9:41:54	v	46.90	2.	0.	422.	0.
M5L19101.IMG	5/19/95	9:42:07	u	43.50	2.	0.	2138.	0.
M5L19102.IMG	5/19/95	9:42:26	h	47.10	5.	0.	0.	0.
M5L19103.IMG	5/19/95	9:42:39	v	47.60	5.	0.	0.	0.
M5L19104.IMG	5/19/95	9:42:51	u	43.50	5.	0.	405.	0.
M5L19105.IMG	5/19/95	9:44:10	h	47.60	2.	0.	71.	0.
M5L19106.IMG	5/19/95	9:44:14	v	47.60	2.	0.	172.	0.
M5L19107.IMG	5/19/95	9:44:25	u	44.00	2.	0.	949.	0.
M5L19108.IMG	5/19/95	9:44:35	u	47.90	2.	0.	0.	19418.
M5L19109.IMG	5/19/95	9:45:10	h	47.90	5.	0.	0.	0.
M5L19110.IMG	5/19/95	9:45:15	v	47.90	5.	0.	0.	0.
M5L19111.IMG	5/19/95	9:45:28	u	45.20	5.	0.	79.	0.
M5L19112.IMG	5/19/95	9:46:37	h	47.40	2.	0.	136.	0.
M5L19113.IMG	5/19/95	9:46:41	v	47.40	2.	0.	337.	0.
M5L19114.IMG	5/19/95	9:46:49	u	43.70	2.	0.	1868.	0.
M5L19115.IMG	5/19/95	9:47:14	h	48.10	5.	0.	0.	0.
M5L19116.IMG	5/19/95	9:47:18	v	48.10	5.	0.	0.	0.
M5L19117.IMG	5/19/95	9:47:29	u	44.40	5.	0.	145.	0.
M5L19118.IMG	5/19/95	9:48:26	h	47.10	2.	0.	307.	0.
M5L19119.IMG	5/19/95	9:48:31	v	47.10	2.	0.	455.	0.
M5L19120.IMG	5/19/95	9:48:41	u	44.00	2.	0.	826.	0.
M5L19121.IMG	5/19/95	9:48:59	h	47.90	5.	0.	0.	0.
M5L19122.IMG	5/19/95	9:49:03	v	47.90	5.	0.	0.	0.
M5L19123.IMG	5/19/95	9:49:14	u	44.20	5.	0.	206.	0.
M5L19124.IMG	5/19/95	9:51:22	h	47.10	2.	0.	184.	0.
M5L19125.IMG	5/19/95	9:51:25	v	47.10	2.	0.	412.	0.
M5L19126.IMG	5/19/95	9:51:34	u	44.20	2.	0.	775.	0.
M5L19127.IMG	5/19/95	9:51:49	h	47.90	5.	0.	0.	0.
M5L19128.IMG	5/19/95	9:51:52	v	47.90	5.	0.	0.	0.
M5L19129.IMG	5/19/95	9:51:58	u	44.00	5.	0.	405.	0.
M5L19130.IMG	5/19/95	9:52:06	u	47.90	5.	0.	0.	19023.
M5L19131.IMG	5/19/95	9:54:03	h	47.40	2.	0.	278.	0.
M5L19132.IMG	5/19/95	9:54:06	v	47.40	2.	0.	433.	0.
M5L19133.IMG	5/19/95	9:54:14	u	43.70	2.	0.	1419.	0.
M5L19134.IMG	5/19/95	9:54:59	h	48.10	5.	0.	0.	0.
M5L19135.IMG	5/19/95	9:55:04	v	48.10	5.	0.	0.	0.
M5L19136.IMG	5/19/95	9:55:13	u	44.90	5.	0.	96.	0.
M5L19137.IMG	5/19/95	9:55:40	u	48.10	2.	0.	0.	19498.
M5L19138.IMG	5/19/95	10:04:15	u	42.50	2.	0.	2649.	0.
M5L19139.IMG	5/19/95	10:17:50	h	46.60	2.	0.	190.	0.
M5L19140.IMG	5/19/95	10:17:54	v	46.60	2.	0.	365.	0.
M5L19141.IMG	5/19/95	10:18:03	u	43.00	2.	0.	1348.	0.
M5L19142.IMG	5/19/95	10:18:30	x	43.20	5.	0.	201.	0.
M5L19143.IMG	5/19/95	10:18:59	h	46.20	5.	0.	0.	0.
M5L19144.IMG	5/19/95	10:19:04	v	46.20	5.	0.	0.	0.
M5L19145.IMG	5/19/95	10:19:14	u	43.70	5.	0.	153.	0.
M5L19146.IMG	5/19/95	10:19:21	u	46.20	5.	0.	0.	18760.
M5L19147.IMG	5/19/95	10:35:59	u	44.90	5.	-5.	544.	11.
M5L19148.IMG	5/19/95	10:37:23	h	47.40	5.	-5.	0.	0.
M5L19149.IMG	5/19/95	10:37:50	v	47.40	5.	-5.	0.	0.
M5L19150.IMG	5/19/95	10:39:50	h	46.60	2.	-5.	0.	0.
M5L19151.IMG	5/19/95	10:39:55	v	46.60	2.	-5.	0.	0.
M5L19152.IMG	5/19/95	10:40:04	u	43.50	2.	-5.	0.	0.
M5L19153.IMG	5/19/95	10:41:01	h	47.90	5.	-5.	0.	0.

M5L19154.IMG	5/19/95	10:41:13	v	48.10	5.	-5.	0.	0.
M5L19155.IMG	5/19/95	10:41:24	u	44.20	5.	-5.	0.	0.
M5L19156.IMG	5/19/95	10:44:33	h	46.60	2.	-5.	0.	0.
M5L19157.IMG	5/19/95	10:44:36	v	46.60	2.	-5.	0.	0.
M5L19158.IMG	5/19/95	10:44:46	u	44.00	2.	-5.	0.	0.
M5L19159.IMG	5/19/95	10:48:01	h	47.60	2.	-5.	19.	0.
M5L19160.IMG	5/19/95	10:48:06	v	47.60	2.	-5.	142.	0.
M5L19161.IMG	5/19/95	10:48:20	u	46.20	2.	-5.	334.	13059.
M5L19162.IMG	5/19/95	10:49:47	h	46.60	2.	-5.	0.	0.
M5L19163.IMG	5/19/95	10:49:53	v	46.60	2.	-5.	0.	0.
M5L19164.IMG	5/19/95	10:50:01	u	43.20	2.	-5.	1.	0.
M5L19165.IMG	5/19/95	10:51:40	h	46.90	2.	-5.	0.	0.
M5L19166.IMG	5/19/95	10:51:43	v	46.90	2.	-5.	0.	0.
M5L19167.IMG	5/19/95	10:51:49	u	43.50	2.	-5.	0.	0.
M5L19168.IMG	5/19/95	10:52:09	h	47.60	5.	-5.	0.	0.
M5L19169.IMG	5/19/95	10:52:14	v	47.60	5.	-5.	0.	0.
M5L19170.IMG	5/19/95	10:52:22	u	44.00	5.	-5.	0.	0.
M5L19171.IMG	5/19/95	10:53:53	h	46.60	2.	-5.	0.	0.
M5L19172.IMG	5/19/95	10:53:56	v	46.60	2.	-5.	0.	0.
M5L19173.IMG	5/19/95	10:54:03	u	43.50	2.	-5.	0.	0.
M5L19174.IMG	5/19/95	10:57:32	h	46.20	2.	-5.	0.	0.
M5L19175.IMG	5/19/95	10:57:36	v	46.20	2.	-5.	0.	0.
M5L19176.IMG	5/19/95	10:57:46	u	43.70	2.	-5.	0.	0.
M5L19177.IMG	5/19/95	10:58:02	h	47.40	5.	-5.	0.	0.
M5L19178.IMG	5/19/95	10:58:06	v	47.40	5.	-5.	0.	0.
M5L19179.IMG	5/19/95	10:58:13	u	44.00	5.	-5.	0.	0.
M5L19180.IMG	5/19/95	10:59:45	h	46.60	2.	-5.	0.	0.
M5L19181.IMG	5/19/95	10:59:49	v	46.60	2.	-5.	0.	0.
M5L19182.IMG	5/19/95	10:59:57	u	43.20	2.	-5.	71.	0.
M5L19183.IMG	5/19/95	11:00:20	h	46.20	5.	-5.	0.	0.
M5L19184.IMG	5/19/95	11:00:23	v	46.20	5.	-5.	0.	0.
M5L19185.IMG	5/19/95	11:00:30	u	44.20	5.	-5.	0.	0.
M5L19186.IMG	5/19/95	11:01:46	h	46.90	2.	-5.	2.	0.
M5L19187.IMG	5/19/95	11:01:49	v	46.90	2.	-5.	21.	0.
M5L19188.IMG	5/19/95	11:01:56	u	43.70	2.	-5.	111.	0.
M5L19189.IMG	5/19/95	11:02:09	h	45.90	5.	-5.	0.	0.
M5L19190.IMG	5/19/95	11:02:14	v	45.90	5.	-5.	0.	0.
M5L19191.IMG	5/19/95	11:02:20	u	44.70	5.	-5.	11.	0.
M5L19192.IMG	5/19/95	11:04:24	h	46.60	2.	-5.	28.	0.
M5L19193.IMG	5/19/95	11:04:28	v	46.60	2.	-5.	41.	0.
M5L19194.IMG	5/19/95	11:04:39	u	42.70	2.	-5.	768.	0.
M5L19195.IMG	5/19/95	11:05:06	h	47.10	5.	-5.	0.	0.
M5L19196.IMG	5/19/95	11:05:09	v	47.10	5.	-5.	0.	0.
M5L19197.IMG	5/19/95	11:05:16	u	44.70	5.	-5.	24.	0.
M5L19198.IMG	5/19/95	11:06:01	h	48.40	10.	-5.	0.	0.
M5L19199.IMG	5/19/95	11:06:04	v	48.40	10.	-5.	0.	0.
M5L19200.IMG	5/19/95	11:06:10	u	45.90	10.	-5.	0.	0.
M5L19201.IMG	5/19/95	11:08:23	h	46.90	2.	-5.	2.	0.
M5L19202.IMG	5/19/95	11:08:26	v	46.90	2.	-5.	3.	0.
M5L19203.IMG	5/19/95	11:08:35	u	43.20	2.	-5.	186.	0.
M5L19204.IMG	5/19/95	11:08:49	h	45.70	5.	-5.	0.	0.
M5L19205.IMG	5/19/95	11:08:57	v	46.40	5.	-5.	0.	0.
M5L19206.IMG	5/19/95	11:09:04	u	44.70	5.	-5.	0.	0.
M5L19207.IMG	5/19/95	11:09:15	h	46.20	10.	-5.	0.	0.
M5L19208.IMG	5/19/95	11:09:19	v	46.20	10.	-5.	0.	0.
M5L19209.IMG	5/19/95	11:09:25	u	46.60	10.	-5.	0.	0.
M5L19210.IMG	5/19/95	11:11:11	h	48.80	5.	-5.	12.	3681.
M5L19211.IMG	5/19/95	11:11:17	v	48.80	5.	-5.	15.	802.
M5L19212.IMG	5/19/95	11:11:28	u	46.60	5.	-5.	338.	5606.
M5L19213.IMG	5/19/95	11:11:43	u	46.60	5.	-5.	1.	5640.
M5L19214.IMG	5/19/95	11:14:36	h	46.90	2.	-5.	0.	0.
M5L19215.IMG	5/19/95	11:14:39	v	46.90	2.	-5.	0.	0.

M5L19216.IMG	5/19/95	11:14:46	u	43.50	2.	-5.	168.	0.
M5L19217.IMG	5/19/95	11:15:05	h	47.10	5.	-5.	0.	0.
M5L19218.IMG	5/19/95	11:15:08	v	47.10	5.	-5.	0.	0.
M5L19219.IMG	5/19/95	11:15:14	u	44.90	5.	-5.	0.	0.
M5L19220.IMG	5/19/95	11:15:39	h	48.10	10.	-5.	0.	0.
M5L19221.IMG	5/19/95	11:15:42	v	48.10	10.	-5.	0.	0.
M5L19222.IMG	5/19/95	11:15:49	u	46.40	10.	-5.	0.	0.
M5L19223.IMG	5/19/95	11:16:53	h	46.90	2.	-5.	67.	0.
M5L19224.IMG	5/19/95	11:16:56	v	46.90	2.	-5.	69.	0.
M5L19225.IMG	5/19/95	11:17:01	u	43.50	2.	-5.	351.	0.
M5L19226.IMG	5/19/95	11:17:27	h	46.90	5.	-5.	0.	0.
M5L19227.IMG	5/19/95	11:17:30	v	46.90	5.	-5.	0.	0.
M5L19228.IMG	5/19/95	11:17:35	u	44.70	5.	-5.	54.	0.
M5L19229.IMG	5/19/95	11:17:53	h	48.40	10.	-5.	0.	0.
M5L19230.IMG	5/19/95	11:17:56	v	48.40	10.	-5.	0.	0.
M5L19231.IMG	5/19/95	11:18:01	u	46.20	10.	-5.	0.	0.
M5L19232.IMG	5/19/95	11:19:11	h	47.40	2.	-5.	136.	0.
M5L19233.IMG	5/19/95	11:19:14	v	46.90	2.	-5.	59.	19448.
M5L19234.IMG	5/19/95	11:19:18	u	43.70	2.	-5.	915.	0.
M5L19235.IMG	5/19/95	11:19:38	h	48.80	5.	-5.	0.	0.
M5L19236.IMG	5/19/95	11:19:41	v	48.80	5.	-5.	0.	0.
M5L19237.IMG	5/19/95	11:19:48	u	44.40	5.	-5.	107.	0.
M5L19238.IMG	5/19/95	11:20:07	h	48.80	10.	-5.	0.	0.
M5L19239.IMG	5/19/95	11:20:10	v	48.80	10.	-5.	0.	18492.
M5L19240.IMG	5/19/95	11:20:19	u	46.20	10.	-5.	0.	0.
M5L19241.IMG	5/19/95	11:21:23	h	46.90	2.	-5.	511.	0.
M5L19242.IMG	5/19/95	11:21:26	v	46.90	2.	-5.	105.	19349.
M5L19243.IMG	5/19/95	11:21:29	u	43.20	2.	-5.	1909.	0.
M5L19244.IMG	5/19/95	11:21:48	h	48.40	5.	-5.	7310.	0.
M5L19245.IMG	5/19/95	11:21:51	v	48.40	5.	-5.	2.	19395.
M5L19246.IMG	5/19/95	11:21:56	u	44.90	5.	-5.	134.	0.
M5L19247.IMG	5/19/95	11:22:16	h	48.60	10.	-5.	0.	0.
M5L19248.IMG	5/19/95	11:22:19	v	48.60	10.	-5.	0.	0.
M5L19249.IMG	5/19/95	11:22:26	u	46.20	10.	-5.	3.	0.
M5L19250.IMG	5/19/95	11:22:58	h	50.80	20.	-5.	0.	0.
M5L19251.IMG	5/19/95	11:23:01	v	50.80	20.	-5.	0.	0.
M5L19252.IMG	5/19/95	11:23:08	u	50.30	20.	-5.	0.	0.
M5L19253.IMG	5/19/95	11:24:50	u	44.90	5.	-5.	185.	0.
M5L19254.IMG	5/19/95	11:25:29	h	48.60	5.	-5.	0.	9800.
M5L19255.IMG	5/19/95	11:25:32	v	48.60	5.	-5.	18.	19309.
M5L19256.IMG	5/19/95	11:25:36	u	44.70	5.	-5.	204.	0.
M5L19257.IMG	5/19/95	11:25:50	h	49.60	10.	-5.	0.	364.
M5L19258.IMG	5/19/95	11:25:53	v	49.60	10.	-5.	1.	18604.
M5L19259.IMG	5/19/95	11:25:58	u	46.60	10.	-5.	15.	0.
M5L19260.IMG	5/19/95	11:26:14	h	47.60	20.	-5.	0.	0.
M5L19261.IMG	5/19/95	11:26:17	v	47.60	20.	-5.	0.	0.
M5L19262.IMG	5/19/95	11:26:20	u	47.60	20.	-5.	0.	0.
M5L19263.IMG	5/19/95	11:28:22	h	48.80	5.	-5.	8326.	0.
M5L19264.IMG	5/19/95	11:28:25	v	48.80	5.	-5.	0.	19524.
M5L19265.IMG	5/19/95	11:28:33	u	44.90	5.	-5.	31.	0.
M5L19266.IMG	5/19/95	11:28:56	h	46.90	10.	-5.	0.	0.
M5L19267.IMG	5/19/95	11:28:59	v	46.90	10.	-5.	0.	0.
M5L19268.IMG	5/19/95	11:29:02	u	46.90	10.	-5.	0.	0.
M5L19269.IMG	5/19/95	11:30:11	h	47.90	5.	-5.	0.	0.
M5L19270.IMG	5/19/95	11:30:14	v	47.90	5.	-5.	0.	0.
M5L19271.IMG	5/19/95	11:30:24	u	44.20	5.	-5.	0.	0.
M5L19272.IMG	5/19/95	11:30:40	h	48.10	10.	-5.	0.	0.
M5L19273.IMG	5/19/95	11:30:44	v	48.10	10.	-5.	0.	0.
M5L19274.IMG	5/19/95	11:30:51	u	47.40	10.	-5.	0.	0.
M5L19275.IMG	5/19/95	11:32:15	h	47.90	5.	-5.	0.	0.
M5L19276.IMG	5/19/95	11:32:18	v	47.90	5.	-5.	0.	19351.
M5L19277.IMG	5/19/95	11:32:22	u	44.90	5.	-5.	0.	0.

