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SPECTRAL CHARACTERIZATION OF THE LANDSAT THEMATIC MAPPER SENSORS

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EXECUTIVE SUMMARY

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A summary and an analysis of data collected by Hughes/Santa Barbara Research Center* on the spectral characteristics of the Landsat-4 and Landsat-4 backup Thematic Mapper instruments, the protoflight (TM/PF) and flight (TM/F) models, respectively, are presented. Tests were conducted on the instruments and their components to determine compliance with two sets of spectral specifications: Band-by-band spectral coverage and channel-by-channel within-band spectral matching.

Spectral coverage specifications were placed on: (1) band edges--points at 50% of peak response, (2) band edge slopes--steepness of rise and fall-off of response, (3) spectral flatness--evenness of response between edges, and (4) spurious system response--ratio of out-of-band response to in-band response. Compliance with the spectral coverage specifications was determined by analysis of spectral measurements on the individual components contributing to the overall spectral response: filters, detectors, and optical surfaces. The protoflight and flight model TM's used filter pieces cut from the same substrate and detectors from the same batch (except band 6); any differences between the calculated relative spectral responses (RSR) resulted from optics differences (except band 6).

The RSR's for the reflective bands were similar between TM/PF and TM/F except for the within-band flatnesses (Table 1). Calculated spectral responses for the reflective bands in both TM/PF and TM/F were within specifications with four exceptions. Insufficient spectral flatnesses in bands 2, 3 and 7 accounted for three. The other was the high upper-band edge for band 5, which had a specification of 1750 ±20 nm and was calculated as 1784 nm; this implies that there will be more contribution from variable atmospheric water vapor absorption.

*R.W. Cline, J.C. Lansing and D.G. Brandshaft of Hughes/SBRC provided data and assistance in interpretation.

In the emissive thermal band 6, the TM/PF and TM/F showed fundamentally different spectral responses. The TM/PF upper-band edge was detector limited at a temperature-dependent value of about 11.7 µm. The TM/F upper-band edge was filter limited at 12.4 µm. A specification of 12.5 µm for the upper-band edge was chosen to provide a wide enough window for a radiometric precision of 0.5°C. While the TM/PF upper-band edge was lower than specified, the detectors were sufficiently sensitive that the driving radiometric requirement of 0.5°C was met. In the case of the TM/F, the detectors were less sensitive and had an overall lower signal to noise performance even though the upper-band edge requirement was met as well as the 0.5°C requirement.

Out-of-band responses for all bands were within specification. Bands 1 and 3 had some sensitivity to near-IR radiation. Band 1 filters had transmission peaks at 800 and 885 nm of 0.5% and 0.7%, respectively. When measured on the TM/F model, an approximately 1 count contribution to band 1 resulted when the radiance between 776 and 905 nm resulted in 100 counts in band 4. Band 3 filters had peaks in out-of-band transmission at 945 and 1000 nm, of 2.8% and 1.2%, respectively. The impact of this on the band 3 response has not been determined.

The spectral matching specification stated that "after system calibration, the peak-to-peak signal variations between channels within any of the first five bands and band seven, when all channels are viewing the same scene radiance, shall be less than 0.5 percent of the minimum saturation levels [for two test conditions]." The two test conditions were a linearly varying spectral radiance and a flat spectral radiance. The TM/PF test involved calibrating the individual channels or 1.22 meter integrating sphere and then recording the mismatch in their outputs to a spectrally different source, the TM calibrator (modified by filters). The TM/PF test gave out-of-specification results which appeared to be attributable to spatial non-uniformity of the calibrator source. A refined test was used for the TM/F testing, using a small integrating sphere source with and without filters for the two targets. With the exception of band 4, which showed a 1.7% mismatch, all bands were within specifications. Calculations using the relative spectral response data for the 5 MSS sensors (MSS 1, 2, 3, 4 and 4-backup) showed that the TM/F had comparable or better spectral matching than the MSS sensors.

An examination for white light leaks in the along-scan line spread function for the flight model TM revealed several minor leaks in the primary focal plane bands (1-4). The magnitude of these light leaks is dependent on the spectral character of the illumination. Also, the magnitudes of the light leaks are comparable for all detectors in a half-band. For the odd channels of band 1, which were the worst observed, with the TM calibrator 'white' light source, a light leak at 13.1 IFOV off the detector center made about a 1% contribution to the signal. The location and shape of the light leaks suggests they are associated with the slots at the sides of the individual band assemblies. It is believed the TM/PF has comparable light leaks.

Table 1
TM Spectral Performance Calculated from Component Measurements

BAND	SCANNER	BAND EDGES AT HALF MAXIMUM (NM)		EDGE SLOPE INTERVALS (NM) LOWER			EDGE SLOPE INTERVALS (NM) UPPER			SPECTRAL FLATNESS (%)		SPURIOUS SYSTEM RESPONSE# (%)
		LOWER	UPPER	20-70%	5-70%	5-75%	70-20%	70-5%	75-5%	RAW	"ADJUSTED"*	
1	PF	452	518	7	14	--	5	14	--	32	78	1.64
	F	452	518	8	15	--	6	14	--	42	76	1.64
2	PF	529	610	20	25	--	9	19	--	26	71$^+$	1.30
	F	528	610	17	22	--	9	18	--	48	72$^+$	1.30
3	PF	624	693	14	21	--	7	18	--	65	71$^+$	2.87
	F	626	693	15	22	--	6	18	--	56	73$^+$	2.87
4	PF	776	905	13	23	--	9	17	--	76	--	0.78
	F	776	904	13	24	--	10	18	--	53	81	0.78
5	PF	1568	1784$^+$	--	--	32	--	--	42	84	--	0.79
	F	1567	1784$^+$	--	--	33	--	--	43	84	--	0.79
7	PF	2097	2347	--	--	75	--	--	37	59$^+$	--	1.25
	F	2097	2349	--	--	71	--	--	37	57$^+$	--	1.25
6**	PF	10.42	11.66$^+$	--	--	0.25	--	--	1.01$^+$	67$^+$	--	0.81
	F	10.45	12.43	--	--	0.34$^+$	--	--	0.26	78	--	0.81

* NASA specifications allowed division by a linear factor (slope) prior to calculating flatness for bands 1-4 to account for sloping response of Si detectors
\+ Out-of-specification characteristic
\# Specification was on system response, except for bands 4 and 6, calculations used filter response only
** Band 6 band edges and edge slopes in micrometers (μm)

SPECTRAL CHARACTERIZATION OF THE LANDSAT THEMATIC MAPPER SENSORS

INTRODUCTION

The intent of this document is to provide a summary of the information obtained on the spectral characteristics of the two Thematic Mapper (TM) instruments built and tested by Hughes Aircraft Company for the NASA Landsat Program. The first of these two units, the protoflight (TM/PF) model, was integrated into the Landsat-4 satellite, which was launched on 16 July, 1982. The second, the flight (TM/F) unit, has been integrated into the Landsat-4 backup spacecraft, which is scheduled for possible launch in 1985.

Each Thematic Mapper has seven spectral bands. These bands, with their nominal bandpasses are:

1. Blue-green, 450 nm to 520 nm.

2. Green, 520 nm to 600 nm.

3. Red, 630 nm to 690 nm.

4. Near-IR, 760 nm to 900 nm.

5. Mid-IR 1, 1550 nm to 1750 nm.

6. Thermal-IR, 10.4 μm to 12.5 μm.

7. Mid-IR 2, 2080 nm to 2350 nm.

Each reflective band consists of an array of 16 channels; the thermal band consists of four channels. Although there are multiple detectors per band, there is only one filter per band (covering all detectors). This design differs from the MSS where each channel has both an individual detector and filter. The first four bands are located at the primary focal plane of the TM, which is uncooled, and all use monolithic silicon detectors. Bands 5 through 7 are located on the cooled focal plane, which operates at 90°K-105°K. Bands 5 and 7 use monolithic InSb detectors; band 6 uses photoconductive HgCdTe detectors.

NASA placed two sets of specifications related to spectral performance on the instrument. One set of specifications concerned the spectral coverage of the bands. The specifications were on the following parameters (Fig. 1):

1. Lower and upper-band edges--points at 50% of peak relative spectral response (RSR).

2. Lower and upper-edge slopes--widths between specified percentages of maximum spectral response.

3. Spectral flatness--percentage of bandpass within given percentage (10% for reflective bands, 20% for thermal band) of peak response, after dividing out detector slope for silicon detectors.

4. Spurious system response--percentage of response outside 5% RSR points relative to response inside 50% points for solar equivalent input.

The second set of specifications concerned the spectral matching of the channels within each of the reflective bands. It stated that when all channels within a band are calibrated to produce equivalent outputs when viewing the specified flat scene radiances, then the maximum difference in output between channels when all are viewing the specified spectrally sloping scene shall be less than 0.5 percent of the minimum saturation level (Fig. 2).