M5L19278.IMG	5/19/95	11:32:38	h	45.90	10.	-5.	0.	0.
M5L19279.IMG	5/19/95	11:32:41	v	45.90	10.	-5.	0.	0.
M5L19280.IMG	5/19/95	11:32:44	u	45.90	10.	-5.	0.	0.
M5L19281.IMG	5/19/95	11:37:53	h	47.90	5.	-5.	0.	0.
M5L19282.IMG	5/19/95	11:37:58	v	47.90	5.	-5.	0.	0.
M5L19283.IMG	5/19/95	11:38:05	u	44.90	5.	-5.	0.	0.
M5L19284.IMG	5/19/95	11:38:32	h	46.60	10.	-5.	0.	0.
M5L19285.IMG	5/19/95	11:38:35	v	46.60	10.	-5.	0.	0.
M5L19286.IMG	5/19/95	11:38:40	u	46.60	10.	-5.	0.	0.
M5L19287.IMG	5/19/95	11:40:25	u	47.90	5.	-5.	0.	9102.
M5L19288.IMG	5/19/95	11:40:50	h	47.90	5.	-5.	0.	0.
M5L19289.IMG	5/19/95	11:40:59	v	47.90	5.	-5.	0.	0.
ML516001.IMG	5/15/95	11:48:25	x	47.10	10.	1.	0.	13739.
ML516002.IMG	5/15/95	11:48:48	x	47.10	10.	1.	0.	13782.
ML516010.IMG	5/15/95	11:49:49	x	47.10	10.	1.	0.	13768.
ML516011.IMG	5/15/95	11:50:29	x	47.10	10.	1.	0.	13206.
ML516012.IMG	5/15/95	11:50:56	x	47.10	10.	1.	0.	12962.
ML516013.IMG	5/15/95	11:50:56	x	47.10	10.	1.	0.	12962.
ML516014.IMG	5/15/95	11:50:56	x	47.10	10.	1.	0.	12962.
ML516015.IMG	5/15/95	12:02:30	u	46.40	10.	1.	0.	10152.
ML516016.IMG	5/16/95	9:29:08	h	45.90	5.	0.	0.	0.
ML516017.IMG	5/16/95	9:29:23	v	45.90	5.	0.	0.	0.
ML516018.IMG	5/16/95	9:30:01	u	44.20	10.	0.	0.	768.
ML516019.IMG	5/16/95	9:30:32	u	45.70	10.	0.	0.	8883.
ML516020.IMG	5/16/95	9:52:36	h	44.90	10.	0.	0.	0.
ML516021.IMG	5/16/95	9:52:46	v	44.90	10.	0.	0.	0.
ML516022.IMG	5/16/95	9:53:25	u	43.50	10.	0.	184.	1.
ML516023.IMG	5/16/95	9:53:59	h	45.70	5.	0.	53.	0.
ML516024.IMG	5/16/95	9:54:08	v	45.20	5.	0.	265.	0.
ML516025.IMG	5/16/95	9:54:30	u	45.20	20.	0.	0.	0.
ML516026.IMG	5/16/95	9:55:06	h	43.70	10.	0.	1.	1526.
ML516027.IMG	5/16/95	9:56:12	v	44.70	5.	0.	299.	0.
ML516028.IMG	5/16/95	9:56:48	u	45.70	5.	0.	134.	0.
ML516029.IMG	5/16/95	9:57:11	h	42.70	10.	0.	286.	0.
ML516030.IMG	5/16/95	9:59:06	v	44.20	5.	0.	140.	0.
ML516031.IMG	5/16/95	9:59:14	u	44.90	5.	0.	307.	0.
ML516032.IMG	5/16/95	9:59:42	h	43.00	10.	0.	196.	0.
ML516033.IMG	5/16/95	10:00:57	h	44.90	5.	0.	149.	0.
ML516034.IMG	5/16/95	10:01:10	v	44.90	5.	0.	306.	0.
ML516035.IMG	5/16/95	10:01:30	u	43.00	10.	0.	200.	0.
ML516036.IMG	5/16/95	10:01:56	h	44.90	10.	0.	0.	8485.
ML516037.IMG	5/16/95	10:03:05	v	45.20	5.	0.	33.	0.
ML516038.IMG	5/16/95	10:03:16	u	45.20	5.	0.	267.	0.
ML516039.IMG	5/16/95	10:03:42	u	43.20	10.	0.	133.	5.
ML516040.IMG	5/16/95	10:04:23	x	45.70	5.	0.	0.	0.
ML516041.IMG	5/16/95	10:04:35	v	45.70	5.	0.	0.	0.
ML516042.IMG	5/16/95	10:04:56	x	43.00	10.	0.	183.	0.
ML516043.IMG	5/16/95	10:05:09	x	43.00	10.	0.	187.	0.
ML516044.IMG	5/16/95	10:06:26	h	45.70	5.	0.	0.	0.
ML516045.IMG	5/16/95	10:06:35	v	45.70	5.	0.	135.	0.
ML516046.IMG	5/16/95	10:07:09	u	43.20	10.	0.	163.	4.
ML516047.IMG	5/16/95	10:08:09	v	44.70	5.	0.	375.	0.
ML516048.IMG	5/16/95	10:08:15	h	44.70	5.	0.	492.	0.
ML516049.IMG	5/16/95	10:08:26	v	46.20	5.	0.	0.	0.
ML516050.IMG	5/16/95	10:09:01	u	44.70	10.	0.	0.	6897.
ML516051.IMG	5/16/95	10:09:52	h	44.40	5.	0.	322.	0.
ML516052.IMG	5/16/95	10:10:02	v	44.90	5.	0.	465.	0.
ML516053.IMG	5/16/95	10:10:26	v	46.40	10.	0.	0.	0.
ML516054.IMG	5/16/95	10:10:33	v	46.40	10.	0.	0.	0.
ML516055.IMG	5/16/95	10:11:17	u	46.60	20.	0.	0.	0.
ML516056.IMG	5/16/95	10:13:02	h	44.90	10.	0.	0.	0.
ML516057.IMG	5/16/95	10:13:12	v	44.90	10.	0.	0.	0.

ML516058.IMG	5/16/95	10:13:28	u	47.90	20.	0.	0.	6316.
ML516059.IMG	5/16/95	10:15:43	h	44.90	10.	0.	5.	0.
ML516060.IMG	5/16/95	10:15:56	h	44.90	10.	0.	4.	0.
ML516061.IMG	5/16/95	10:16:26	v	46.90	10.	0.	0.	0.
ML516062.IMG	5/16/95	10:16:41	u	46.60	20.	0.	1.	0.
ML516063.IMG	5/16/95	10:18:43	h	46.40	10.	0.	0.	0.
ML516064.IMG	5/16/95	10:18:52	v	46.40	10.	0.	0.	0.
ML516065.IMG	5/16/95	10:19:15	u	45.20	20.	0.	0.	0.
ML516066.IMG	5/16/95	10:19:58	h	45.20	10.	0.	0.	0.
ML516067.IMG	5/16/95	10:20:06	v	45.20	10.	0.	0.	0.
ML516068.IMG	5/16/95	10:20:16	u	45.40	20.	0.	0.	0.
ML516069.IMG	5/16/95	10:20:54	h	45.40	10.	0.	0.	0.
ML516070.IMG	5/16/95	10:21:00	v	45.40	10.	0.	0.	0.
ML516071.IMG	5/16/95	10:21:11	u	45.90	20.	0.	1.	0.
ML516072.IMG	5/16/95	10:23:14	h	45.70	10.	0.	0.	0.
ML516073.IMG	5/16/95	10:23:23	v	45.70	10.	0.	0.	0.
ML516074.IMG	5/16/95	10:23:33	u	45.70	20.	0.	0.	0.
ML516075.IMG	5/16/95	10:24:16	h	45.70	10.	0.	0.	0.
ML516076.IMG	5/16/95	10:24:26	v	45.70	10.	0.	0.	0.
ML516077.IMG	5/16/95	10:24:36	u	45.40	20.	0.	0.	0.
ML516078.IMG	5/16/95	10:25:15	h	45.70	10.	0.	0.	0.
ML516079.IMG	5/16/95	10:25:22	v	45.70	10.	0.	0.	0.
ML516080.IMG	5/16/95	10:25:30	u	45.70	20.	0.	0.	0.
ML516081.IMG	5/16/95	10:27:54	h	45.70	10.	0.	0.	0.
ML516082.IMG	5/16/95	10:28:32	v	44.20	20.	0.	0.	0.
ML516083.IMG	5/16/95	10:28:56	u	45.70	5.	0.	270.	0.
ML516084.IMG	5/16/95	10:29:21	v	45.20	5.	0.	351.	0.
ML516085.IMG	5/16/95	10:30:11	h	45.20	5.	0.	255.	0.
ML516086.IMG	5/16/95	10:30:35	u	44.00	20.	0.	0.	0.
ML516087.IMG	5/16/95	10:32:59	h	45.70	5.	0.	160.	0.
ML516088.IMG	5/16/95	10:33:13	v	45.70	5.	0.	262.	0.
ML516089.IMG	5/16/95	10:33:36	u	44.20	10.	0.	258.	5293.
ML516090.IMG	5/16/95	10:33:52	u	45.20	20.	0.	0.	0.
ML516091.IMG	5/16/95	10:35:03	h	46.40	5.	0.	143.	0.
ML516092.IMG	5/16/95	10:35:16	v	46.40	5.	0.	269.	0.
ML516093.IMG	5/16/95	10:35:40	u	44.40	20.	0.	0.	0.
ML516094.IMG	5/16/95	10:35:53	u	44.20	10.	0.	305.	2186.
ML516095.IMG	5/16/95	10:37:31	h	46.40	5.	0.	159.	0.
ML516096.IMG	5/16/95	10:37:46	v	46.40	5.	0.	336.	0.
ML516097.IMG	5/16/95	10:37:59	u	46.20	20.	0.	0.	0.
ML516098.IMG	5/16/95	10:38:29	h	46.20	5.	0.	0.	0.
ML516099.IMG	5/16/95	10:38:38	v	46.20	5.	0.	318.	0.
ML516100.IMG	5/16/95	10:38:55	u	46.20	20.	0.	0.	0.
ML516101.IMG	5/16/95	10:39:13	u	44.00	10.	0.	351.	0.
ML516102.IMG	5/16/95	10:41:36	h	46.60	5.	0.	173.	0.
ML516103.IMG	5/16/95	10:41:49	v	46.60	5.	0.	295.	0.
ML516104.IMG	5/16/95	10:42:19	u	44.70	10.	0.	275.	4146.
ML516105.IMG	5/16/95	10:42:34	u	44.70	20.	0.	0.	0.
ML516106.IMG	5/16/95	10:43:12	h	46.60	5.	0.	175.	0.
ML516107.IMG	5/16/95	10:43:22	v	46.60	5.	0.	290.	0.
ML516108.IMG	5/16/95	10:43:42	u	43.70	20.	0.	0.	0.
ML516109.IMG	5/16/95	10:45:07	h	46.60	5.	0.	217.	0.
ML516110.IMG	5/16/95	10:45:16	v	46.60	5.	0.	301.	0.
ML516111.IMG	5/16/95	10:45:37	u	43.20	20.	0.	0.	0.
ML516112.IMG	5/16/95	10:47:01	h	46.20	10.	0.	0.	0.
ML516113.IMG	5/16/95	10:47:32	v	46.20	20.	0.	0.	0.
ML516114.IMG	5/16/95	10:48:32	h	45.90	10.	0.	0.	0.
ML516115.IMG	5/16/95	10:48:41	v	45.90	10.	0.	0.	0.
ML516116.IMG	5/16/95	10:48:52	u	45.90	20.	0.	0.	0.
ML516117.IMG	5/16/95	10:50:30	h	46.60	5.	0.	207.	0.
ML516118.IMG	5/16/95	10:50:44	v	46.60	5.	0.	317.	0.
ML516119.IMG	5/16/95	10:51:02	u	43.20	10.	0.	395.	0.