Hughes developed separate tests to determine compliance with the spectral coverage and spectral matching specifications. In addition, other tests conducted on the TM instruments revealed spectrally related information. Time and program constraints limited the number and detail of the spectral tests conducted, and in general, less spectral data was collected on the TM instruments than on the MSS sensors (Markham and Barker, 1982).

SPECTRAL COVERAGE

Procedures

The primary spectral coverage test* was based on analyses of spectral measurements on the components contributing to the spectral response: filters, detectors and optical surfaces. The overall spectral response for a TM channel was defined as:

$$RSR_{Ai}(\lambda) = \frac{T_{OA}(\lambda)*T_{FA}(\lambda)*R_{Ai}(\lambda)}{K_{Ai}} \qquad (1)$$

*Hughes Aircraft Company, Santa Barbara Research Center, "TM System Spectral Response," internal memorandum HS236-7213, Jan. 13, 1981; "F-1 TM System Relative Spectral Response," internal memorandum HS236-8162, Nov. 9, 1982.

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Where:

$RSR_{Ai}(\lambda)$ = normalized relative spectral response in band A, channel i (percent).

$T_{OA}(\lambda)$ = spectral throughput of the optical system in band A (percent).

$T_{FA}(\lambda)$ = spectral transmission of the filters in band A (percent).

$R_{Ai}(\lambda)$ = relative spectral response of detector i for band A (percent).

K_{Ai} = the normalization factor to bring the peak overall band A, channel i response to 100%.

By measuring the component responses and then calculating the overall spectral response, determination of compliance with the spectral coverage specifications could be facilitated without tying up the TM instrument for the test. Note that the filter and optical responses were band specific, whereas the detector response was channel specific.

The optical system for bands 1-4 consists of five mirror surfaces: the scan mirror, the primary and secondary telescope mirrors and the two mirrors of the scan line corrector (Fig. 3). Bands 5-7 have two additional mirror surfaces and two windows: the relay spherical and folding mirrors and the ambient and dewar windows. The optical components' transmittances and reflectances were measured with a spectrophotometer. Measurements of mirror reflectance were taken on witness samples which were coated concurrently with each mirror. Reflectance measurements were taken at an angle corresponding to use within the system, that is, normal incidence for all but the scan and scan line corrector mirrors, which were measured at a 45 degree angle. Window transmittances were measured on the actual flight parts at a normal angle of incidence. The products of the appropriate set of measurements were used as the optical spectral throughputs for the individual bands.

Each TM band has one filter for all channels within the band (Fig. 4). The small size of each filter made measuring its spectral transmittance difficult, so measurements made on the filter material prior to sizing were used in the calculations of RSR. Filter materials for bands 1-5, 7 were measured at nominal operating temperature. Band 6 filter material could not be measured at operating temperature ($90^{o}K$-$105^{o}K$) prior to sizing, and was therefore measured at ambient temperature. Measurements on a piece of witness filter material at ambient and at $90^{o}K$ were used to determine a factor for converting ambient measurements to $90^{o}K$ conditions. Both the TM/PF and TM/F used filters cut from the same pieces of filter material, therefore identical filter transmission data were used for both calculations of RSR.

Each TM has 16 silicon photodiode detectors for each of bands 1-4, 16 InSb detectors for bands 5 and 7 and four HgCdTe detectors for band 6 (Fig. 4). The relative spectral responses of three of the TM/PF detectors per band were measured for bands 1-4. Differences between the three detector measurements were deemed to be smaller than the measurement errors, so the

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average of the three was used to represent all 16 detectors of the TM/PF. As the detector spectral response should theoretically be smooth, a best-fit curve through the averaged measured responses was used in the calculations of RSR. The TM/PF measurements were also used to represent the TM/F detectors as all detector arrays were from the same batch. For bands 5 and 7, one element of "sister" arrays (manufactured from the same wafer as the actual parts) were measured, as the actual parts could not be measured directly. These measurements were used to represent all 16 detectors for both the TM/PF and TM/F. For band 6 in the TM/PF all four detectors were measured and were individually used to make channel-by-channel calculations of RSR. For the TM/F, the odd (1 and 3) channels were similar and the even (2 and 4) channels were similar, and only two calculations were made for band 6.

Thus, with the exception of band 6, RSR's for the TM units were calculated on a band-by-band basis. In addition, again excluding band 6, the same numbers were used for the TM/F as for the TM/PF for the filter and detector responses. In the reflective bands only the differences in the optical surfaces between TM/PF and TM/F affected the calculated RSR's. In band 6, RSR was calculated on a channel-by-channel basis for the TM/PF and with one calculation for the even channels and one for the odd channels for the TM/F.

The one spectral coverage specification not addressed by the RSR calculation was spurious system response. The spurious system response, a measure of out-of-band response, is the integrated response outside the 5% response points relative to inside the 50% response points for solar equivalent input. What was typically used to determine compliance with this specification was the filter vendor's (Optical Coating Laboratory, Inc.) calculations of the integrated spurious filter transmission--with the integration being performed across the nominal range of sensitivity for the detectors, but not considering the detector's response or solar irradiance. For bands 4 and 6, the nominal detector responses and solar irradiances were considered in the calculation and these should give more accurate representations of true out-of-band response.

A limited empirical determination of out-of-band response was also conducted on the TM/F.* Peak responses of the primary focal plane bands to scans of a slit of light passed separately through witness filter pieces of the other bands were recorded.

Results

The results of the RSR calculations are presented in Figures 5-11, along with a comparison of the spectral performance to specifications. In Appendix A the RSR data for TM/PF and TM/F are tabulated (Tables A1-A7). For the reflective bands (1-5, 7) performance was within specifications and near nominal with the following exceptions:

1. Bands 2 and 3 flatnesses were slightly below specifications (<5%), and band 7 flatness was below specifications.

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*Hughes Aircraft Company, SBRC, "Light Leaks in the Prime Focal Plane Assembly-II," internal memorandum HS236-8163, November 19, 1982.

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2. Band 5 upper-band edge was higher than specifications: 1730-1770 nm specified, 1784 nm actual.

3. Band 2 band edges were shifted upward about 9 nm relative to nominal.

4. Band 4, 5 and 7 lower-band edges were 16-18 nm higher than nominal.

The band 5 out-of-specification upper-band edge resulted in the inclusion of a portion of the spectrum affected by atmospheric water absorption. This could contribute to increased sensitivity of the band to atmospheric water content variability. The other variations from specifications are not expected to produce significant data utility impacts. In bands 1-5 and 7 the TM/PF and TM/F responses were similar, with the only differences being apparent in the within-band shape. The differences in within-band shape were due to the only differences in the numbers input to the RSR calculations: optics.

In band 6, the TM/PF and TM/F showed fundamentally different spectral responses. The TM/PF upper-band edge was detector determined at a temperature dependent value of about 11.7 μm; the TM/F upper-band edge was filter determined at 12.43 μm. The TM/PF band 6 was out of specification in terms of the upper band edge, upper-edge slope and flatness. The TM/F band 6 was within specification except for the lower-edge slope which was slightly wide. The principal reason for the 10.4 μm to 12.5 μm bandwidth specification on band 6 was to allow sufficient signal to achieve the 0.5°K radiometric sensitivity requirement. As the TM/PF scanner's band 6 radiometric response was significantly better than specified, the failure to meet the spectral specification was not critical.

The calculated out-of-band responses suggest that all bands are within specifications (Table 1). In most bands the spurious response is simply an indication as to how rapidly the RSR rises from 0% to 5% and drops from 5% to 0%. The bands in general do not contain significant response peaks away from the primary response region. In band 1 there are two minor transmission "peaks" at 800 and 885nm with magnitudes of 0.5% and 0.7%, respectively (Fig. 12). In band 3 there is some transmission in the 950-1100nm range, reaching a peak transmittance of 3% at about 955nm (Fig. 13).

In the empirical test of spurious system response each band gave the highest output to light externally filtered through a piece of its filter material, as expected (Table 2). Also adjacent bands showed some spectral "crosstalk" as their spectral responses overlapped. The only noteworthy out-of-band response occurred in band 1. Band 1 gave a 1.2 count response for a radiance passing through a band 4 filter that produced 115 counts in band 4. This indicates that the two small peaks in the filter transmission of band 1 in the band 4 region result in a 1 count response in band 1 for about every 100 counts in band 4. A comparable impact on band 4 output filtered by a band 1 filter material was not obtained due to the lower gain setting in band 4 and the higher response of silicon in the band 4 region. Note that the impact of the band 3 response at 950-1100 nm was not evaluated in this test as no TM band covered this spectral region. The impact of the band 3 response at 950-1100 nm would be less than the filter transmission indicates, as the relative response of the silicon detectors drops rapidly with increasing wavelength in this region. At 950 nm it is down to about 50% of its peak response at 850 nm and dropping rapidly.