ML516120.IMG	5/16/95	10:51:21	h	46.40	5.	0.	251.	0.
ML516121.IMG	5/16/95	10:52:34	u	44.90	20.	0.	0.	0.
ML516122.IMG	5/16/95	10:53:06	h	45.90	10.	0.	0.	0.
ML516123.IMG	5/16/95	10:53:19	v	45.90	10.	0.	0.	0.
ML516124.IMG	5/16/95	10:53:40	u	43.50	10.	0.	389.	0.
ML516125.IMG	5/16/95	10:54:11	h	46.20	5.	0.	295.	0.
ML516126.IMG	5/16/95	10:54:19	v	46.20	5.	0.	377.	0.
ML516127.IMG	5/16/95	10:54:41	u	44.70	10.	0.	307.	538.
ML516128.IMG	5/16/95	10:54:50	u	44.40	20.	0.	0.	0.
ML516129.IMG	5/16/95	10:57:20	h	46.60	5.	0.	214.	0.
ML516130.IMG	5/16/95	10:57:30	v	46.60	5.	0.	311.	0.
ML516131.IMG	5/16/95	10:58:03	u	44.40	20.	0.	0.	0.
ML516132.IMG	5/16/95	10:58:23	u	44.40	20.	0.	0.	0.
ML516133.IMG	5/16/95	10:59:54	u	44.70	10.	0.	275.	1799.
ML516134.IMG	5/16/95	11:00:18	h	47.10	5.	0.	202.	0.
ML516135.IMG	5/16/95	11:00:27	v	47.10	5.	0.	310.	0.
ML516136.IMG	5/16/95	11:00:56	u	44.70	10.	0.	281.	1202.
ML516137.IMG	5/16/95	11:11:15	h	46.90	5.	0.	0.	0.
ML516138.IMG	5/16/95	11:11:32	v	46.90	5.	0.	0.	0.
ML516139.IMG	5/16/95	11:12:14	u	44.90	20.	0.	0.	0.
ML516140.IMG	5/16/95	11:12:46	h	46.90	5.	0.	0.	0.
ML516141.IMG	5/16/95	11:12:54	v	46.90	5.	0.	0.	0.
ML516142.IMG	5/16/95	11:13:15	u	44.70	10.	0.	0.	1991.
ML516143.IMG	5/16/95	11:13:43	h	46.90	5.	0.	0.	0.
ML516144.IMG	5/16/95	11:13:53	v	46.90	5.	0.	0.	0.
ML516145.IMG	5/16/95	11:14:11	u	44.40	10.	0.	0.	247.
ML516146.IMG	5/16/95	11:16:12	h	46.90	5.	0.	0.	0.
ML516147.IMG	5/16/95	11:16:27	v	46.90	5.	0.	51.	0.
ML516148.IMG	5/16/95	11:16:43	u	45.40	10.	0.	0.	5630.
ML516149.IMG	5/16/95	11:16:50	u	45.40	20.	0.	0.	0.
ML516150.IMG	5/16/95	11:17:14	h	45.90	5.	0.	348.	0.
ML516151.IMG	5/16/95	11:17:43	h	47.10	5.	0.	0.	0.
ML516152.IMG	5/16/95	11:17:59	v	47.10	5.	0.	0.	0.
ML516153.IMG	5/16/95	11:18:19	u	45.20	10.	0.	0.	3419.
ML516154.IMG	5/16/95	11:18:34	u	45.20	20.	0.	0.	0.
ML516155.IMG	5/16/95	11:20:09	h	46.90	5.	0.	0.	0.
ML516156.IMG	5/16/95	11:20:20	v	46.90	5.	0.	57.	0.
ML516157.IMG	5/16/95	11:20:38	u	46.20	10.	0.	0.	7270.
ML516158.IMG	5/16/95	11:20:44	u	45.90	20.	0.	0.	0.
ML516159.IMG	5/16/95	11:21:08	h	48.10	5.	0.	0.	10.
ML516160.IMG	5/16/95	11:21:18	v	48.10	5.	0.	0.	0.
ML516161.IMG	5/16/95	11:21:37	u	45.40	10.	0.	0.	3538.
ML516162.IMG	5/16/95	11:21:46	u	45.20	20.	0.	0.	0.
ML516163.IMG	5/16/95	11:23:04	h	47.10	5.	0.	0.	0.
ML516164.IMG	5/16/95	11:23:20	v	47.10	5.	0.	164.	0.
ML516165.IMG	5/16/95	11:23:43	u	43.70	10.	0.	171.	0.
ML516166.IMG	5/16/95	11:23:50	u	43.50	20.	0.	0.	0.
ML516167.IMG	5/16/95	11:24:36	h	47.90	5.	0.	0.	0.
ML516168.IMG	5/16/95	11:24:50	v	47.90	5.	0.	0.	0.
ML516169.IMG	5/16/95	11:25:10	u	44.90	10.	0.	0.	228.
ML516170.IMG	5/16/95	11:25:19	u	44.90	20.	0.	0.	0.
ML516171.IMG	5/16/95	11:26:37	h	47.90	5.	0.	0.	0.
ML516172.IMG	5/16/95	11:26:46	v	47.90	5.	0.	0.	0.
ML516173.IMG	5/16/95	11:27:12	u	44.70	10.	0.	0.	7.
ML516174.IMG	5/16/95	11:27:22	u	44.20	20.	0.	0.	0.
ML516175.IMG	5/16/95	11:27:59	h	47.40	5.	0.	0.	0.
ML516176.IMG	5/16/95	11:28:11	v	47.40	5.	0.	191.	0.
ML516177.IMG	5/16/95	11:28:29	u	44.40	10.	0.	0.	0.
ML516178.IMG	5/16/95	11:28:41	u	44.40	20.	0.	0.	0.
ML516179.IMG	5/16/95	11:31:03	h	47.90	5.	0.	0.	0.
ML516180.IMG	5/16/95	11:31:14	v	47.90	5.	0.	0.	0.
ML516181.IMG	5/16/95	11:31:32	u	44.90	10.	0.	0.	1.

ML516182.IMG	5/16/95	11:31:39	u	44.90	20.	0.	0.	0.
ML516183.IMG	5/16/95	11:32:06	h	48.40	5.	0.	0.	0.
ML516184.IMG	5/16/95	11:32:18	v	48.40	5.	0.	0.	0.
ML516185.IMG	5/16/95	11:32:37	u	45.20	10.	0.	0.	0.
ML516186.IMG	5/16/95	11:32:45	u	44.90	20.	0.	0.	0.
ML516187.IMG	5/16/95	11:34:08	h	47.10	5.	0.	0.	0.
ML516188.IMG	5/16/95	11:34:23	v	47.10	5.	0.	247.	0.
ML516189.IMG	5/16/95	11:34:42	u	44.20	10.	0.	20.	0.
ML516190.IMG	5/16/95	11:35:16	h	46.60	5.	0.	366.	0.
ML516191.IMG	5/16/95	11:35:35	v	47.60	5.	0.	67.	0.
ML516192.IMG	5/16/95	11:35:57	u	44.20	10.	0.	55.	0.
ML516193.IMG	5/16/95	11:38:39	h	48.10	5.	0.	0.	0.
ML516194.IMG	5/16/95	11:38:53	v	48.10	5.	0.	0.	0.
ML516195.IMG	5/16/95	11:39:45	u	43.70	10.	0.	211.	0.
ML516196.IMG	5/16/95	11:40:27	h	47.90	5.	0.	0.	0.
ML516197.IMG	5/16/95	11:40:39	v	47.90	5.	0.	9.	0.
ML516198.IMG	5/16/95	11:41:00	u	44.40	10.	0.	21.	0.
ML516199.IMG	5/16/95	11:41:08	u	44.40	20.	0.	0.	0.
ML516200.IMG	5/16/95	11:45:02	h	48.10	5.	0.	0.	0.
ML516201.IMG	5/16/95	11:45:17	v	48.10	5.	0.	161.	0.
ML516202.IMG	5/16/95	11:45:35	u	44.40	10.	0.	0.	0.
ML516203.IMG	5/16/95	11:45:45	u	44.40	20.	0.	0.	0.
ML516204.IMG	5/16/95	11:46:11	h	48.60	5.	0.	0.	3458.
ML516205.IMG	5/16/95	11:46:52	v	47.60	5.	0.	277.	0.
ML516206.IMG	5/16/95	11:47:13	u	43.70	10.	0.	138.	0.
ML516207.IMG	5/16/95	11:49:32	h	48.40	5.	0.	0.	0.
ML516208.IMG	5/16/95	11:49:45	v	48.40	5.	0.	0.	0.
ML516209.IMG	5/16/95	11:50:07	u	46.20	10.	0.	0.	7194.
ML516210.IMG	5/16/95	11:50:54	h	48.10	5.	0.	2.	0.
ML516211.IMG	5/16/95	11:51:03	v	48.10	5.	0.	28.	0.
ML516212.IMG	5/16/95	11:51:21	u	45.40	10.	0.	3.	2150.
ML516213.IMG	5/16/95	11:51:28	u	45.70	20.	0.	0.	0.
ML516214.IMG	5/16/95	11:53:32	h	48.60	5.	0.	0.	0.
ML516215.IMG	5/16/95	11:53:42	v	48.60	5.	0.	0.	0.
ML516216.IMG	5/16/95	11:54:03	u	45.70	10.	0.	0.	565.
ML516217.IMG	5/16/95	11:54:12	u	45.70	20.	0.	0.	0.
ML516218.IMG	5/16/95	11:54:33	h	48.40	5.	0.	0.	0.
ML516219.IMG	5/16/95	11:54:42	v	48.40	5.	0.	0.	0.
ML516220.IMG	5/16/95	11:55:00	u	45.40	10.	0.	0.	11.
ML516221.IMG	5/16/95	11:56:44	h	48.40	5.	0.	0.	0.
ML516222.IMG	5/16/95	11:56:55	v	48.40	5.	0.	0.	0.
ML516223.IMG	5/16/95	11:57:15	u	44.70	10.	0.	0.	0.
ML516224.IMG	5/16/95	11:57:23	u	44.40	20.	0.	0.	0.
ML516225.IMG	5/16/95	11:57:47	h	48.60	5.	0.	0.	0.
ML516226.IMG	5/16/95	11:57:57	v	48.60	5.	0.	0.	0.
ML516227.IMG	5/16/95	11:58:13	u	44.90	10.	0.	0.	0.
ML516228.IMG	5/16/95	11:58:21	u	44.70	20.	0.	0.	0.
ML518001.IMG	5/17/95	12:11:09	u	43.00	2.	1.	2190.	0.
ML518002.IMG	5/17/95	12:12:01	u	43.00	2.	1.	1675.	0.
ML518003.IMG	5/17/95	12:12:33	u	43.00	2.	1.	1285.	0.
ML518004.IMG	5/17/95	12:12:44	u	43.00	2.	1.	1350.	0.
ML518005.IMG	5/17/95	12:13:28	u	47.40	10.	1.	0.	8705.
ML518006.IMG	5/17/95	12:16:41	h	47.10	2.	1.	41.	724.
ML518007.IMG	5/17/95	12:17:06	h	47.90	10.	1.	0.	0.
ML518008.IMG	5/17/95	12:17:31	v	46.60	2.	1.	340.	0.
ML518009.IMG	5/17/95	12:17:52	v	48.40	10.	1.	0.	0.
ML518010.IMG	5/17/95	12:18:18	u	44.00	5.	1.	246.	0.
ML518011.IMG	5/17/95	12:18:31	u	47.10	10.	1.	4.	6.
ML518012.IMG	5/17/95	12:21:54	h	46.20	2.	1.	364.	0.
ML518013.IMG	5/17/95	12:22:19	v	46.60	2.	1.	457.	0.
ML518014.IMG	5/17/95	12:22:44	u	44.00	5.	1.	271.	0.
ML518015.IMG	5/17/95	12:23:08	u	47.40	5.	1.	4.	18987.

ML518016.IMG	5/17/95	12:31:06	h	46.60	2.	1.	167.	0.
ML518017.IMG	5/17/95	12:31:19	v	46.60	2.	1.	243.	0.
ML518018.IMG	5/17/95	12:31:53	u	44.40	5.	1.	118.	542.
ML518019.IMG	5/17/95	12:32:08	u	48.10	5.	1.	3.	19177.
ML518020.IMG	5/17/95	12:32:35	h	47.40	2.	1.	72.	134.
ML518021.IMG	5/17/95	12:32:47	v	47.40	2.	1.	196.	0.
ML518022.IMG	5/17/95	12:33:10	u	44.70	5.	1.	101.	771.
ML518023.IMG	5/17/95	12:33:22	u	47.60	5.	1.	5.	19105.
ML518024.IMG	5/17/95	12:35:02	h	46.60	2.	1.	287.	0.
ML518025.IMG	5/17/95	12:35:12	v	46.60	2.	1.	381.	0.
ML518026.IMG	5/17/95	12:35:29	u	44.40	5.	1.	157.	0.
ML518027.IMG	5/17/95	12:35:50	u	47.60	5.	1.	7.	19091.
ML518028.IMG	5/17/95	12:36:12	h	46.60	2.	1.	307.	0.
ML518029.IMG	5/17/95	12:36:24	v	46.60	2.	1.	416.	0.
ML518030.IMG	5/17/95	12:36:45	u	45.20	5.	1.	99.	1058.
ML518031.IMG	5/17/95	12:36:58	u	47.60	5.	1.	8.	19158.
ML518032.IMG	5/17/95	12:38:29	h	46.40	2.	1.	351.	0.
ML518033.IMG	5/17/95	12:38:43	v	46.90	2.	1.	334.	0.
ML518034.IMG	5/17/95	12:38:57	u	44.20	5.	1.	230.	0.
ML518035.IMG	5/17/95	12:39:09	u	47.60	5.	1.	9.	19141.
ML518036.IMG	5/17/95	12:39:34	h	46.40	2.	1.	343.	0.
ML518037.IMG	5/17/95	12:39:49	v	47.40	2.	1.	14.	11524.
ML518038.IMG	5/17/95	12:40:13	u	44.20	5.	1.	160.	0.
ML518039.IMG	5/17/95	12:40:26	u	47.40	5.	1.	9.	19099.
ML518040.IMG	5/17/95	12:42:09	h	46.60	2.	1.	194.	0.
ML518041.IMG	5/17/95	12:42:19	v	46.60	2.	1.	305.	0.
ML518042.IMG	5/17/95	12:42:35	u	44.40	5.	1.	216.	0.
ML518043.IMG	5/17/95	12:42:44	u	48.10	5.	1.	7.	19167.
ML518044.IMG	5/17/95	12:43:20	h	46.60	2.	1.	311.	0.
ML518045.IMG	5/17/95	12:43:32	v	46.60	2.	1.	442.	0.
ML518046.IMG	5/17/95	12:43:47	u	44.00	5.	1.	197.	0.
ML518047.IMG	5/18/95	9:07:46	h	46.90	2.	0.	344.	0.
ML518048.IMG	5/18/95	9:07:56	v	46.90	2.	0.	457.	0.
ML518049.IMG	5/18/95	9:08:14	u	44.00	5.	0.	310.	0.
ML518050.IMG	5/18/95	9:08:30	u	48.10	5.	0.	3.	19185.
ML518051.IMG	5/18/95	9:08:54	h	46.90	2.	0.	248.	0.
ML518052.IMG	5/18/95	9:09:11	v	46.90	2.	0.	380.	0.
ML518053.IMG	5/18/95	9:09:39	u	44.20	5.	0.	226.	0.
ML518054.IMG	5/18/95	9:09:55	u	47.60	5.	0.	4.	19063.
ML518055.IMG	5/18/95	9:11:12	h	46.60	2.	0.	374.	0.
ML518056.IMG	5/18/95	9:11:32	v	47.10	2.	0.	320.	0.
ML518057.IMG	5/18/95	9:11:54	u	43.50	5.	0.	379.	0.
ML518058.IMG	5/18/95	9:12:05	u	48.40	5.	0.	0.	19150.
ML518059.IMG	5/18/95	9:12:37	h	46.60	2.	0.	736.	0.
ML518060.IMG	5/18/95	9:12:55	v	47.40	2.	0.	225.	0.
ML518061.IMG	5/18/95	9:13:12	u	44.20	5.	0.	252.	0.
ML518062.IMG	5/18/95	9:13:23	u	48.40	5.	0.	0.	19171.
ML518063.IMG	5/18/95	9:14:34	h	45.90	2.	0.	546.	0.
ML518064.IMG	5/18/95	9:14:52	v	46.40	2.	0.	839.	0.
ML518065.IMG	5/18/95	9:15:10	u	44.00	5.	0.	279.	0.
ML518066.IMG	5/18/95	9:15:23	u	47.90	5.	0.	0.	19085.
ML518067.IMG	5/18/95	9:15:51	h	46.90	2.	0.	416.	0.
ML518068.IMG	5/18/95	9:16:06	v	46.90	2.	0.	417.	0.
ML518069.IMG	5/18/95	9:16:20	u	43.70	5.	0.	301.	0.
ML518070.IMG	5/18/95	9:16:33	u	47.60	5.	0.	0.	18996.
ML518071.IMG	5/18/95	9:17:49	h	46.40	2.	0.	506.	0.
ML518072.IMG	5/18/95	9:18:01	v	47.10	2.	0.	371.	0.
ML518073.IMG	5/18/95	9:18:18	u	44.00	5.	0.	279.	0.
ML518074.IMG	5/18/95	9:18:32	u	48.60	5.	0.	0.	19281.
ML518075.IMG	5/18/95	9:18:47	h	46.60	2.	0.	454.	0.
ML518076.IMG	5/18/95	9:18:59	v	46.60	2.	0.	697.	0.
ML518077.IMG	5/18/95	9:19:13	u	43.70	5.	0.	338.	0.

ML518078.IMG	5/18/95	9:19:24	u	47.60	5.	0.	0.	19078.
ML518079.IMG	5/18/95	9:20:54	h	47.40	2.	0.	387.	0.
ML518080.IMG	5/18/95	9:21:06	v	47.40	2.	0.	432.	0.
ML518081.IMG	5/18/95	9:21:22	u	44.40	5.	0.	251.	0.
ML518082.IMG	5/18/95	9:21:31	u	47.90	5.	0.	0.	18928.
ML518083.IMG	5/18/95	9:21:45	h	46.90	2.	0.	647.	0.
ML518084.IMG	5/18/95	9:22:03	v	47.60	2.	0.	382.	0.
ML518085.IMG	5/18/95	9:22:24	u	44.20	5.	0.	277.	0.
ML518086.IMG	5/18/95	9:22:33	u	48.10	5.	0.	0.	19151.
ML518087.IMG	5/18/95	9:23:35	h	47.10	2.	0.	403.	0.
ML518088.IMG	5/18/95	9:23:58	v	47.60	2.	0.	354.	0.
ML518089.IMG	5/18/95	9:24:10	u	44.20	5.	0.	281.	0.
ML518090.IMG	5/18/95	9:24:20	u	48.10	5.	0.	6.	19045.
ML518091.IMG	5/18/95	9:24:56	h	47.10	2.	0.	378.	0.
ML518092.IMG	5/18/95	9:25:13	v	47.90	2.	0.	171.	34.
ML518093.IMG	5/18/95	9:25:24	u	44.90	5.	0.	206.	0.
ML518094.IMG	5/18/95	9:25:43	u	48.10	5.	0.	1.	18973.
ML518095.IMG	5/18/95	9:26:43	h	47.40	2.	0.	290.	0.
ML518096.IMG	5/18/95	9:26:56	v	47.60	2.	0.	291.	0.
ML518097.IMG	5/18/95	9:27:15	u	45.20	5.	0.	143.	491.
ML518098.IMG	5/18/95	9:27:27	u	48.10	5.	0.	10.	18975.
ML518099.IMG	5/18/95	9:27:43	h	47.40	2.	0.	287.	0.
ML518100.IMG	5/18/95	9:27:57	v	48.10	2.	0.	136.	1592.
ML518101.IMG	5/18/95	9:28:10	u	44.90	5.	0.	152.	26.
ML518102.IMG	5/18/95	9:28:23	u	48.10	5.	0.	8.	19054.
ML518103.IMG	5/18/95	9:29:35	h	47.60	2.	0.	349.	0.
ML518104.IMG	5/18/95	9:29:45	v	47.60	2.	0.	356.	0.
ML518105.IMG	5/18/95	9:30:01	u	44.70	5.	0.	188.	0.
ML518106.IMG	5/18/95	9:30:12	u	48.10	5.	0.	6.	19044.
ML518107.IMG	5/18/95	9:30:34	h	47.90	2.	0.	261.	0.
ML518108.IMG	5/18/95	9:30:50	v	48.10	2.	0.	159.	48.
ML518109.IMG	5/18/95	9:31:07	u	44.40	5.	0.	330.	0.
ML518110.IMG	5/18/95	9:31:18	u	48.10	5.	0.	3.	19039.
ML518111.IMG	5/18/95	9:32:17	h	47.40	2.	0.	270.	0.
ML518112.IMG	5/18/95	9:32:33	v	48.10	2.	0.	277.	0.
ML518113.IMG	5/18/95	9:32:46	u	44.90	5.	0.	166.	0.
ML518114.IMG	5/18/95	9:32:58	u	48.40	5.	0.	3.	19093.
ML518115.IMG	5/18/95	9:33:21	h	47.60	2.	0.	188.	0.
ML518116.IMG	5/18/95	9:33:30	v	47.60	2.	0.	310.	0.
ML518117.IMG	5/18/95	9:33:43	u	45.20	5.	0.	128.	720.
ML518118.IMG	5/18/95	9:33:53	u	47.90	5.	0.	4.	19028.
ML518119.IMG	5/18/95	9:41:01	h	47.40	2.	0.	289.	0.
ML518120.IMG	5/18/95	9:41:11	v	47.40	2.	0.	415.	0.
ML518121.IMG	5/18/95	9:41:26	u	44.70	5.	0.	203.	0.
ML518122.IMG	5/18/95	9:41:38	u	47.90	5.	0.	0.	19139.
ML518123.IMG	5/18/95	9:42:04	h	47.10	2.	0.	351.	0.
ML518124.IMG	5/18/95	9:42:19	v	47.90	2.	0.	182.	1.
ML518125.IMG	5/18/95	9:42:39	u	43.50	5.	0.	357.	0.
ML518126.IMG	5/18/95	9:42:50	u	47.90	5.	0.	0.	19181.
ML518127.IMG	5/18/95	9:44:23	h	47.10	2.	0.	26.	2593.
ML518128.IMG	5/18/95	9:44:31	v	47.10	2.	0.	217.	0.
ML518129.IMG	5/18/95	9:44:46	u	44.90	5.	0.	158.	0.
ML518130.IMG	5/18/95	9:44:56	u	47.90	5.	0.	0.	19137.
ML518131.IMG	5/18/95	9:45:15	h	46.90	2.	0.	276.	0.
ML518132.IMG	5/18/95	9:45:31	v	46.90	2.	0.	413.	0.
ML518133.IMG	5/18/95	9:45:43	u	44.00	5.	0.	279.	0.
ML518134.IMG	5/18/95	9:46:03	u	47.90	5.	0.	0.	19131.
ML518135.IMG	5/18/95	9:46:49	h	46.60	2.	0.	371.	0.
ML518136.IMG	5/18/95	9:47:01	v	47.10	2.	0.	211.	0.
ML518137.IMG	5/18/95	9:47:17	u	45.20	5.	0.	26.	6708.
ML518138.IMG	5/18/95	9:47:33	u	48.10	5.	0.	0.	19105.
ML518139.IMG	5/18/95	9:47:59	h	46.90	2.	0.	218.	0.

ML518140.IMG	5/18/95	9:48:17	v	47.10	2.	0.	206.	0.
ML518141.IMG	5/18/95	9:48:35	u	44.40	5.	0.	164.	0.
ML518142.IMG	5/18/95	9:48:46	u	47.90	5.	0.	0.	19140.
ML518143.IMG	5/18/95	9:50:12	h	46.90	2.	0.	153.	0.
ML518144.IMG	5/18/95	9:50:22	v	46.90	2.	0.	284.	0.
ML518145.IMG	5/18/95	9:50:38	u	44.40	5.	0.	223.	0.
ML518146.IMG	5/18/95	9:50:50	u	47.90	5.	0.	0.	19150.
ML518147.IMG	5/18/95	9:51:17	h	46.90	2.	0.	222.	0.
ML518148.IMG	5/18/95	9:51:28	v	46.90	2.	0.	323.	0.
ML518149.IMG	5/18/95	9:51:44	u	44.20	5.	0.	211.	0.
ML518150.IMG	5/18/95	9:51:52	u	47.90	5.	0.	0.	19068.
ML518151.IMG	5/18/95	9:53:29	h	46.60	2.	0.	363.	0.
ML518152.IMG	5/18/95	9:53:41	v	47.10	2.	0.	279.	0.
ML518153.IMG	5/18/95	9:53:54	u	45.20	5.	0.	92.	2094.
ML518154.IMG	5/18/95	9:54:03	u	47.90	5.	0.	0.	19037.
ML518155.IMG	5/18/95	9:54:34	h	46.60	2.	0.	181.	0.
ML518156.IMG	5/18/95	9:54:43	v	46.60	2.	0.	313.	0.
ML518157.IMG	5/18/95	9:54:55	u	44.70	5.	0.	132.	0.
ML518158.IMG	5/18/95	9:55:11	u	47.90	5.	0.	0.	19113.
ML518159.IMG	5/18/95	9:56:22	h	46.60	2.	0.	382.	0.
ML518160.IMG	5/18/95	9:56:39	v	47.60	2.	0.	177.	0.
ML518161.IMG	5/18/95	9:56:52	u	44.70	5.	0.	165.	0.
ML518162.IMG	5/18/95	9:57:04	u	47.60	5.	0.	0.	19151.
ML518163.IMG	5/18/95	9:57:26	h	47.40	2.	0.	211.	0.
ML518164.IMG	5/18/95	9:57:38	v	47.10	2.	0.	264.	0.
ML518165.IMG	5/18/95	9:57:49	u	44.70	5.	0.	196.	0.
ML518166.IMG	5/18/95	9:57:59	u	47.90	5.	0.	0.	19133.
ML518167.IMG	5/18/95	9:59:00	h	46.90	2.	0.	187.	0.
ML518168.IMG	5/18/95	9:59:08	v	46.90	2.	0.	315.	0.
ML518169.IMG	5/18/95	9:59:19	u	44.20	5.	0.	197.	0.
ML518170.IMG	5/18/95	9:59:28	u	47.90	5.	0.	0.	19161.
ML518171.IMG	5/18/95	9:59:50	h	46.90	2.	0.	296.	0.
ML518172.IMG	5/18/95	10:00:03	v	46.90	2.	0.	403.	0.
ML518173.IMG	5/18/95	10:00:15	u	44.70	5.	0.	96.	1658.
ML518174.IMG	5/18/95	10:00:23	u	47.90	5.	0.	0.	19135.
ML518175.IMG	5/18/95	10:01:51	h	47.10	2.	0.	247.	0.
ML518176.IMG	5/18/95	10:02:02	v	47.10	2.	0.	354.	0.
ML518177.IMG	5/18/95	10:02:19	u	44.40	5.	0.	234.	0.
ML518178.IMG	5/18/95	10:02:30	u	47.90	5.	0.	0.	19157.
ML518179.IMG	5/18/95	10:02:46	h	46.90	2.	0.	359.	0.
ML518180.IMG	5/18/95	10:02:59	v	46.90	2.	0.	525.	0.
ML518181.IMG	5/18/95	10:03:09	u	44.20	5.	0.	246.	0.
ML518182.IMG	5/18/95	10:03:18	u	47.90	5.	0.	0.	19139.
ML518183.IMG	5/18/95	10:04:41	h	47.10	2.	0.	273.	0.
ML518184.IMG	5/18/95	10:04:50	v	47.10	2.	0.	385.	0.
ML518185.IMG	5/18/95	10:05:01	u	44.00	5.	0.	257.	0.
ML518186.IMG	5/18/95	10:05:20	u	47.60	5.	0.	0.	19125.
ML518187.IMG	5/18/95	10:05:51	h	46.90	2.	0.	218.	0.
ML518188.IMG	5/18/95	10:06:00	v	47.10	2.	0.	328.	0.
ML518189.IMG	5/18/95	10:06:12	u	44.00	5.	0.	274.	0.
ML518190.IMG	5/18/95	10:06:26	u	47.90	5.	0.	0.	19076.
ML518191.IMG	5/18/95	10:07:28	h	47.10	2.	0.	306.	0.
ML518192.IMG	5/18/95	10:07:37	v	47.10	2.	0.	474.	0.
ML518193.IMG	5/18/95	10:07:47	u	44.20	5.	0.	283.	0.
ML518194.IMG	5/18/95	10:08:05	u	47.90	5.	0.	0.	19031.
ML518195.IMG	5/18/95	10:08:28	h	47.40	2.	0.	203.	0.
ML518196.IMG	5/18/95	10:08:51	v	47.40	2.	0.	334.	0.
ML518197.IMG	5/18/95	10:09:11	u	44.20	5.	0.	227.	0.
ML518198.IMG	5/18/95	10:09:21	u	47.60	5.	0.	0.	18984.
ML518199.IMG	5/18/95	10:18:06	h	47.40	2.	0.	196.	0.
ML518200.IMG	5/18/95	10:18:16	v	47.40	2.	0.	315.	0.
ML518201.IMG	5/18/95	10:18:28	u	44.20	5.	0.	216.	0.

ML518202.IMG	5/18/95	10:18:42	u	47.60	5.	0.	0.	19081.
ML518203.IMG	5/18/95	10:19:15	h	47.60	2.	0.	195.	0.
ML518204.IMG	5/18/95	10:19:23	v	47.60	2.	0.	327.	0.
ML518205.IMG	5/18/95	10:19:40	u	44.20	5.	0.	253.	0.
ML518206.IMG	5/18/95	10:19:50	u	48.10	5.	0.	0.	19040.
ML518207.IMG	5/18/95	10:21:31	x	47.40	2.	0.	163.	0.
ML518208.IMG	5/18/95	10:21:39	h	47.40	2.	0.	285.	0.
ML518209.IMG	5/18/95	10:21:54	v	44.90	5.	0.	160.	0.
ML518210.IMG	5/18/95	10:22:05	u	47.90	5.	0.	0.	19082.
ML518211.IMG	5/18/95	10:22:25	u	47.60	2.	0.	213.	0.
ML518212.IMG	5/18/95	10:22:33	h	47.60	2.	0.	350.	0.
ML518213.IMG	5/18/95	10:22:45	v	44.70	5.	0.	221.	0.
ML518214.IMG	5/18/95	10:22:59	u	48.10	5.	0.	0.	19097.
ML518215.IMG	5/18/95	10:24:56	u	47.40	2.	0.	155.	0.
ML518216.IMG	5/18/95	10:25:17	h	47.40	2.	0.	282.	0.
ML518217.IMG	5/18/95	10:26:10	v	47.40	2.	0.	308.	0.
ML518218.IMG	5/18/95	10:26:24	u	44.20	5.	0.	276.	0.
ML518219.IMG	5/18/95	10:26:33	u	48.40	5.	0.	0.	19162.
ML518220.IMG	5/18/95	10:26:48	h	46.60	2.	0.	996.	0.
ML518221.IMG	5/18/95	10:27:02	v	47.10	2.	0.	545.	0.
ML518222.IMG	5/18/95	10:27:15	u	43.70	5.	0.	323.	0.
ML518223.IMG	5/18/95	10:27:28	u	47.90	5.	0.	0.	19088.
ML518224.IMG	5/18/95	10:31:40	h	47.60	2.	0.	213.	0.
ML518225.IMG	5/18/95	10:31:58	h	48.80	2.	0.	0.	18994.
ML518226.IMG	5/18/95	10:32:14	v	47.60	2.	0.	316.	0.
ML518227.IMG	5/18/95	10:32:28	v	49.10	2.	0.	0.	19077.
ML519001.IMG	5/19/95	8:29:24	u	44.20	2.	0.	590.	14818.
ML522001.IMG	5/22/95	8:11:19	x	0.00	2.	0.	19600.	0.
ML522002.IMG	5/22/95	8:12:05	x	0.00	2.	0.	19600.	0.
ML522003.IMG	5/22/95	8:12:45	x	0.00	2.	0.	19600.	0.
ML522004.IMG	5/22/95	8:12:53	x	0.00	2.	0.	19600.	0.
ML522005.IMG	5/22/95	8:46:39	x	44.00	5.	3.	57.	0.
ML522006.IMG	5/22/95	8:47:30	u	43.70	2.	5.	658.	4493.
ML522007.IMG	5/22/95	8:48:05	h	45.90	2.	5.	103.	0.
ML522008.IMG	5/22/95	8:48:20	v	46.20	2.	5.	93.	0.
ML522009.IMG	5/22/95	8:49:06	u	44.90	5.	5.	128.	195.
ML522010.IMG	5/22/95	8:49:51	h	46.20	2.	5.	38.	304.
ML522011.IMG	5/22/95	8:50:07	v	46.20	2.	5.	40.	2.
ML522012.IMG	5/22/95	8:50:46	u	44.40	5.	5.	105.	10.
ML522013.IMG	5/22/95	8:52:25	h	45.70	2.	5.	458.	0.
ML522014.IMG	5/22/95	8:52:47	v	46.20	2.	5.	328.	0.
ML522015.IMG	5/22/95	8:53:00	u	44.90	5.	5.	277.	28.
ML522016.IMG	5/22/95	8:59:23	h	45.70	2.	5.	28.	0.
ML522017.IMG	5/22/95	8:59:30	v	45.70	2.	5.	31.	0.
ML522018.IMG	5/22/95	8:59:42	u	44.90	5.	5.	26.	2038.
ML522019.IMG	5/22/95	9:00:06	h	45.90	2.	5.	28.	5.
ML522020.IMG	5/22/95	9:00:11	v	45.90	2.	5.	30.	0.
ML522021.IMG	5/22/95	9:00:21	u	44.90	5.	5.	27.	3446.
ML522022.IMG	5/22/95	9:01:38	u	44.20	5.	5.	48.	6.
ML522023.IMG	5/22/95	9:01:58	h	46.40	2.	5.	22.	2704.
ML522024.IMG	5/22/95	9:02:03	v	46.40	2.	5.	28.	8.
ML522025.IMG	5/22/95	9:02:11	u	45.40	5.	5.	28.	9117.
ML522026.IMG	5/22/95	9:03:44	h	45.70	2.	5.	0.	0.
ML522027.IMG	5/22/95	9:03:50	v	45.70	2.	5.	0.	0.
ML522028.IMG	5/22/95	9:03:59	u	44.00	5.	5.	0.	3.
ML522029.IMG	5/22/95	9:04:21	h	45.70	2.	5.	0.	0.
ML522030.IMG	5/22/95	9:04:25	v	45.70	2.	5.	0.	0.
ML522031.IMG	5/22/95	9:04:39	u	44.00	5.	5.	0.	5.
ML522032.IMG	5/22/95	9:05:22	h	45.20	5.	5.	0.	0.
ML522033.IMG	5/22/95	9:05:26	v	45.20	5.	5.	0.	0.
ML522034.IMG	5/22/95	9:05:32	u	45.20	5.	5.	0.	3312.