SPECTRAL MATCHING

TM/PF Procedures*

The spectral matching test designed for the TM/PF scanner made use of instrumentation configurations already planned for other tests and data from existing tests, therebylimiting the impact on program scheduling. First, each channel of the TM/PF scanner was calibrated on a 1.22 m integrating sphere of known spectral radiance (Fig. 14). This test, conducted 29-30 June 1981, was a standard calibration test and provided the gains and offsets for each channel. Then on 8-11 July 1981, a second test, slightly modified to allow for spectral matching data collection, was conducted. In this test, the TM/PF was aligned to the TM calibrator (a collimator and several light sources) (Fig. 14). The output of each channel to the TM calibrator MTF source (a small integrating sphere) was recorded and converted to radiance using the gains and offsets from the first test. The MTF source was filtered for the band 1, 2 and 4 tests. As the large integrating sphere and the MTF light source were spectrally different, this provided a spectral matching test, with the differences in output between channels to the second source indicating the mismatch.

The spectral mismatch was determined as follows:

1. Using the gains and offsets of each channel in a band from the 29-30 June large integrating sphere test, the effective spectral radiance of the calibrator MTF source in each channel was calculated from the 8-11 July test output, e.g. band 1 channel 1:

	Parameter	Units	Value	Source
a	GAIN	(mux/mw $cm^{-2}st^{-1}\mu m^{-1}$)	16.490	29-30 June test
b.	OFFSET	(mux)	1.187	29-30 June test
c.	OUTPUT TO CALIBRATOR	(mux)	146.720	8-11 July test
d.	EFFECTIVE SPECTRAL RADIANCE	($mw/cm^2 st\ \mu m$)	8.825	$\frac{(c)-(b)}{(a)}$

2. The channels with the maximum and minimum effective spectral radiances in each band were determined. The difference in their spectral radiances was the spectral mismatch. This difference was expressed as a percentage of the average output of all channels in the band to the calibrator or as a percentage of the minimum saturation level. The first number gave a better measure of the spectral mismatch; the second number was useful for comparing to the specifications.

Although a spectral matching test, this test was not responsive to the original NASA specifications. It somewhat more closely matched a set of spectral matching

*Hughes Aircraft Company, SBRC, "Spectral Matching Test Requirement-Supplement to Test BL07," internal memorandum HS236-6922, July 21, 1980.

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parameters provided by the Landsat-4 science office (Fig. 15).

TM/PF Results

The results of the TM/PF spectral matching tests (Table 3)* showed "spectral mismatches" of up to 6% of signal values (2% of minimum saturation levels), suggesting that either the detectors were poorly matched within bands or the filters had significant local variations in spectral transmittance. Two factors may have caused the indicated spectral mismatches to be greater than the actual values. First, the two tests were conducted about two weeks apart. Although TM detectors are stable relative to MSS photomultipliers, some changes in gains and offsets may have affected the results. Second, measurements of the TM calibrator's MTF spherical integrating source (SIS) indicated significant non-uniformities in illumination. As in the test using the calibrator's SIS, each channel views a different portion of the source, these non-uniformities could have contributed to inflating the spectral mismatches.+ No additional spectral matching tests were performed on the TM/PF to improve the spectral mismatch estimates.

TM/F Procedures†

The spectral matching test was redesigned for the TM/F tests. Data from a 1.22 m integrating sphere test (14 July 1982) were again used to provide the gains and offsets. Then, a new second test, conducted on 15 July 1982 provided the alternate spectral source. In this test a laboratory collimator and a 15 cm integrating sphere replaced the TM calibrator with its spherical integrating source. In addition, a new set of spectral filters was obtained, such that the differences in spectral slopes of the two sources closely approximated the specified differences.

A second modified TM/F spectral matching test was conducted in an attempt to reduce the inflation of the spectral mismatch due to any non-uniformities of this 15 cm integrating sphere. In this test, the same data as before were taken with the filtered source mounted in the collimator and a second set of data was taken with the spectral filter removed. The data, signal levels in MUX, were converted to effective spectral radiance using the 1.22 m sphere calibration. To calculate spectral mismatch, the minimum difference in any channel's output to the two sources was subtracted from the maximum difference in any channels output to give the error quantity, which was then expressed as a percentage of the output or the minimum saturation level. An additional correction was applied to the resultant percentages to account for the fact that the difference in spectra for the collimator with and without filters did not conform to the specified values.

*Hughes Aircraft Co., SBRC, "TM PF BL07R Test Result Summary," internal memorandum, HS236-7567, July 23, 1981.

+Hughes Aircraft Co., SBRC, "Protoflight Spectral Matching Performance Revisited," internal memorandum, HS236-7608, August 25, 1981.

†Hughest Aircraft Co., SBRC, "TM Spectral Matching," internal memorandum, HS236-7873, March 1, 1982.

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TM/F Results

Results of the first test (Table 4)* were generally "better" than in the TM/PF tests, except in band 4 where the TM/F test was more severe than the TM/PF test. Still, specifications were not indicated as being met in bands 1, 4 and 5. In the second test (Table 5) better performance was indicated, with all but band 4 meeting specifications.

To provide a reference point for the TM/F spectral mismatch results, the spectral mismatches of the five existing MSS sensors were calculated using their measured channel-by-channel relative spectral responses (Norwood et al., 1972; Felkel et al., 1977; Markham and Barker, 1982) for the specified targets (Table 6).+ The TM spectral mismatches fell within the range of MSS mismatches or were somewhat better. Thus, if the TM/F results can also be considered representative of the TM/PF spectral mismatches, no greater spectral striping problems can be expected on the TM than on past MSS's.

*Hughes Aircraft Company, SBRC, "Spectral Matching Test Results--Second Revision," internal memorandum, HS236-8084-2, July 21, 1982.

+The output of each MSS channel was calculated as:

$$\mathrm{OUTPUT} = \sum_{I=a}^{b} \frac{SR(I) * RSR(I)}{\sum_{I=a}^{b} RSR(I)}$$

Where:

I	- points of RSR measurement
a,b	- range of non-zero relative spectral responses for channel
SR(I)	- sloped radiance at I for comparable TM Band (mw/cm^2 st μm)
RSR(I)	- relative spectral response of channel at I
OUTPUT	- output of channel (mw/cm^2 st μm)

The maximum output minus the minimum output equalled the spectral mismatch. This divided by the average output in the band provided the percentage spectral mismatch.

PRIMARY FOCAL PLANT LIGHT LEAKS*

One additional spectrally related characteristic observed on the TM/F was a family of light leaks in the primary focal plane. These leaks were discovered during the spatial coverage testing of the TM/F. The light leaks have the following characteristics:

1. They affect all four bands in the prime focal plane (PFP) and no bands in the cooled focal plane (CFP).

2. They appear as secondary maxima in the scan direction line spread function (Fig. 16).

3. Their position is the same for both the odd and even half bands, (the odd and even detectors are displaced from each other by 2.5 IFOV's) (Table 7). The magnitude of the light leaks is the same for all detectors in a half-band.

4. They are roughly 20 IFOV's (track direction) by 1 IFOV (scan direction) in dimensions.

5. They are white leaks: the light does not pass through the spectral filters, though their relative magnitude does depend on the spectral character of the illumination.

The location and shape of the light leaks suggests they are associated with the gaps between the filter mounts in the primary focal plane (Fig. 4). The gaps between the filter mounts and the slots between the individual band assemblies do not perfectly coincide. This may be allowing light to scatter into the detectors. Note that the PFP diagram is for the TM/PF, whereas the light leak data is the TM/F. It is believed that the TM/PF has comparable leaks, though not exactly at the same locations and of the same magnitudes. Also note that the worst measured light leak was about 1% of the detector's response, though this percentage would be greater when the detector is centered on a dark target and the light leaks are centered on a neighboring bright area.

SUMMARY

Spectral coverage for the TM/PF and TM/F instruments was determined by analyses of spectral measurements of the optics, filters and detectors. Individual channel relative spectral responses were not measured. In the reflective bands, optics accounted for the only differences between the TM/PF and the TM/F, and the calculated spectral responses were similar. The only significant deviation from specifications in the reflective bands was the band 5 upper-band edge which extended to 1784 nm into an atmospheric water absorption region. In band 6 (emissive thermal) the TM/PF and TM/F had fundamentally different spectral responses. The TM/PF upper-band edge was lower than specifications, however the detectors were sufficiently sensitive to exceed the 0.5^{o}K radiometric specification, so the narrower bandwidth was not critical. The TM/F met the upper-band edge specification, as well as the radiometric specification, but was less sensitive overall.

*Hughes Aircraft Co., SBRC, "Light Leaks in the Prime Focal Plane Assembly-II," internal memorandum, HS236-8163, November 19, 1982.

Band 1 and band 3 filters had minor transmission peaks in the near-IR region: 0.5% and 0.7% at 800 nm and 885 nm respectively for band 1, 2.8% and 1.2% at 945 nm and 1000 nm respectively for band 3.

Satisfactory spectral matching data for the TM/PF was never obtained. The TM/F spectral matching data indicated within specification performance ($\leq$ 0.5%) for all but band 4 (1.7%). Comparison to MSS performance indicated TM performed comparably or better than MSS's in spectral matching.