ML522035.IMG	5/22/95	9:07:15	h	45.40	2.	5.	44.	0.
ML522036.IMG	5/22/95	9:07:22	v	45.40	2.	5.	43.	0.
ML522037.IMG	5/22/95	9:07:31	u	44.40	5.	5.	23.	9.
ML522038.IMG	5/22/95	9:07:52	h	45.70	2.	5.	14.	0.
ML522039.IMG	5/22/95	9:07:56	v	45.70	2.	5.	18.	0.
ML522040.IMG	5/22/95	9:08:06	u	44.00	5.	5.	12.	5.
ML522041.IMG	5/22/95	9:08:32	h	45.90	5.	5.	0.	0.
ML522042.IMG	5/22/95	9:08:35	v	45.90	5.	5.	0.	0.
ML522043.IMG	5/22/95	9:08:47	u	44.20	5.	5.	8.	9.
ML522044.IMG	5/22/95	9:16:02	h	45.90	2.	4.	7.	1.
ML522045.IMG	5/22/95	9:16:06	v	45.90	2.	4.	10.	0.
ML522046.IMG	5/22/95	9:16:18	u	44.40	5.	4.	14.	6.
ML522047.IMG	5/22/95	9:16:40	h	45.70	2.	4.	12.	0.
ML522048.IMG	5/22/95	9:16:44	v	45.70	2.	4.	15.	0.
ML522049.IMG	5/22/95	9:16:53	u	44.90	5.	4.	4.	4003.
ML522050.IMG	5/22/95	9:19:01	h	45.70	2.	4.	0.	1.
ML522051.IMG	5/22/95	9:19:06	v	45.70	2.	4.	0.	0.
ML522052.IMG	5/22/95	9:19:15	u	44.00	5.	4.	0.	6.
ML522053.IMG	5/22/95	9:19:31	h	45.90	2.	4.	0.	0.
ML522054.IMG	5/22/95	9:19:34	v	45.90	2.	4.	0.	0.
ML522055.IMG	5/22/95	9:19:41	u	44.20	5.	4.	0.	7.
ML522056.IMG	5/22/95	9:20:49	h	45.40	5.	4.	0.	0.
ML522057.IMG	5/22/95	9:21:01	v	45.40	5.	4.	0.	0.
ML522058.IMG	5/22/95	9:21:15	u	44.20	5.	4.	0.	8.
ML522059.IMG	5/22/95	9:22:23	h	45.40	2.	4.	8.	0.
ML522060.IMG	5/22/95	9:22:29	v	45.40	2.	4.	1.	0.
ML522061.IMG	5/22/95	9:22:39	u	44.40	5.	4.	0.	156.
ML522062.IMG	5/22/95	9:22:51	h	45.90	2.	4.	0.	0.
ML522063.IMG	5/22/95	9:22:55	v	45.90	2.	4.	0.	0.
ML522064.IMG	5/22/95	9:23:02	u	44.20	5.	4.	0.	8.
ML522065.IMG	5/22/95	9:26:48	h	45.90	2.	4.	4.	0.
ML522066.IMG	5/22/95	9:26:52	v	45.90	2.	4.	3.	0.
ML522067.IMG	5/22/95	9:29:34	h	46.40	2.	4.	6.	0.
ML522068.IMG	5/22/95	9:29:40	v	46.40	2.	4.	6.	0.
ML522069.IMG	5/22/95	9:29:51	u	44.90	5.	4.	5.	16.
ML522070.IMG	5/22/95	9:30:35	h	46.20	2.	4.	2.	0.
ML522071.IMG	5/22/95	9:30:39	v	46.20	2.	4.	4.	0.
ML522072.IMG	5/22/95	9:30:49	u	44.70	5.	4.	3.	1100.
ML522073.IMG	5/22/95	9:32:37	h	46.20	2.	4.	0.	0.
ML522074.IMG	5/22/95	9:32:41	v	46.20	2.	4.	0.	0.
ML522075.IMG	5/22/95	9:32:49	u	44.40	5.	4.	0.	13.
ML522076.IMG	5/22/95	9:33:05	h	46.40	2.	4.	0.	0.
ML522077.IMG	5/22/95	9:33:11	v	46.40	2.	4.	0.	0.
ML522078.IMG	5/22/95	9:33:23	u	44.20	5.	4.	0.	7.
ML522079.IMG	5/22/95	9:34:45	h	45.70	2.	4.	348.	0.
ML522080.IMG	5/22/95	9:34:49	v	45.70	2.	4.	1320.	0.
ML522081.IMG	5/22/95	9:34:56	u	44.20	5.	4.	0.	6.
ML522082.IMG	5/22/95	9:35:11	h	46.40	2.	4.	0.	0.
ML522083.IMG	5/22/95	9:35:14	v	46.40	2.	4.	0.	0.
ML522084.IMG	5/22/95	9:35:21	u	44.20	5.	4.	0.	7.
ML522085.IMG	5/22/95	9:45:03	h	46.40	2.	4.	0.	5.
ML522086.IMG	5/22/95	9:45:07	v	46.40	2.	4.	0.	0.
ML522087.IMG	5/22/95	9:45:15	u	44.90	5.	4.	0.	613.
ML522088.IMG	5/22/95	9:45:39	h	46.60	2.	4.	0.	1.
ML522089.IMG	5/22/95	9:45:43	v	46.60	2.	4.	0.	0.
ML522090.IMG	5/22/95	9:45:53	u	43.70	5.	4.	0.	1.
ML522091.IMG	5/22/95	9:47:46	h	46.20	2.	4.	0.	0.
ML522092.IMG	5/22/95	9:48:04	h	46.20	2.	4.	0.	0.
ML522093.IMG	5/22/95	9:48:12	v	46.20	2.	4.	0.	0.
ML522094.IMG	5/22/95	9:48:22	u	44.00	5.	4.	0.	2.
ML522095.IMG	5/22/95	9:48:46	x	46.40	2.	4.	0.	0.
ML522096.IMG	5/22/95	9:48:51	h	46.40	2.	4.	0.	0.

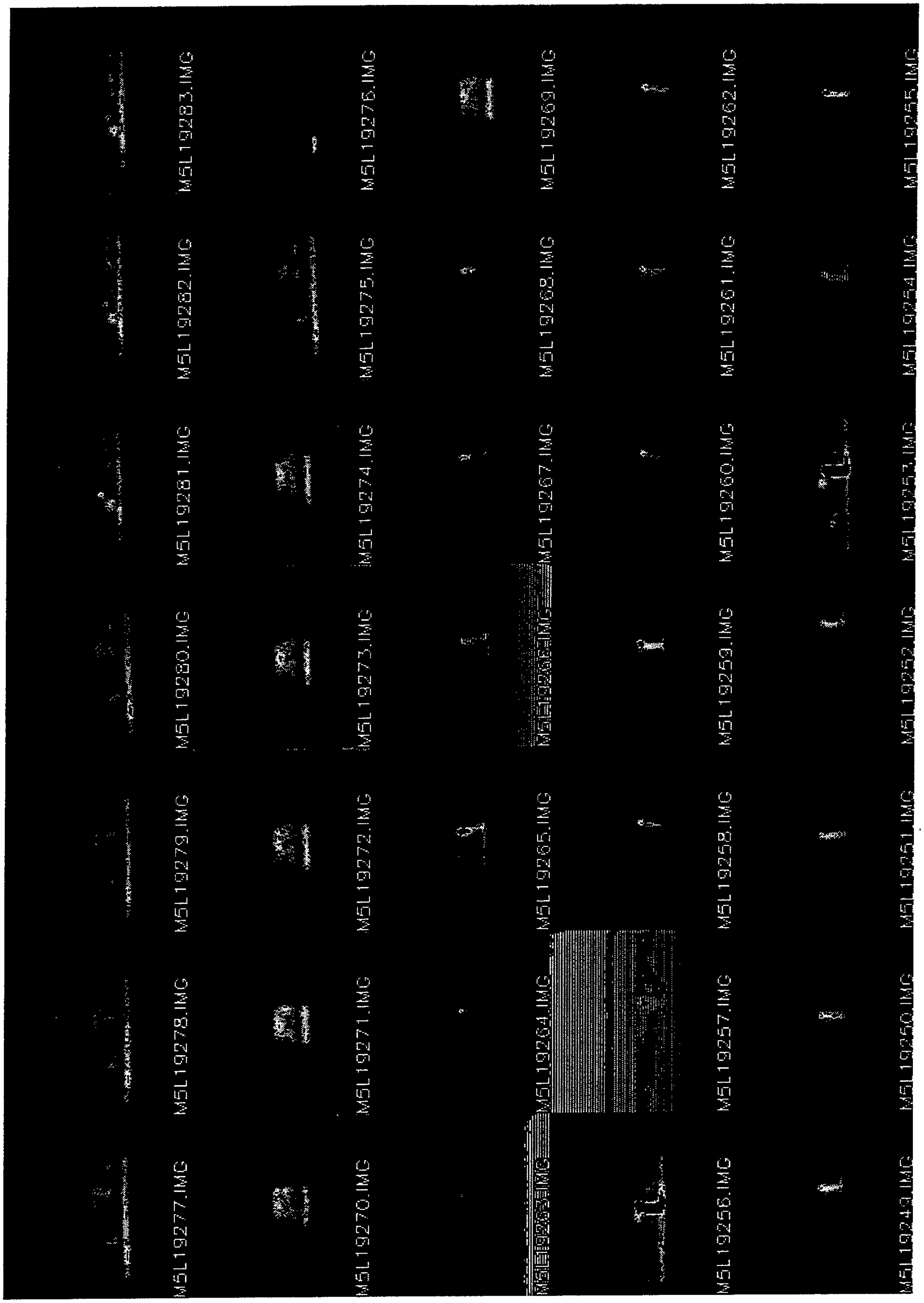
ML522097.IMG	5/22/95	9:49:27	v	46.20	2.	4.	0.	0.
ML522098.IMG	5/22/95	9:49:31	u	46.20	2.	4.	0.	0.
ML522099.IMG	5/22/95	9:49:45	u	44.00	2.	4.	703.	3311.
ML522100.IMG	5/22/95	9:51:20	h	45.90	2.	4.	0.	0.
ML522101.IMG	5/22/95	9:51:25	v	45.90	2.	4.	0.	0.
ML522102.IMG	5/22/95	9:51:37	u	43.70	2.	4.	894.	2818.
ML522103.IMG	5/22/95	9:51:53	h	46.20	2.	4.	0.	0.
ML522104.IMG	5/22/95	9:51:57	v	46.20	2.	4.	0.	0.
ML522105.IMG	5/22/95	9:52:07	u	44.20	2.	4.	156.	5117.
ML522106.IMG	5/22/95	10:36:07	h	47.10	2.	4.	0.	0.
ML522107.IMG	5/22/95	10:36:15	v	47.10	2.	4.	0.	0.
ML522108.IMG	5/22/95	10:36:32	v	46.90	2.	4.	0.	0.
ML522109.IMG	5/22/95	10:36:51	u	44.40	2.	4.	4.	6647.
ML522110.IMG	5/22/95	10:37:20	h	46.90	2.	4.	0.	0.
ML522111.IMG	5/22/95	10:37:25	v	46.40	2.	4.	0.	0.
ML522112.IMG	5/22/95	10:37:35	u	44.70	2.	4.	5.	6955.
ML522113.IMG	5/22/95	10:38:29	h	46.90	2.	4.	0.	0.
ML522114.IMG	5/22/95	10:38:33	v	46.90	2.	4.	0.	0.
ML522115.IMG	5/22/95	10:38:52	u	44.20	2.	4.	690.	3843.
ML522116.IMG	5/22/95	10:39:25	h	46.90	2.	4.	0.	0.
ML522117.IMG	5/22/95	10:39:29	v	46.90	2.	4.	0.	0.
ML522118.IMG	5/22/95	10:39:41	u	44.20	2.	4.	1143.	2748.
ML522119.IMG	5/22/95	10:41:09	h	46.90	2.	4.	0.	0.
ML522120.IMG	5/22/95	10:41:14	v	46.90	2.	4.	0.	0.
ML522121.IMG	5/22/95	10:41:25	u	44.20	2.	4.	434.	4618.
ML522122.IMG	5/22/95	10:41:40	h	47.10	2.	4.	0.	0.
ML522123.IMG	5/22/95	10:41:45	v	47.10	2.	4.	0.	0.
ML522124.IMG	5/22/95	10:41:56	u	44.40	2.	4.	436.	4469.
ML522125.IMG	5/22/95	10:50:27	h	47.40	2.	4.	0.	0.
ML522126.IMG	5/22/95	10:50:31	v	47.40	2.	4.	3.	0.
ML522127.IMG	5/22/95	10:50:58	u	44.70	2.	4.	365.	5244.
ML522128.IMG	5/22/95	10:51:11	h	47.10	2.	4.	4.	0.
ML522129.IMG	5/22/95	10:51:16	v	47.10	2.	4.	0.	0.
ML522130.IMG	5/22/95	10:51:27	u	44.90	2.	4.	1.	6435.
ML522131.IMG	5/22/95	10:53:00	h	47.10	2.	4.	0.	0.
ML522132.IMG	5/22/95	10:53:05	v	47.10	2.	4.	0.	0.
ML522133.IMG	5/22/95	10:53:14	u	43.70	2.	4.	1699.	1756.
ML522134.IMG	5/22/95	10:53:27	h	46.90	2.	4.	0.	0.
ML522135.IMG	5/22/95	10:53:32	v	46.90	2.	4.	0.	0.
ML522136.IMG	5/22/95	10:53:41	u	44.40	2.	4.	913.	3436.
ML522137.IMG	5/22/95	10:54:51	h	47.10	2.	4.	0.	0.
ML522138.IMG	5/22/95	10:54:58	v	47.10	2.	4.	0.	0.
ML522139.IMG	5/22/95	10:55:07	u	44.20	2.	4.	1175.	3080.
ML522140.IMG	5/22/95	10:55:21	h	47.10	2.	4.	0.	0.
ML522141.IMG	5/22/95	10:55:25	v	47.10	2.	4.	0.	0.
ML522142.IMG	5/22/95	10:55:33	u	44.70	2.	4.	465.	4504.
ML522143.IMG	5/22/95	11:05:25	h	47.10	2.	5.	0.	0.
ML522144.IMG	5/22/95	11:05:30	v	47.10	2.	5.	905.	0.
ML522145.IMG	5/22/95	11:05:42	u	44.40	2.	5.	1680.	4428.
ML522146.IMG	5/22/95	11:05:55	h	47.60	2.	5.	0.	1.
ML522147.IMG	5/22/95	11:06:00	v	47.60	2.	5.	0.	0.
ML522148.IMG	5/22/95	11:06:10	u	44.40	2.	5.	1569.	5269.
ML522149.IMG	5/22/95	11:08:39	h	47.40	2.	5.	0.	0.
ML522150.IMG	5/22/95	11:08:45	v	47.40	2.	5.	1141.	0.
ML522151.IMG	5/22/95	11:08:54	u	44.20	2.	5.	1784.	4135.
ML522152.IMG	5/22/95	11:09:10	h	47.40	2.	5.	32.	0.
ML522153.IMG	5/22/95	11:09:15	v	47.40	2.	5.	1116.	0.
ML522154.IMG	5/22/95	11:09:25	u	44.40	2.	5.	2206.	2276.
ML522155.IMG	5/22/95	11:11:18	h	47.90	2.	5.	0.	3.
ML522156.IMG	5/22/95	11:11:23	v	47.90	2.	5.	0.	0.
ML522157.IMG	5/22/95	11:11:34	u	44.90	2.	5.	1362.	6366.
ML522158.IMG	5/22/95	11:11:52	h	47.60	2.	5.	0.	1171.

ML522159.IMG	5/22/95	11:11:59	v	47.60	2.	5.	87.	2.
ML522160.IMG	5/22/95	11:12:09	u	44.40	2.	5.	1591.	5267.
ML522161.IMG	5/22/95	11:19:45	u	44.40	5.	4.	0.	0.
ML522162.IMG	5/22/95	11:22:19	h	47.90	2.	4.	0.	1.
ML522163.IMG	5/22/95	11:22:24	v	47.90	2.	4.	0.	0.
ML522164.IMG	5/22/95	11:22:54	u	44.20	2.	4.	1559.	4086.
ML522165.IMG	5/22/95	11:23:17	h	48.10	2.	4.	0.	2872.
ML522166.IMG	5/22/95	11:23:25	v	48.10	2.	4.	0.	453.
ML522167.IMG	5/22/95	11:23:42	u	44.20	2.	4.	1624.	3923.
ML522168.IMG	5/22/95	11:25:56	h	47.60	2.	4.	0.	0.
ML522169.IMG	5/22/95	11:26:04	v	47.60	2.	4.	222.	0.
ML522170.IMG	5/22/95	11:26:19	u	44.40	2.	4.	1571.	4456.
ML522171.IMG	5/22/95	11:26:34	h	48.10	2.	4.	0.	15.
ML522172.IMG	5/22/95	11:26:41	v	48.10	2.	4.	0.	0.
ML522173.IMG	5/22/95	11:27:16	u	44.40	2.	4.	1563.	4540.
ML522174.IMG	5/22/95	11:28:27	h	47.60	2.	4.	0.	0.
ML522175.IMG	5/22/95	11:28:32	v	47.60	2.	4.	0.	0.
ML522176.IMG	5/22/95	11:28:45	u	44.20	2.	4.	1685.	3660.
ML522177.IMG	5/22/95	11:28:55	h	47.60	2.	4.	0.	0.
ML522178.IMG	5/22/95	11:29:06	v	47.60	2.	4.	0.	0.
ML522179.IMG	5/22/95	11:29:23	u	44.40	2.	4.	1616.	3858.
ML522180.IMG	5/22/95	11:38:45	h	47.60	2.	4.	0.	0.
ML522181.IMG	5/22/95	11:38:50	v	47.60	2.	4.	48.	0.
ML522182.IMG	5/22/95	11:39:32	u	44.20	2.	4.	2671.	1650.
ML522183.IMG	5/22/95	11:40:07	h	47.90	2.	4.	6.	0.
ML522184.IMG	5/22/95	11:40:13	v	47.90	2.	4.	14.	0.
ML522185.IMG	5/22/95	11:40:40	u	44.20	2.	4.	2477.	2106.
ML522186.IMG	5/22/95	11:41:18	h	47.90	2.	4.	0.	0.
ML522187.IMG	5/22/95	11:42:27	h	47.90	2.	4.	0.	0.
ML522188.IMG	5/22/95	11:42:32	v	47.90	2.	4.	1439.	0.
ML522189.IMG	5/22/95	11:42:48	u	44.40	2.	4.	2444.	2373.
ML522190.IMG	5/22/95	11:42:59	h	47.40	2.	4.	680.	0.
ML522191.IMG	5/22/95	11:43:03	v	47.40	2.	4.	2100.	0.
ML522192.IMG	5/22/95	11:43:19	u	44.40	2.	4.	2758.	1550.
ML522193.IMG	5/22/95	11:45:42	h	48.10	2.	4.	94.	0.
ML522194.IMG	5/22/95	11:45:47	v	48.10	2.	4.	1368.	0.
ML522195.IMG	5/22/95	11:46:01	u	44.40	2.	4.	3018.	1394.
ML522196.IMG	5/22/95	11:46:24	h	48.10	2.	4.	0.	0.
ML522197.IMG	5/22/95	11:46:31	v	48.10	2.	4.	1044.	0.
ML522198.IMG	5/22/95	11:46:44	u	44.40	2.	4.	2599.	2265.
ML523001.IMG	5/23/95	8:40:42	x	44.90	2.	4.	0.	0.
ML523002.IMG	5/23/95	8:41:30	x	44.90	2.	4.	0.	0.
ML523003.IMG	5/23/95	8:42:28	x	44.90	2.	4.	0.	0.
ML523004.IMG	5/23/95	8:42:36	x	44.90	2.	4.	580.	0.
ML523005.IMG	5/23/95	8:43:07	x	45.20	2.	4.	0.	0.
ML523006.IMG	5/23/95	8:43:18	v	45.20	2.	4.	0.	0.
ML523007.IMG	5/23/95	8:43:36	u	43.70	2.	4.	0.	6091.
ML523008.IMG	5/23/95	8:44:52	h	45.20	2.	4.	0.	0.
ML523009.IMG	5/23/95	8:44:59	v	45.20	2.	4.	706.	0.
ML523010.IMG	5/23/95	8:45:06	u	43.50	2.	4.	70.	1.
ML523011.IMG	5/23/95	8:45:23	h	45.90	2.	4.	0.	0.
ML523012.IMG	5/23/95	8:45:28	v	45.90	2.	4.	0.	0.
ML523013.IMG	5/23/95	8:45:40	u	43.50	2.	4.	645.	0.
ML523014.IMG	5/23/95	8:45:58	h	45.70	2.	4.	0.	0.
ML523015.IMG	5/23/95	8:46:03	v	45.70	2.	4.	0.	0.
ML523016.IMG	5/23/95	8:46:13	u	43.50	2.	4.	6.	641.
ML523017.IMG	5/23/95	8:46:26	h	45.90	2.	4.	0.	0.
ML523018.IMG	5/23/95	8:46:30	v	45.90	2.	4.	0.	0.
ML523019.IMG	5/23/95	8:46:38	u	43.50	2.	4.	15.	368.
ML523020.IMG	5/23/95	8:46:51	h	45.90	2.	4.	0.	0.
ML523021.IMG	5/23/95	8:46:55	v	45.90	2.	4.	0.	0.
ML523022.IMG	5/23/95	8:47:04	u	43.50	2.	4.	49.	185.

ML523023.IMG	5/23/95	8:47:19	h	45.70	2.	4.	0.	0.
ML523024.IMG	5/23/95	8:47:24	v	45.70	2.	4.	0.	0.
ML523025.IMG	5/23/95	8:47:36	u	43.50	2.	4.	0.	867.
ML523026.IMG	5/23/95	8:47:55	u	43.70	2.	4.	0.	4578.
ML523027.IMG	5/23/95	8:48:40	h	46.20	2.	4.	0.	0.
ML523028.IMG	5/23/95	8:48:46	v	46.20	2.	4.	0.	0.
ML523029.IMG	5/23/95	8:48:59	u	43.20	2.	4.	437.	0.
ML523030.IMG	5/23/95	8:49:14	u	44.00	5.	4.	0.	0.
ML523031.IMG	5/23/95	8:49:51	h	45.40	2.	4.	0.	0.
ML523032.IMG	5/23/95	8:49:59	v	45.40	2.	4.	0.	0.
ML523033.IMG	5/23/95	8:50:09	u	43.20	2.	4.	0.	3674.
ML523034.IMG	5/23/95	8:50:35	u	42.70	5.	4.	3.	0.
ML523035.IMG	5/23/95	8:51:55	h	46.40	2.	4.	0.	0.
ML523036.IMG	5/23/95	8:51:58	v	46.40	2.	4.	0.	0.
ML523037.IMG	5/23/95	8:52:10	u	43.20	5.	4.	3.	0.
ML523038.IMG	5/23/95	8:55:08	h	46.20	2.	4.	51.	0.
ML523039.IMG	5/23/95	8:55:12	v	46.20	2.	4.	43.	0.
ML523040.IMG	5/23/95	8:55:25	u	44.00	2.	4.	26.	4667.
ML523041.IMG	5/23/95	8:55:37	h	46.40	2.	4.	15.	0.
ML523042.IMG	5/23/95	8:55:41	v	46.40	2.	4.	13.	0.
ML523043.IMG	5/23/95	8:55:53	u	43.70	2.	4.	141.	29.
ML523044.IMG	5/23/95	8:56:45	h	46.20	2.	4.	91.	0.
ML523045.IMG	5/23/95	8:56:49	v	46.20	2.	4.	84.	0.
ML523046.IMG	5/23/95	8:57:02	u	44.20	2.	4.	125.	10888.
ML523047.IMG	5/23/95	8:57:21	h	46.40	2.	4.	72.	0.
ML523048.IMG	5/23/95	8:57:26	v	46.40	2.	4.	54.	0.
ML523049.IMG	5/23/95	8:57:47	u	44.40	5.	4.	50.	0.
ML523050.IMG	5/23/95	8:58:55	h	45.90	2.	4.	0.	0.
ML523051.IMG	5/23/95	8:58:59	v	45.90	2.	4.	0.	0.
ML523052.IMG	5/23/95	8:59:10	u	43.70	2.	4.	15.	5544.
ML523053.IMG	5/23/95	8:59:26	h	46.20	2.	4.	7.	0.
ML523054.IMG	5/23/95	8:59:29	v	46.20	2.	4.	16.	0.
ML523055.IMG	5/23/95	8:59:39	u	43.50	2.	4.	90.	2710.
ML523056.IMG	5/23/95	9:00:51	h	45.20	2.	4.	2.	0.
ML523057.IMG	5/23/95	9:00:55	v	45.90	2.	4.	2.	0.
ML523058.IMG	5/23/95	9:01:07	u	43.50	5.	4.	11.	0.
ML523059.IMG	5/23/95	9:01:33	h	46.20	2.	4.	0.	0.
ML523060.IMG	5/23/95	9:01:37	v	46.20	2.	4.	0.	0.
ML523061.IMG	5/23/95	9:01:46	u	44.20	5.	4.	1.	0.
ML523062.IMG	5/23/95	9:03:27	h	46.60	2.	4.	9.	0.
ML523063.IMG	5/23/95	9:03:31	v	46.60	2.	4.	8.	0.
ML523064.IMG	5/23/95	9:03:49	u	46.90	2.	4.	8.	0.
ML523065.IMG	5/23/95	9:03:53	h	46.90	2.	4.	17.	0.
ML523066.IMG	5/23/95	9:03:59	v	44.40	5.	4.	17.	0.
ML523067.IMG	5/23/95	9:06:03	x	46.20	2.	4.	112.	0.
ML523068.IMG	5/23/95	9:06:47	h	46.60	2.	4.	138.	0.
ML523069.IMG	5/23/95	9:06:51	v	46.60	2.	4.	247.	0.
ML523070.IMG	5/23/95	9:06:58	u	44.90	5.	4.	94.	0.
ML523071.IMG	5/23/95	9:07:18	h	46.60	2.	4.	105.	0.
ML523072.IMG	5/23/95	9:07:22	v	46.60	2.	4.	139.	0.
ML523073.IMG	5/23/95	9:07:28	u	45.20	5.	4.	112.	0.
ML523074.IMG	5/23/95	9:12:35	h	46.60	2.	4.	20.	0.
ML523075.IMG	5/23/95	9:12:40	v	46.60	2.	4.	25.	0.
ML523076.IMG	5/23/95	9:12:49	u	44.90	5.	4.	18.	0.
ML523077.IMG	5/23/95	9:13:03	h	46.90	2.	4.	17.	0.
ML523078.IMG	5/23/95	9:13:07	v	46.90	2.	4.	15.	0.
ML523079.IMG	5/23/95	9:13:14	u	44.70	5.	4.	20.	0.
ML523080.IMG	5/23/95	9:14:44	h	46.60	2.	4.	17.	0.
ML523081.IMG	5/23/95	9:14:48	v	46.60	2.	4.	18.	0.
ML523082.IMG	5/23/95	9:14:55	u	44.20	5.	4.	17.	0.
ML523083.IMG	5/23/95	9:15:10	h	47.40	2.	4.	13.	12862.
ML523084.IMG	5/23/95	9:15:15	v	47.40	2.	4.	8.	6333.