Several minor leaks were detected in the TM/F prime focal plane. The odd channels of band 1 (magnitude of the light leaks comparable for all detectors in a half band), had the largest light leaks. In the band 1 odd channels, with the TM calibrator 'white' light source, a light leak at 13.1 IFOV along scan off the detector center made about a 1% contribution to the signal. The location and shape of the light leaks suggests that they are associated with the slots at the sides of the individual band assemblies. It is believed the TM/PF has comparable light leaks.

ACKNOWLEDGEMENTS

This paper is based solely on data obtained from Hughes/SBRC. This data has been provided along with generous assistance in interpretation by R. W. Cline, J. C. Lansing and D. G. Brandshaft. The assistance of Sy Lee and Ronald Achenbach in data entry and presentation is also greatly appreciated.

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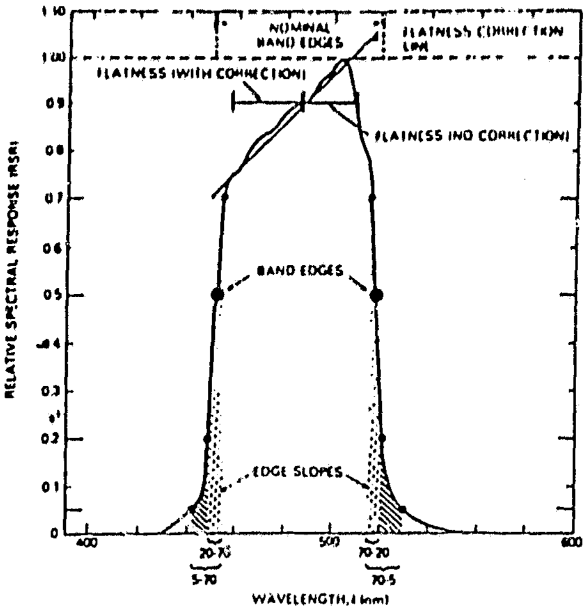


Figure 1. Spectral coverage parameters under specification for TM bands 1-4. The bands 5-7 specifications were on the 5-75% edge slope and the band 6 flatness specification was at 80% RSR.

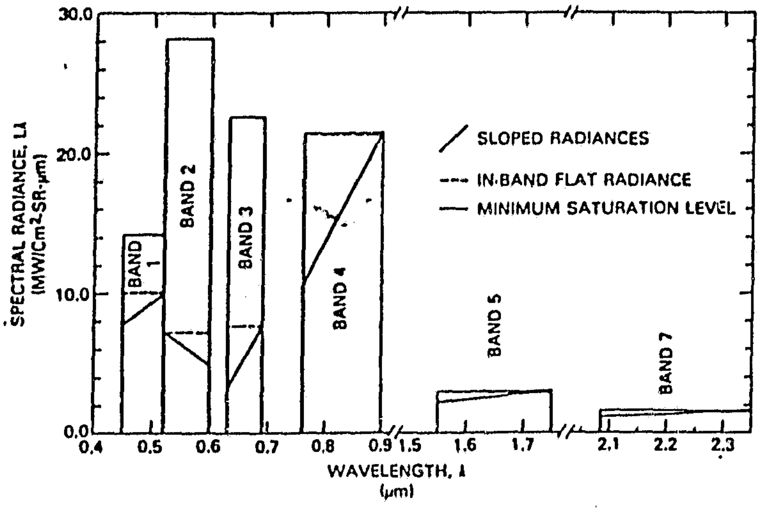


Figure 2. Spectral matching requirements for the Thematic Mapper reflective bands. When all channels within a band are calibrated to produce equivalent outputs when viewing the specified flat scene radiance, then the maximum difference in output between channels when all are viewing the spectrally sloping scene shall be less than 0.5 percent of the minimum saturation level.

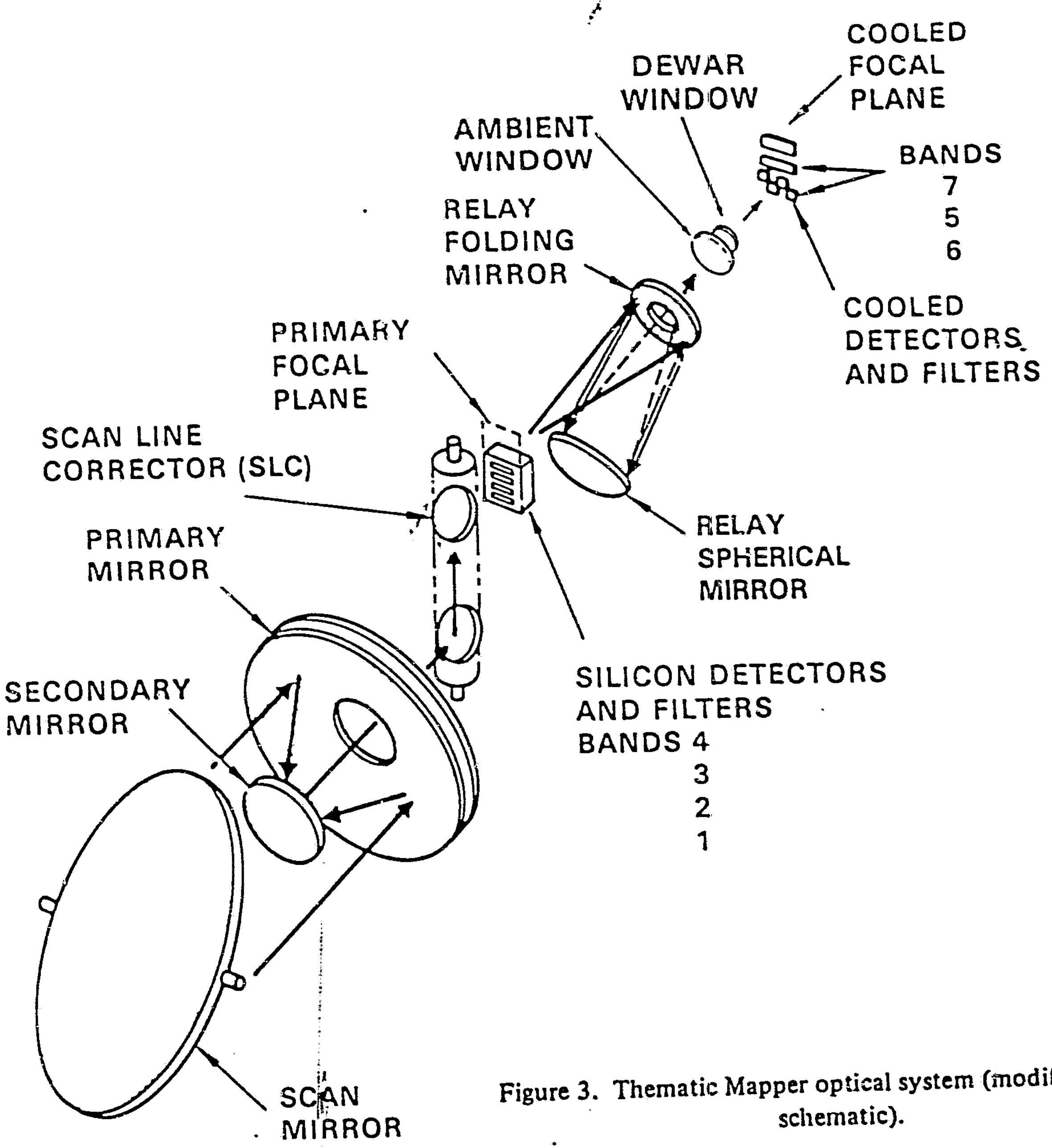


Figure 3. Thematic Mapper optical system (modified Hughes schematic).