ML523085.IMG	5/23/95	9:15:31	u	44.70	5.	4.	19.	0.
ML523086.IMG	5/23/95	9:16:49	h	46.60	2.	4.	60.	0.
ML523087.IMG	5/23/95	9:16:56	v	46.60	2.	4.	65.	0.
ML523088.IMG	5/23/95	9:17:05	u	43.70	5.	4.	61.	0.
ML523089.IMG	5/23/95	9:17:23	h	47.60	5.	4.	4.	0.
ML523090.IMG	5/23/95	9:17:27	v	47.60	5.	4.	3.	0.
ML523091.IMG	5/23/95	9:17:36	u	45.20	5.	4.	30.	0.
ML523092.IMG	5/23/95	9:18:06	h	46.60	2.	4.	50.	0.
ML523093.IMG	5/23/95	9:18:10	v	46.60	2.	4.	51.	0.
ML523094.IMG	5/23/95	9:18:23	u	44.40	2.	4.	169.	5022.
ML523095.IMG	5/23/95	9:18:38	h	46.90	5.	4.	5.	0.
ML523096.IMG	5/23/95	9:18:41	v	46.90	5.	4.	7.	0.
ML523097.IMG	5/23/95	9:18:54	u	44.70	5.	4.	36.	0.
ML523098.IMG	5/23/95	9:21:24	h	46.90	2.	4.	51.	1816.
ML523099.IMG	5/23/95	9:21:30	v	46.90	2.	4.	57.	7.
ML523100.IMG	5/23/95	9:21:42	u	44.20	2.	4.	140.	5186.
ML523101.IMG	5/23/95	9:22:13	h	48.10	5.	4.	2.	0.
ML523102.IMG	5/23/95	9:22:20	v	47.90	5.	4.	1.	0.
ML523103.IMG	5/23/95	9:22:27	u	47.90	5.	4.	0.	0.
ML523104.IMG	5/23/95	9:24:23	h	46.60	2.	4.	0.	0.
ML523105.IMG	5/23/95	9:24:29	v	46.60	2.	4.	0.	0.
ML523106.IMG	5/23/95	9:24:39	u	44.20	2.	4.	15.	11760.
ML523107.IMG	5/23/95	9:25:00	h	46.20	5.	4.	0.	0.
ML523108.IMG	5/23/95	9:25:04	v	46.20	5.	4.	0.	0.
ML523109.IMG	5/23/95	9:25:14	u	45.20	5.	4.	0.	76.
ML523110.IMG	5/23/95	9:25:50	h	46.90	2.	4.	0.	0.
ML523111.IMG	5/23/95	9:25:55	v	46.90	2.	4.	0.	0.
ML523112.IMG	5/23/95	9:26:08	u	44.70	2.	4.	20.	14006.
ML523113.IMG	5/23/95	9:26:26	h	46.20	5.	4.	0.	0.
ML523114.IMG	5/23/95	9:27:16	v	46.20	5.	4.	0.	0.
ML523115.IMG	5/23/95	9:27:35	u	44.90	5.	4.	0.	0.
ML523116.IMG	5/23/95	9:34:15	h	46.90	2.	4.	8.	0.
ML523117.IMG	5/23/95	9:34:20	v	46.90	2.	4.	7.	0.
ML523118.IMG	5/23/95	9:34:29	u	44.20	2.	4.	42.	9600.
ML523119.IMG	5/23/95	9:34:45	h	46.60	5.	4.	0.	0.
ML523120.IMG	5/23/95	9:34:51	v	46.60	5.	4.	0.	0.
ML523121.IMG	5/23/95	9:35:01	u	44.90	5.	4.	4.	0.
ML523122.IMG	5/23/95	9:35:17	h	47.10	2.	4.	0.	5.
ML523123.IMG	5/23/95	9:35:22	v	47.10	2.	4.	0.	0.
ML523124.IMG	5/23/95	9:35:35	u	44.00	2.	4.	51.	5609.
ML523125.IMG	5/23/95	9:35:49	h	46.90	5.	4.	0.	0.
ML523126.IMG	5/23/95	9:35:55	v	46.90	5.	4.	0.	0.
ML523127.IMG	5/23/95	9:36:02	u	44.70	5.	4.	8.	0.
ML523128.IMG	5/23/95	9:37:51	h	46.60	2.	4.	8.	0.
ML523129.IMG	5/23/95	9:37:56	v	46.60	2.	4.	6.	0.
ML523130.IMG	5/23/95	9:38:05	u	44.40	2.	4.	50.	4467.
ML523131.IMG	5/23/95	9:38:20	h	46.40	5.	4.	0.	0.
ML523132.IMG	5/23/95	9:38:25	v	46.40	5.	4.	0.	0.
ML523133.IMG	5/23/95	9:38:33	u	44.90	5.	4.	6.	0.
ML523134.IMG	5/23/95	9:39:00	h	46.90	2.	4.	8.	0.
ML523135.IMG	5/23/95	9:39:05	v	46.90	2.	4.	10.	0.
ML523136.IMG	5/23/95	9:39:16	u	44.40	2.	4.	52.	5733.
ML523137.IMG	5/23/95	9:39:38	h	46.60	5.	4.	0.	0.
ML523138.IMG	5/23/95	9:39:43	v	46.60	5.	4.	0.	0.
ML523139.IMG	5/23/95	9:39:51	u	44.70	5.	4.	6.	0.
ML523140.IMG	5/23/95	9:41:35	h	46.20	2.	4.	0.	0.
ML523141.IMG	5/23/95	9:41:41	v	46.20	2.	4.	0.	0.
ML523142.IMG	5/23/95	9:41:52	u	44.20	2.	4.	0.	5646.
ML523143.IMG	5/23/95	9:42:08	h	47.40	5.	4.	0.	0.
ML523144.IMG	5/23/95	9:42:35	v	45.70	5.	4.	0.	0.
ML523145.IMG	5/23/95	9:42:47	u	44.40	5.	4.	0.	0.
ML523146.IMG	5/23/95	9:43:14	h	46.40	2.	4.	0.	0.

ML523147.IMG	5/23/95	9:43:20	v	46.40	2.	4.	0.	0.
ML523148.IMG	5/23/95	9:43:31	u	44.20	2.	4.	9.	3930.
ML523149.IMG	5/23/95	9:43:51	h	46.60	5.	4.	0.	0.
ML523150.IMG	5/23/95	9:43:55	v	46.60	5.	4.	0.	0.
ML523151.IMG	5/23/95	9:44:06	u	44.70	5.	4.	0.	0.
ML523152.IMG	5/23/95	9:45:20	h	46.60	2.	4.	0.	0.
ML523153.IMG	5/23/95	9:45:25	v	46.60	2.	4.	0.	0.
ML523154.IMG	5/23/95	9:45:35	u	44.70	2.	4.	0.	15194.
ML523155.IMG	5/23/95	9:46:04	h	46.60	5.	4.	0.	0.
ML523156.IMG	5/23/95	9:46:08	v	46.60	5.	4.	0.	0.
ML523157.IMG	5/23/95	9:46:16	u	44.70	5.	4.	0.	0.
ML523158.IMG	5/23/95	9:46:31	h	46.60	2.	4.	0.	0.
ML523159.IMG	5/23/95	9:46:55	v	46.60	2.	4.	0.	0.
ML523160.IMG	5/23/95	9:47:06	u	44.00	2.	4.	0.	4592.
ML523161.IMG	5/23/95	9:47:20	h	46.40	5.	4.	0.	0.
ML523162.IMG	5/23/95	9:47:25	v	46.40	5.	4.	0.	0.
ML523163.IMG	5/23/95	9:47:32	u	43.50	5.	4.	0.	0.
ML523164.IMG	5/23/95	9:50:03	h	47.10	2.	4.	8.	0.
ML523165.IMG	5/23/95	9:50:07	v	46.90	2.	4.	6.	0.
ML523166.IMG	5/23/95	9:50:17	u	44.20	2.	4.	31.	8449.
ML523167.IMG	5/23/95	9:50:33	h	47.40	5.	4.	0.	0.
ML523168.IMG	5/23/95	9:52:10	x	47.10	2.	4.	2.	0.
ML523169.IMG	5/23/95	9:52:21	x	47.10	2.	4.	2.	0.
ML523170.IMG	5/23/95	9:52:39	u	44.20	2.	4.	27.	9110.
ML523171.IMG	5/23/95	9:52:58	h	47.10	5.	4.	0.	0.
ML523172.IMG	5/23/95	9:53:07	v	47.10	5.	4.	0.	0.
ML523173.IMG	5/23/95	9:53:14	u	44.70	5.	4.	9.	0.
ML523174.IMG	5/23/95	9:54:48	h	46.60	2.	4.	37.	0.
ML523175.IMG	5/23/95	9:55:01	v	47.40	2.	4.	20.	0.
ML523176.IMG	5/23/95	9:55:13	u	44.20	2.	4.	49.	4731.
ML523177.IMG	5/23/95	9:55:29	h	47.40	5.	4.	0.	0.
ML523178.IMG	5/23/95	9:55:33	v	47.40	5.	4.	0.	0.
ML523179.IMG	5/23/95	9:55:45	u	45.40	5.	4.	22.	11.
ML523180.IMG	5/23/95	9:55:58	h	46.90	2.	4.	27.	0.
ML523181.IMG	5/23/95	9:56:07	v	46.90	2.	4.	27.	0.
ML523182.IMG	5/23/95	9:56:15	u	44.40	2.	4.	60.	6657.
ML523183.IMG	5/23/95	9:56:34	h	47.10	5.	4.	0.	0.
ML523184.IMG	5/23/95	9:56:38	v	47.10	5.	4.	0.	0.
ML523185.IMG	5/23/95	9:56:47	u	45.20	5.	4.	28.	0.
ML523186.IMG	5/23/95	9:57:49	h	47.10	2.	4.	24.	427.
ML523187.IMG	5/23/95	9:57:54	v	47.10	2.	4.	25.	0.
ML523188.IMG	5/23/95	9:58:07	u	44.20	2.	4.	134.	398.
ML523189.IMG	5/23/95	9:58:20	h	46.60	5.	4.	0.	0.
ML523190.IMG	5/23/95	9:58:24	v	46.60	5.	4.	0.	0.
ML523191.IMG	5/23/95	9:58:32	x	45.20	5.	4.	25.	0.



M5L19277.IMG
M5L19278.IMG
M5L19279.IMG
M5L19280.IMG
M5L19281.IMG
M5L19282.IMG
M5L19283.IMG
M5L19270.IMG
M5L19271.IMG
M5L19272.IMG
M5L19273.IMG
M5L19274.IMG
M5L19275.IMG
M5L19276.IMG
M5L19264.IMG
M5L19265.IMG
M5L19267.IMG
M5L19268.IMG
M5L19269.IMG
M5L19256.IMG
M5L19257.IMG
M5L19258.IMG
M5L19259.IMG
M5L19260.IMG
M5L19261.IMG
M5L19262.IMG
M5L19249.IMG
M5L19250.IMG
M5L19251.IMG
M5L19252.IMG
M5L19253.IMG
M5L19254.IMG
M5L19255.IMG

APPENDIX F. IDL IMAGE PROCESSING CODES

The following programs are used to determine TBRD automatically from a file which contains all the specific information about a target. The desired information is shown in the file compilation of image names in Appendix E.