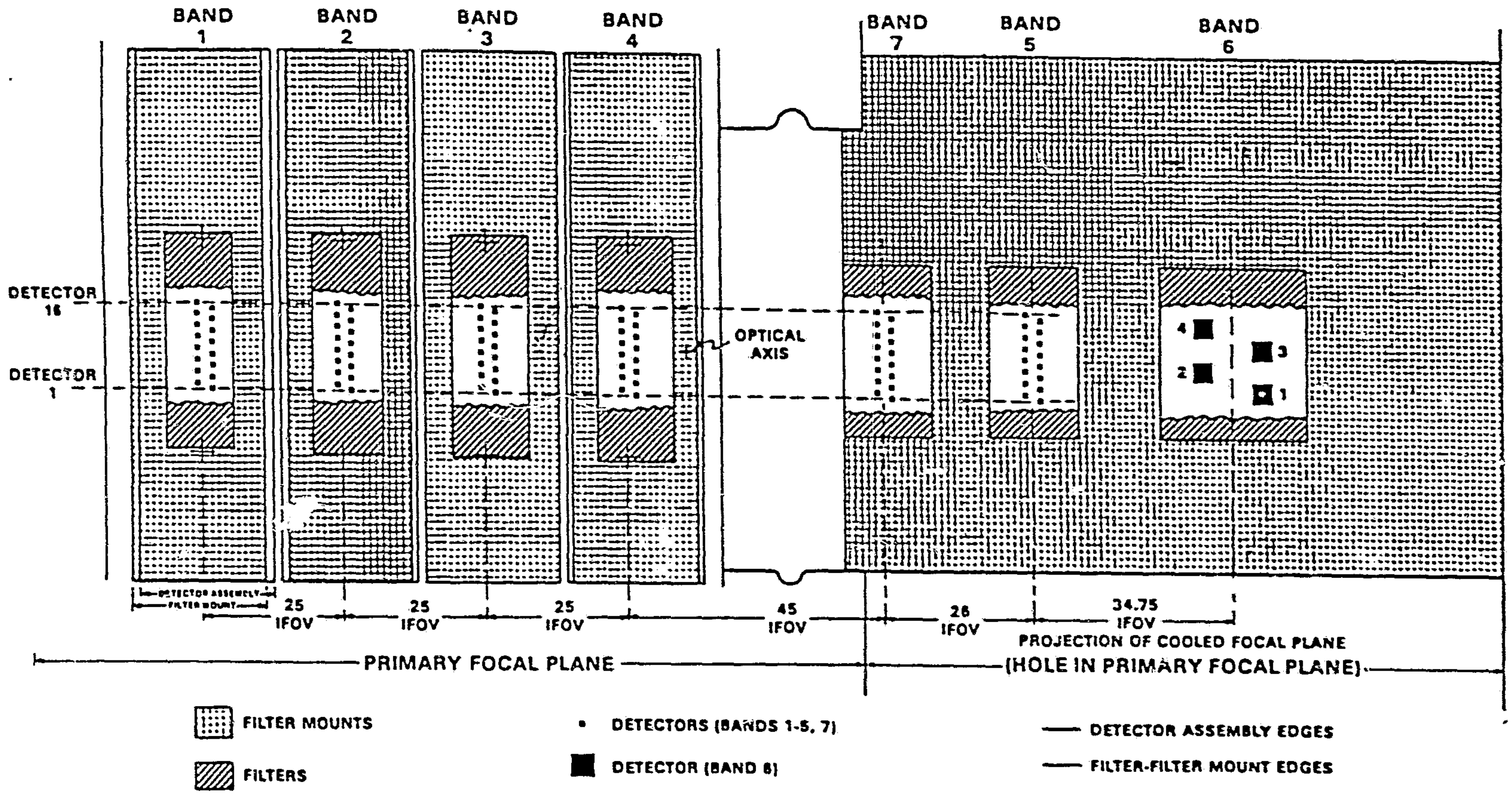
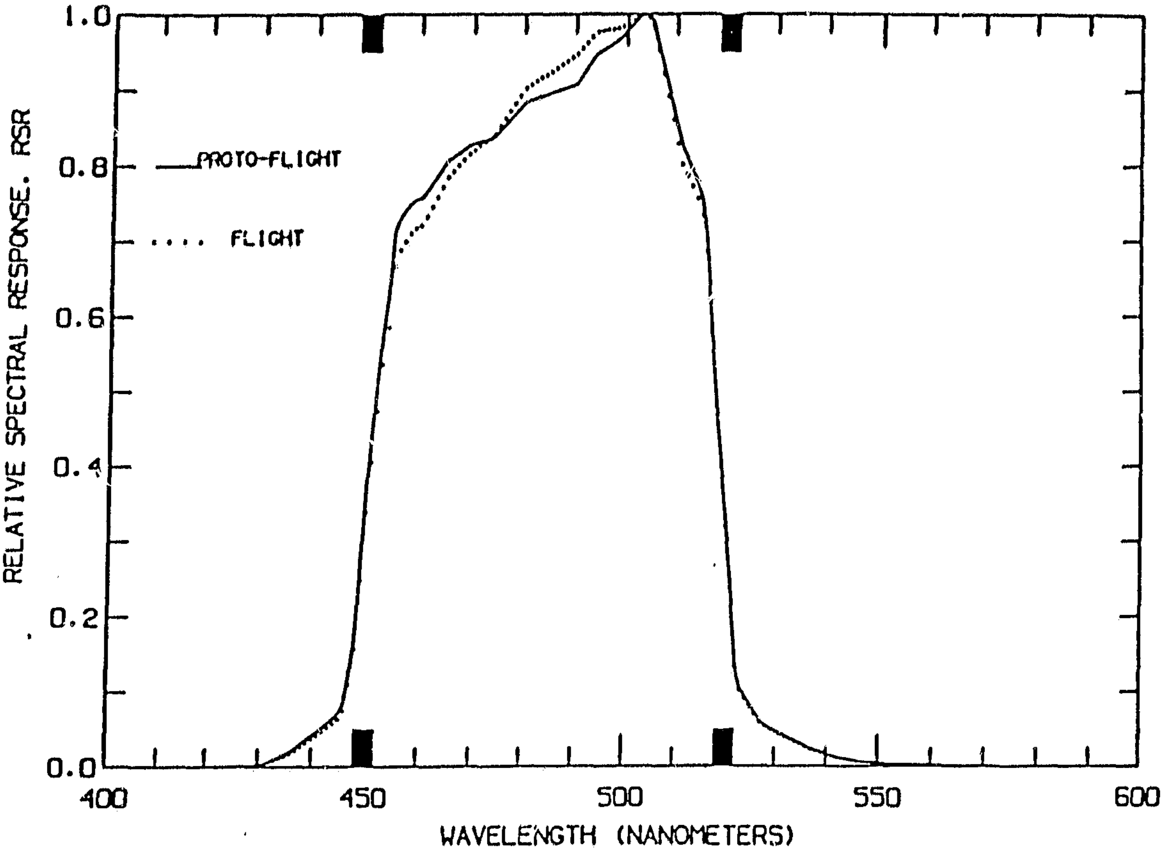


Figure 4. TM/PF primary focal plane and projection of cooled focal plane at primary focal plane.



SPECTRAL PARAMETER	SPECIFICATION	PROTOFLIGHT	FLIGHT
LOWER BAND EDGE (nm)	450 ± 10	452	452
UPPER BAND EDGE (nm)	520 ± 10	518	518
LOWER BAND EDGE SLOPE (nm)			
20% TO 70%	20 (MAX)	7	8
5% TO 70%	30 (MAX)	14	15
UPPER BAND EDGE SLOPE (nm)			
70% TO 20%	20 (MAX)	5	6
70% TO 5%	40 (MAX)	14	14
FLATNESS (%)	—	32	42
WITH LINEAR CORRECTION	75 (MIN)	78	76

Figure 5. Thematic Mapper spectral performance – band 1.

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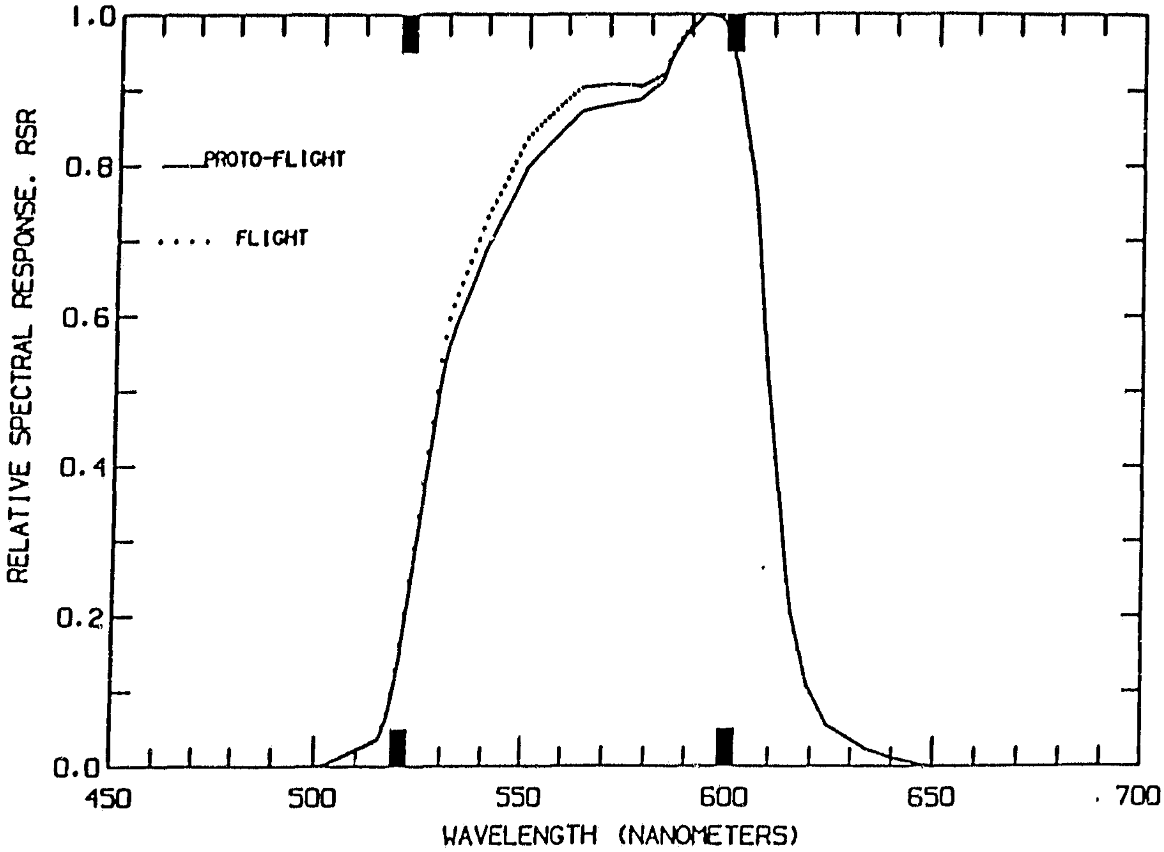