Also the IDL code to subtract the two split-images is contained in this appendix. The file headers denote the use of the code and the code itself is commented to provide its own detailed explanation.

```
;flira12.pro processes a single ship for contrast using sreadpol to get
filenames from
;experiment flir12
;Pete version that uses new contrast with no denominator
;taken from flira8 which selects files directly

;2-17-95 revised x0,ix for x0 always to be peak. changed shipbox to find
peak if the
;new peak selected with the cursor is eliminated by the threshold
;x0,y0          peak value in contiguous area
;ix,iy,nx,ny    box coordinates
;ship           temperature ship
;shipb          raw data ship
;yc             horizon line point
;hz             iy-yc    location of divisor in ship box
;**********************************************************************
*******************
;routines readflir,shipbox,thresh,remake,fileonly,sreadpol used
;readflir  reads file data from flir format
;horizon   allows choice of horizon, formerly profiles
;shipbox   finds contiguous ship and makes ship box
;threshld  finds and returns edge threshold thresh from yy and t as well
as peak x0,y0
;remake    uses threshold thresh0 to make ship and shipb from t and yy
;fileonly  separates filename from file and path for output
;sreadpol  reads polarization file and separates h or v in variable pol

!order=0                                        ;get rid of old program
inverision
iscale=2                                        ;display 2x size

on_ioerror,problem                              ;if error, quit program
;**********************************************************************
********************
;select the files with wild cards
path1=''
file=path1
if(n_elements(path) ne 0) then print,'oldpath= ',path
read,'input path for files or cr for oldpath',path1
if(path1 ne '') then path=path1+'\'  else path='.'
if(strmid(path,strlen(path)-1,1) ne '\') then path=path+'\'        ;fix
oldpath error
read,'input filename of polarization information',file
sreadpol,file,files,pol                         ;get files from flir11p
made separately
files=path+files                                ;put files in standard
findfile format
filelist,files,path                             ;program to list
filenames that are different
;for i=0,num-1 do print,files(i),i              ;print the filenames with
a number
i=''
RESTART: read,'Input start and stop number for processing CR to stop',i
if strlen(i) eq 0 then goto, finish
istart=fix(i)
istop=istart
read,'Stop number ',istop
```

```
C5N=DBLARR((ISTOP-ISTART+1),3) ;The first z is full box, second, above
horiz, third below
read,'input first guess difference t level, eg 1 to include all of
ship',tdif
;*********************************************************************
*******************
close,2
fileout='                                              '
read,'input output filename for contrast results',fileout
openw,2,fileout
printf,2,systime(),'  date of analysis'
printf,2,istop-istart+1,'   number of files'
;*********************************************************************
*******************
auto='     '
read,'input CR for semi-automatic proccessing', auto
tdifsave=tdif                          ;save tdif so that changes will
not affect batch
printf,2,'Temperature difference = ',tdif          ;save in a file
;tdif,nx,ny,yc,iy
printf,2,'file1,tdif,nx,ny,yc(horizon),iy(ship bottom),Polarization'
for i=istart, istop do begin       ;ii = first of pair
   tdif=tdifsave                       ;restore the temperature to the
original batch value
   f=files(i)
   file=f                              ;save the name
   readflir,f,yy,t,bar,tt,head         ;read flir data, convert to
temperature, add bar
;****************************display the raw
data*****************************************
       loadct,0                        ;set color table 0
       iscale=2                        ;make pictures twice their normal
size
       ;remove the path length from the file string and label the tv
image with the filename
       pathlen=strlen(path)+1
       filelen=strlen(file)
       labelen=filelen-pathlen
       label=strmid(file,pathlen,labelen)
window,0,xsize=140*iscale,ysize=140*iscale+50,xpos=0,ypos=0,title='0
'+label
tvscl,rebin(tt,140*iscale,165*iscale)  ;display the image
;********************************************End of temperature
display********************
window,2,xpos=0,ypos=165*iscale+35,xsize=140*iscale,ysize=140*iscale

print,'choose horizon with left button or reject picture with right'
tvscl,rebin(yy,140*iscale,140*iscale)                    ;display the
binary image raw
HORIZON,smooth(rebin(yy,140*iscale,140*iscale),5),xc,yc    ;read cursor
position
if(!err eq 4) then goto, skiploop                        ;skip
processing of file
xc=xc/iscale
yc=yc/iscale                                             ;scale to 140
size not picture size
print,'xc,yc= ',xc,yc
;****************************threshold with temperature
difference***************************
```

```
threshld,t,yy,thres0,x0,y0                                          ;define
thres and find x0,y0 peak

;RESHIP RESTORES THE VARIABLES MODIFED BY SHIPBOX, NOT THRESH
errorct=0                                                 ;don't allow infinite
loopes of choices
;***************************************RESHIP**************************
*********************
reship:
remake,ship,shipb,t,yy,thres0                             ;remake the
thresholded ship and shipb using thres0
tvscl,rebin(shipb,140*iscale,140*iscale)                  ;display the binary
image raw
tvcrs,x0*iscale,y0*iscale                                 ;cursor on hot spot
shipbox,shipb,ship,x0,y0,ix,iy,nx,ny,iscale               ;ix,iy,nx,ny define
ship box contiguous
           ;  WARNING ALL VARIABLES EXCEPT ISCALE ARE CHANGED IN THIS
CALL
boxdraw,ix*iscale,iy*iscale,nx*iscale,ny*iscale           ;show where the box
is in *iscale
tvcrs,x0*iscale,y0*iscale,/device                         ;put the cursor on
the peak location
;**********************************************************************
*********************
;***above makes box with minimum
threshold**************************************************
!ERR=4
;if(auto ne '' or errorct gt 0) then begin                ;suspend auto only
for errors
   print,'right button, use auto position, left, new cursor position'
   cursor,ixnew,iynew,/device,/down                            ;when pushed,
choose
   print,'!ERR= ',!ERR
   if(!ERR eq 4) then print,'auto selected'
   if(!ERR eq 1) then begin
       x0=ixnew/iscale
       y0=iynew/iscale
       print,'new peak at ',x0,y0                                   ;NEW peak
at x0,y0
       remake,ship,shipb,t,yy,thres0                          ;if not
remade, the shipbox will have destroyed shipb
       ;WARNING SHIPBOX DESTROYS SHIPB AND SHIP
       shipbox,shipb,ship,x0,y0,ix,iy,nx,ny,iscale            ;ix,iy,nx,ny
define ship box contiguous
       boxdraw,ix*iscale,iy*iscale,nx*iscale,ny*iscale        ;show where
the box is in *iscale
   endif
;endif                                                        ;semiauto is
two button pushes now

;*****************IF THE HOT SPOT IS FOUND DO LOCAL THRESHOLD IN THE
BOX***************
remake,ship,shipb,t,yy,thres0+tdif                             ;remake with full
threshold
print,'redisplay with full threshold'
shipbox,shipb,ship,x0,y0,ix,iy,nx,ny,iscale                    ;x0,y0,nx,ny
define ship box contiguous
tvscl,rebin(shipb,140*iscale,140*iscale)
boxdraw,ix*iscale,iy*iscale,nx*iscale,ny*iscale
```

```
tvcrs,ix,iy                                           ;place the cursor on
the max for a check
print,'cursor on maximum'
;*************************find a new shipbox based on threshold and
tdif******************

if(total(shipb) eq 0) then begin                      ;if data is all zero,
threshold did not work
       errorct = errorct+1                            ;avoid an infinite
loop
       print,'no ship was found. Data is not usable with this tdif',tdif
       if(errorct gt 2) then begin
           print,' skipping ',file
           goto, skiploop
       endif
       read,'input new tdif',tdif
;      auto=' '                                       ;suspend auto
permanently on first error
       goto, reship

endif

tdiff=''
print,'tdif= ',tdif
tdiff=''
if(auto ne '' or errorct gt 0) then $
read,'input new tdif or CR for old or negative to skip',tdiff
if(strlen(tdiff) eq 0) then tdiff=tdif else begin
   tdif=float(tdiff)
   if(tdif lt 0) then goto, skiploop
   goto,reship
endelse
;

;***********************************************************************
********************

;choices section checks to see which picture is larger and uses the
appropriate tdif
;to remake and replot the temperatures reference windows

;ship  temperature ship in box    & sv extension
;box   temperature box not ship
;shipb binary ship in box
;boxb  binary box


       ship=(t gt thres0 + tdif)*t                    ;be sure NOR to use
the OLD threshold
       shipb=(t gt thres0 + tdif)*yy


       ship=ship(ix:ix+nx,iy:iy+ny)                   ;subset
       shipb=shipb(ix:ix+nx,iy:iy+ny)
       box=t(ix:ix+nx,iy:iy+ny)                       ;everything in the
box from original data
       boxb=yy(ix:ix+nx,iy:iy+ny)
       box=box*(ship eq 0)                            ;not ship
(temperature) in box
```

```
      boxb=boxb*(shipb eq 0)
 zscale=140/nx
 window,5,xpos=140*iscale,ypos=0,xsize=nx*zscale,ysize=ny*zscale
 tvscl,congrid(ship,nx*zscale,ny*zscale)
;**********************************************************************
*******************
;make contrasts  c11 = first file, shipfull, c12=above horizon, c13=up
to horizon
;C3N  full box, above horizon, below horizon
;yc            horizon line point
;iy            ship bottom
;hz            yc-iy    location of divisor in ship box
;**********************************************************************
******************
hz=yc-iy
;if(hz lt 0) then horizon is below ship and ship is flying
;if(hz ge iy+ny) then horizon is completely above ship

c5n(i-istart,0)=pcontra(shipb,boxb)
;from yc(horizon) -iy to ma
if(hz le 0 or hz ge ny) then begin                      ;hz 0 means c5n(i,2)
is ill defined as ship is on horizon
   print,'hz,ny ',hz,ny,' error'                        ;hz gt ny means
c5n(i,1) is below horizon
   c5n(i-istart,1)=c5n(i-istart,0)                      ;hz lt 0 means ship
is flying above horizon
   c5n(i-istart,2)=c5n(i-istart,0)
endif else begin
   c5n(i-istart,1)=pcontra(shipb(*,hz:*),boxb(*,hz:*))
   c5n(i-istart,2)=pcontra(shipb(*,0:hz),boxb(*,0:hz))

           ;duplicate the first if the value hz is zero

endelse
print,fileonly(files(I),path),' ',tdif,nx,ny,yc,iy,' ',pol(i)
print,C5N((I-ISTART),0),format="((F7.3,2x),'Full ship')"
print,C5N((I-ISTART),1),format="((F7.3,2x),'Above Horizon')"
print,C5N((I-ISTART),2),format="((F7.3,2x),'Below Horizon')"

printf,2,fileonly(files(I),path),' ',tdif,nx,ny,yc,iy,' ',pol(i)
printf,2,C5N((I-ISTART),0),format="((F7.3,2x),'Full ship')"
printf,2,C5N((I-ISTART),1),format="((F7.3,2x),'Above Horizon')"
printf,2,C5N((I-ISTART),2),format="((F7.3,2x),'Below Horizon')"



skiploop:
endfor
;**********************************************************************
*******************
goto,finish
problem: print,'I had a problem and quit'
finish: print,'program finished'
close,2
end
```

;program shipsz12 reads output of flira12 (Pete Heisey) which is:
;filename, tdif,ix,iy,nx,ny,H or V

```
;and calculates TBRD with ship size and plots it
close,1                                          ;shut up in case of an error
tempp='
                               '
file='                    '
read,'input filename from analysis output',file
on_ioerror,stoperr
openr,1,file
nfiles=0
iy=0
yc=iy
nx=iy
ny=iy
i=0
t=1.0
HV=' '                                                 ;file count
while not eof(1) do begin                           ;read to end of file
which is not more than nfiles
;loop:readf,1,tempp & print,tempp                    ;read string and print
it
loop:readf,1,tempp
if(nfiles eq 0) then begin                          ;if number of files not
fount yet, look for it
   if(strpos(tempp,'number of files') gt 0) then begin
   reads,tempp,nfiles & print,tempp,nfiles      ;get the number of files
   rdata=fltarr(5,nfiles)                       ;make array of number of
files, may not use it all
   cdata=fltarr(nfiles,3)                       ;array of contrast data
;   namearr=strarr(12,nfiles)                    ;array of filenames
   namearr=strarr(nfiles)
   pol=strarr(nfiles)
   print,'finished making arrays, Nfiles= ' ,nfiles              ;let me
know arrays were made
   endif
endif
if(strpos(tempp,'.IMG') lt 0) then goto, loop else $
  namearr(i)=(strmid(tempp,0,strpos(tempp,'G')+1)) ;search for file end
IMG

;print,(strmid(tempp,strpos(tempp,'G')+1,strlen(tempp)))

y=strcompress(strmid(tempp,strpos(tempp,'G')+1,strlen(tempp)))      ;get
rid of white spaces
;reads,y,t,ix,iy,nx,ny,HV & print,t,ix,iy,nx,ny,HV    ;convert data and
print it
;printf,2,tdif,nx,ny,yc,iy maee this
reads,y,t,nx,ny,yc,iy,HV
rdata(0,i)=t
rdata(1,i)=nx
rdata(2,i)=ny
rdata(3,i)=yc
rdata(4,i)=iy
pol(i)=HV
y=1.0
readf,1,y & cdata(i,0) = y
readf,1,y & cdata(i,1) = y
readf,1,y & cdata(i,2) = y
print,'incrementing loop counter'
```

```
i=i+1                                                ;increment the stored
variable
if(rdata(4,i-1) le 1) then i=i-1                      ;if height is 0, skip
the data
endwhile
goto, stopp
stoperr:print,'io error'
goto,loop
stopp:close,1
if(i lt 0) then i=0
print,'finished',i
rdata=rdata(*,0:i-1)
cdata=cdata(0:i-1,*)
namearr=namearr(0:i-1)
print,'file= ',file
SPLOT9e,RDATA,CDATA,FILE,pol
end
```

```
;program contrast.pro which calculates TBRD for each ship image
;anayzed.  it is a subroutine of shipsz12
function contrast,ship,box
contrast=(shipav(ship)-ship(box))
return,contrast
end
```

```
;program splot 9 is subroutine of shipsz12 which takes the ship
conatrast data and plots it vs. ship range determined by size
PRO SPLOT9,RDATA,CDATA,file,pol
ptitle=file
;cdata(*,0)     contrast for whole ship
;cdata(*,1)     contrast for above horizon
;cdata(*,2)     contrast for below horizon
;rdata(2,*)     ship size from height
hpol=where(strtrim(pol,2) eq 'h')       ;array of number for h
polarization
vpol=where(strtrim(pol,2) eq 'v')       ;array for v polarization
help,hpol,vpol
if(n_elements(hpol) le 1) then hpol=where(strtrim(pol,2) ne 'h')
```

```
if(n_elements(vpol) le 1) then vpol=where(strtrim(pol,2) ne 'v')
LOADCT,39
;read,'Input title',ptitle
;WINDOW,0,XSIZE=1024,YSIZE=768
;plot,1./rdata(2,*),cdata(*,2),CHARSIZE=2,psym=2,color=0,background=255,
charthick=2,title='!17'+ptitle $
;,xtitle='Ship Range',ytitle='Target-Background Radiance
Difference',/nodata
;oplot,1./rdata(2,*),cdata(*,2),psym=2,color=0
;oplot,1./rdata(2,*),cdata(*,0),psym=1,color=0
;oplot,1./rdata(2,*),cdata(*,1),psym=4,color=60
;xyouts,.65,.87,charsize=3,charthick=2,'!17Above
Horizon',color=60,/normal
;xyouts,.65,.82,charsize=3,charthick=2,'!17Full Ship',color=0,/normal
;xyouts,.65,.77,charsize=3,charthick=2,'!17Below
Horizon',color=60,/normal
;WINDOW,1,XSIZE=1024,YSIZE=768
;plot,1./rdata(2,*),cdata(*,0),CHARSIZE=2,psym=2,color=0,background=255,
charthick=2,title='!17'+ptitle $
;,xtitle='Ship Range',ytitle='Target-Background Radiance Difference'
;oplot,1./rdata(2,*),cdata(*,1),psym=4,color=0
;;oplot,1./rdata(2,*),cdata(*,2),psym=6,color=0
WINDOW,2,XSIZE=1024,YSIZE=768
plot,1./rdata(2,*),cdata(*,2),CHARSIZE=2,psym=2,color=0,background=255,c
harthick=2,title='!17'+ptitle,/nodata $
,xtitle='Ship Range from Ship Size',ytitle='Target-Background Radiance
Difference'
oplot,1./rdata(2,hpol),cdata(hpol,2),psym=2,color=0
oplot,1./rdata(2,vpol),cdata(vpol,2),psym=6,color=0
oplot,1./rdata(2,hpol),cdata(hpol,1),psym=1,color=0
oplot,1./rdata(2,vpol),cdata(vpol,1),psym=4,color=0
xyouts,.65,.77,charsize=1,charthick=2,'!17 *+ = H  !9B !9V !17=
V',color=0,/normal
xyouts,.65,.87,charsize=1,charthick=2,'!17Above Horizon  *
!9B',color=0,/normal
xyouts,.65,.82,charsize=1,charthick=2,'!17Below Horizon  +
!9V',color=0,/normal
end
```

;this program subtracts the arrays of the two split images from the splitimage polarimeter.
;program splitcom compares split image in yy array

```
getfiles,files
      ;get array of filenames in files
loop:
                  ;do it again
read,'input number of file to get',ifile
if(ifile lt 0) then goto,problem
f=files(ifile)
readflir,f,yy,t,bar,tt,head                                        ;get
file and make temperature array
!order=0
on_error,1
ybot=yy(0:*,70:*)
ytop=yy(0:*,0:69)
```

```
yes=''
read,'input y to invert',yes
if(yes eq 'y') then begin
ybot=ybot(*,69-indgen(70))                          ;Invert the image
ytop=ytop(*,69-indgen(70))
endif
hotspot,ytop,xhott,yhott                                          ;FIND THE
HOTSPOT IN THE IMAGE
hotspot,ybot,xhotb,yhotb                            ;subroutine
window,1,xsize=140*3,ysize=140*3
tvscl,rebin(ybot,140*3,70*3)
tvscl,rebin(ytop,140*3,70*3),0,70*3       ;display both images
xdif=xhott-xhotb
;calculate displacement to overlay hotspots
ydif=yhott-yhotb
print,xdif,ydif,' xdif ydif'
ytop=float(ytop )                                                       ;make
floating so subtraction will work
ybot=float(ybot)
displace,ybot,fix(xdif),fix(ydif)                  ; subroutine which
                                                          ;overlaps images
window,3,xsize=140*4,ysize=70*4
absoldif=abs(ytop-ybot)                                           ;make the
values of the difference positive
tvscl,rebin(absoldif,140*4,70*4)           ;display difference
goto,loop
problem:print,'exiting'
                                  ;error and normal exit for -1 filename
end
```

```
;pro displace,yval,xdif,ydif
ysize=size(yval)

print,ysize
if (ydif ge 0) then
yval(0:*,abs(ydif):ysize(2)-1)=yval(0:*,0:ysize(2)-1-abs(ydif)) $
 else yval(0:*,0:ysize(2)-1-abs(ydif))=yval(0:*,abs(ydif):ysize(2)-1)
end
```

```
pro hotspot,yval,xhot,yhot
ysize=intarr(5)
ysize=size(yval)
print,max(yval,ymax)  & print,ymax
print, ymax-(ymax/ysize(1))*ysize(1) ,ymax/ysize(1)
xhot= ymax-(ymax/ysize(1))*ysize(1)
yhot=ymax/ysize(1)
end
```

APPENDIX G.

SPLIT IMAGE POLARIMETER IMAGES, 3 AUGUST 1995

The following appendix contains the images recorded of the USS John McCain (Arleigh Burke class DDG) on 3 August, 1995 with the split-field polarimeter. This was a preliminary experiment conducted to test the performance of the optical system in the far field and to validate field performance of all system components. Any Data on the image file not contained in the Experimental notes is stored in the image file header.

Experimental Notes

Image File Name	**Target**	**Thermal Range**	**Remarks**
m0803001	BB		setup test-BB=black body source
m0803002	BB		infinite focus, BB @20'
m0803003	BB		"
m0803004	BB		Black body temperature 36degrees
m0803005	McCain	2	cal table 4003 used
m0803006	McCain	5	
m0803007	McCain	2	
m0803008	McCain	2	
m0803009	McCain	2	
m0803010	McCain	5	
m0803011	McCain	2	
m0803012	McCain	5	
m0803013	BB	2	cal tab. 4004, BB 36 degrees OC=-44
m0803014	BB	5	
m0803015	McCain	5	
m0803016	McCain	2	
m0803017	McCain	2	
m0803018	McCain	2	
m0803019	FOV	2	empty FOV with aft of ship on far right side
m0803020	McCain	5	

m0803021	McCain	10	
m0803022	McCain	5	
m0803023	BB	10	focus set on inf. for BB

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