SPECTRAL PARAMETER	SPECIFICATION	PROTOFLIGHT	FLIGHT
LOWER BAND EDGE (nm)	520 ± 10	529	528
UPPER BAND EDGE (nm)	600 ± 10	610	610
LOWER BAND EDGE SLOPE (nm)			
20% TO 70%	20 (MAX)	20	17
5% TO 70%	30 (MAX)	25	22
UPPER BAND EDGE SLOPE (nm)			
70% TO 20%	20 (MAX)	9	9
70% TO 5%	40 (MAX)	19	18
FLATNESS (%)	—	26	48
WITH LINEAR CORRECTION	75 (MIN)	$\boxed{71}$ •	$\boxed{72}$ •

•OUT OF SPECIFICATION

Figure 6. Thematic Mapper spectral performance – band 2.

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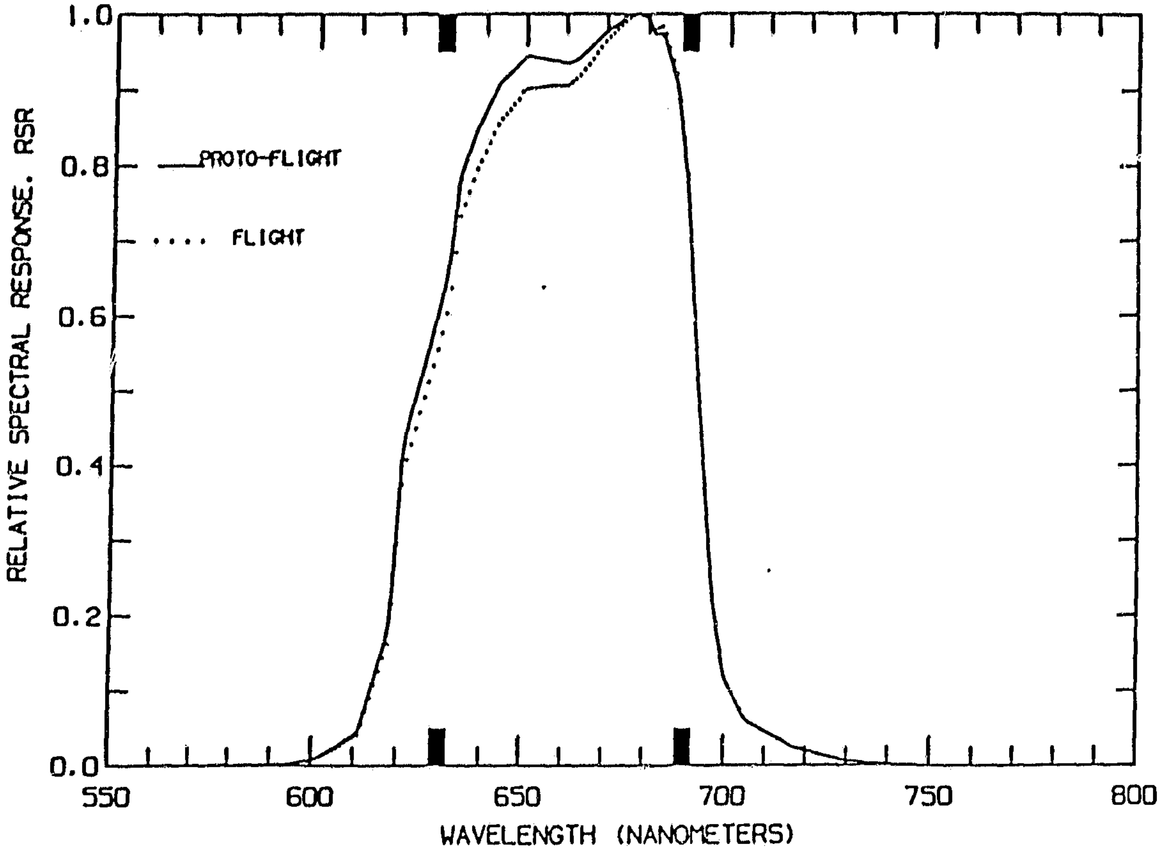
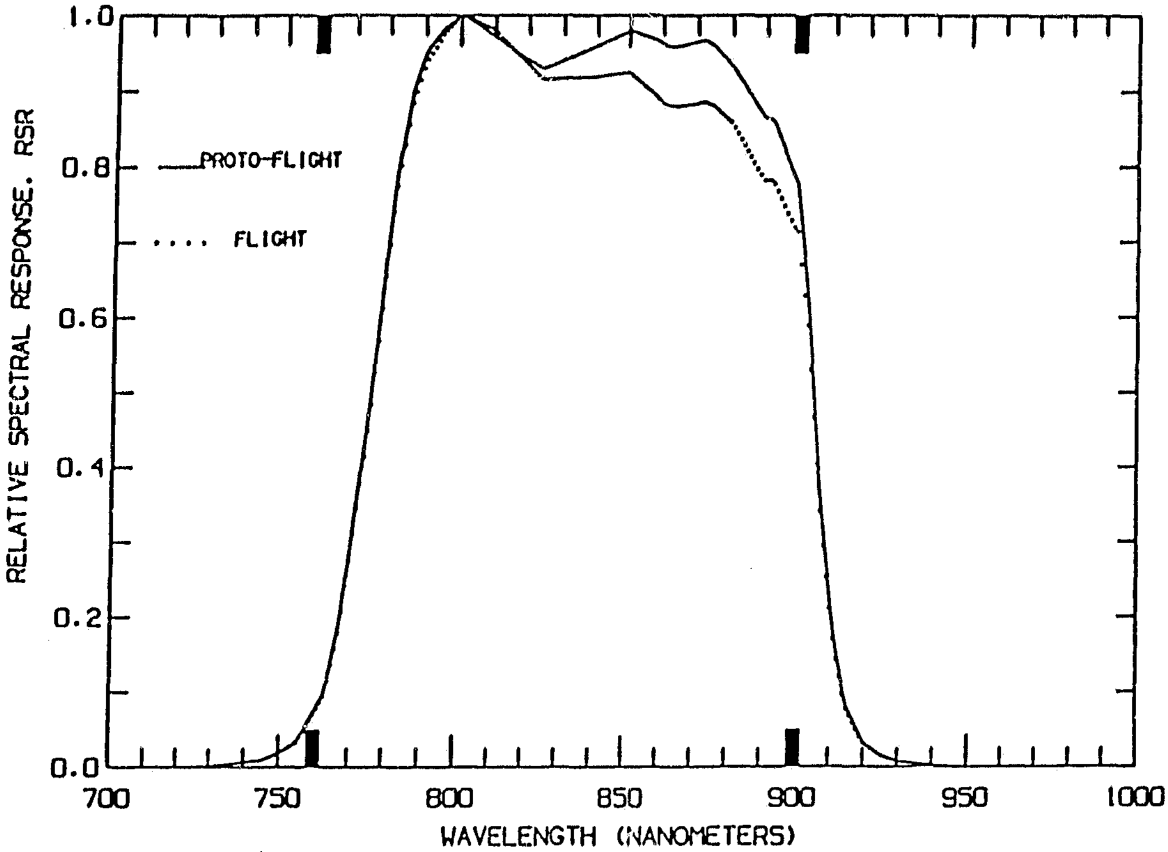


SPECTRAL PARAMETER	SPECIFICATION	PROTOFLIGHT	FLIGHT
LOWER BAND EDGE (nm)	630 ± 20	624	626
UPPER BAND EDGE (nm)	690 ± 10	693	693
LOWER BAND EDGE SLOPE (nm)			
20% TO 70%	20 (MAX)	14	15
5% TO 70%	30 (MAX)	21	22
UPPER BAND EDGE SLOPE (nm)			
70% TO 20%	20 (MAX)	7	6
70% TO 5%	40 (MAX)	18	18
FLATNESS (%)	—	65	56
WITH LINEAR CORRECTION	75 (MIN)	$\boxed{71}$ •	$\boxed{73}$ •

• OUT OF SPECIFICATION

Figure 7. Thematic Mapper spectral performance - band 3.



SPECTRAL PARAMETER	SPECIFICATION	PROTOFLIGHT	FLIGHT
LOWER BAND EDGE (nm)	760 ± 20	776	776
UPPER BAND EDGE (nm)	900 ± 10	905	904
LOWER BAND EDGE SLOPE (nm)			
20% TO 70%	20 (MAX)	13	13
5% TO 70%	30 (MAX)	23	24
UPPER BAND EDGE SLOPE (nm)			
70% TO 20%	30 (MAX)	9	10
70% TO 5%	40 (MAX)	17	18
FLATNESS (%)	—	76	53
WITH LINEAR CORRECTION	75 (MIN)	†	81

† NO CORRECTION NEEDED

Figure 8. Thematic Mapper spectral performance -- band 4.

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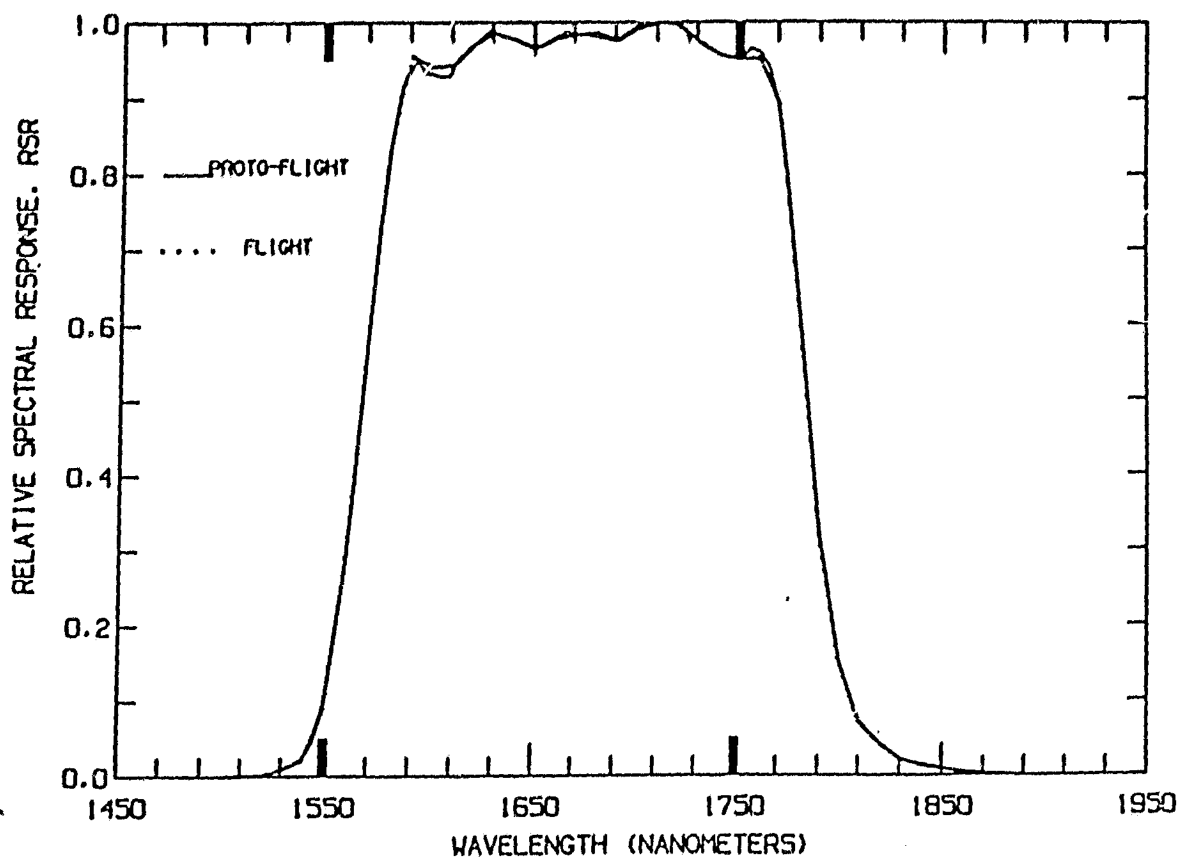

SPECTRAL PARAMETER	SPECIFICATION	PROTOFLIGHT	FLIGHT
LOWER BAND EDGE (nm)	1550 ± 20	1568	1567
UPPER BAND EDGE (nm)	1750 ± 20	$\boxed{1784}$ •	$\boxed{1784}$ •
LOWER BAND EDGE SLOPE (nm) 5% TO 75%	50 (MAX)	32	33
UPPER BAND EDGE SLOPE (nm) 75% TO 5%	50 (MAX)	42	43
FLATNESS (%)	75 (MIN)	84	84

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Figure 9. Thematic Mapper spectral performance – band 5.

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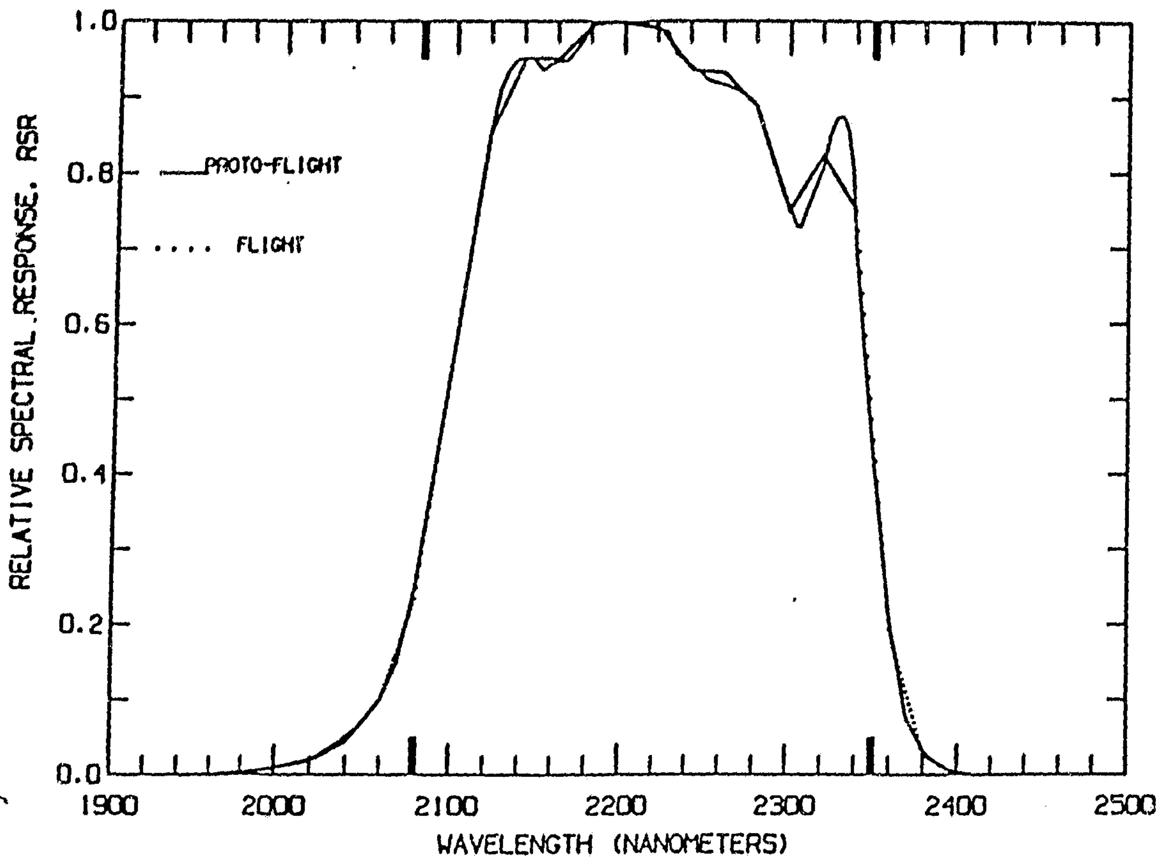

SPECTRAL PARAMETER	SPECIFICATION	PROTOFLIGHT	FLIGHT
LOWER BAND EDGE (nm)	2080 ± 30	2097	2097
UPPER BAND EDGE (nm)	2350 ± 30	2347	2349
LOWER BAND EDGE SLOPE (nm) 5% TO 75%	80	75	71
UPPER BAND EDGE SLOPE (nm) 75% TO 5%	80	37	37
FLATNESS (%)	75	$\boxed{59}$ *	$\boxed{57}$ *

*OUT OF SPECIFICATION

Figure 10. Thematic Mapper spectral performance – band 7.

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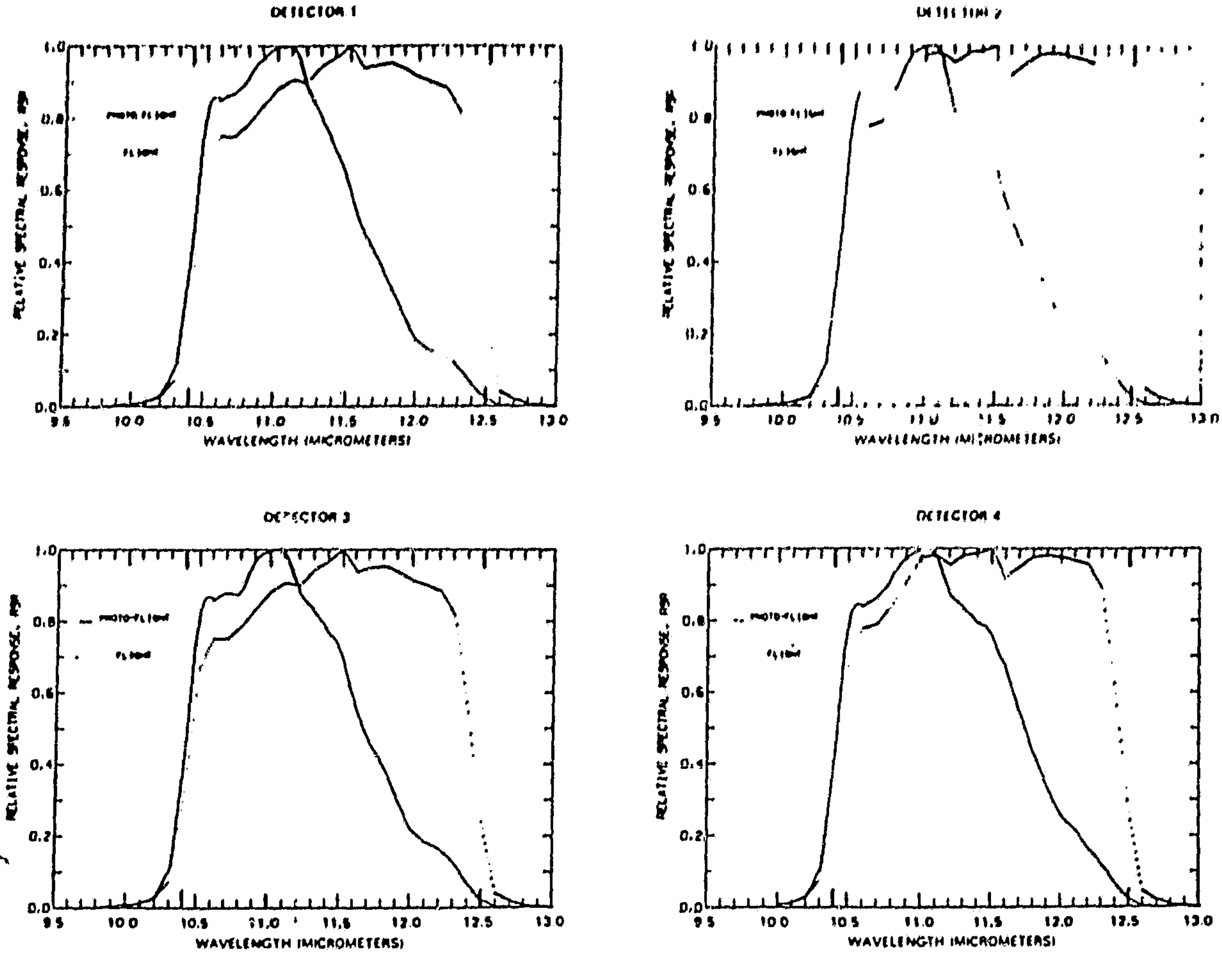

SPECTRAL PARAMETER	SPECIFICATION	PROTOFLIGHT	FLIGHT
LOWER BAND EDGE (μm)	10.4±0.1	10.42	10.45
UPPER BAND EDGE (μm)	12.5±0.1	11.66 •	12.43
LOWER BAND EDGE SLOPE (μm) 5% TO 75%	0.3 (MAX)	0.25	0.34 •
UPPER BAND EDGE SLOPE (μm) 75% TO 5%	0.3 (MAX)	1.01 •	0.26
FLATNESS (%)	75	67 •	78

•OUT OF SPECIFICATION

Figure 11. Thematic Mapper spectral performance - band 6.

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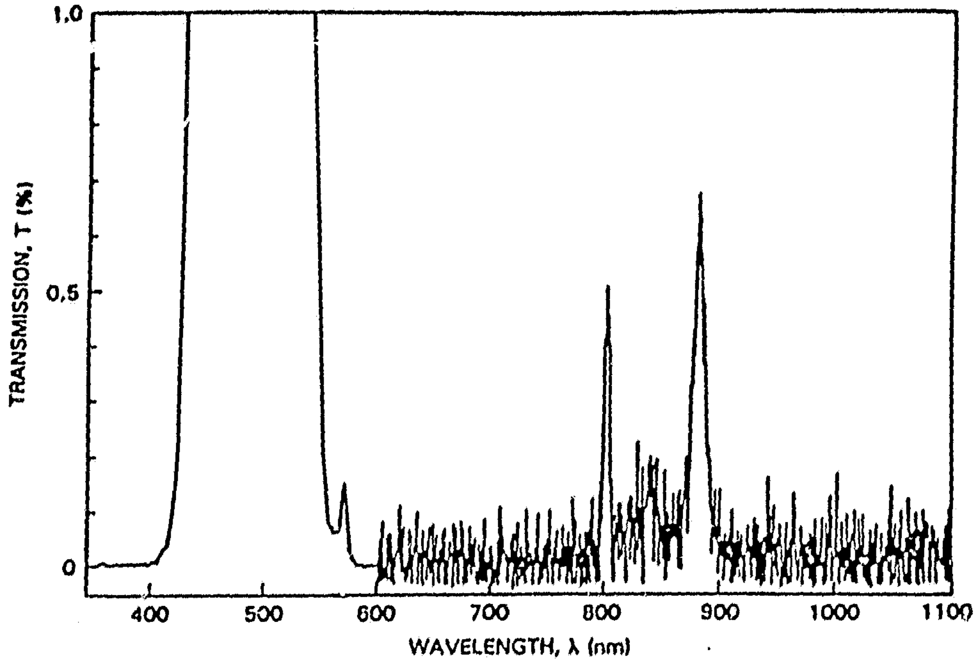

Figure 12. Thematic Mapper band 1 out-of-band filter transmission. Note scale 0-1%.

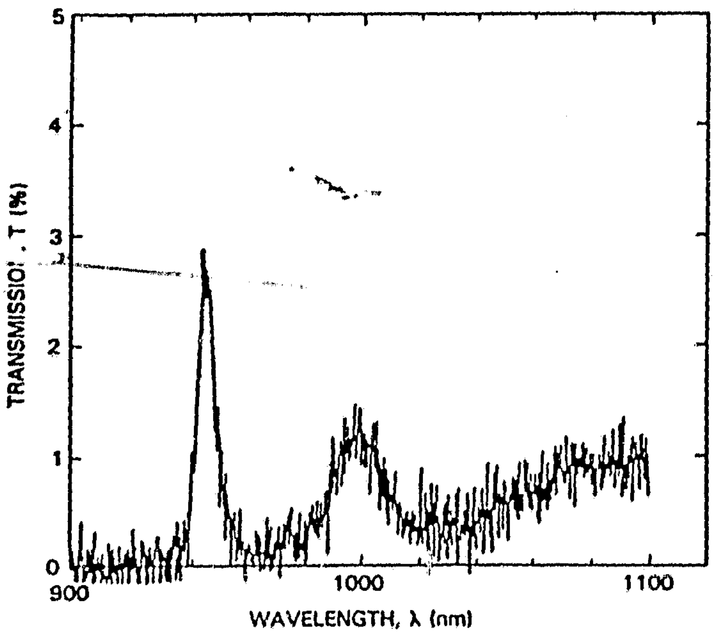

Figure 13. Thematic Mapper band 3 out-of-band filter transmission between 900 & 1100 nm. Note scale 0-5%.

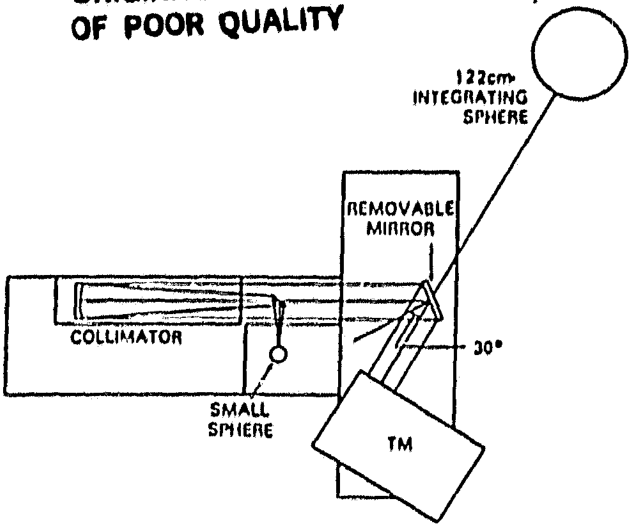

Figure 14. Spectral matching test schematic. One set of measurements was taken viewing the large integrating sphere (mirror removed). A second set of measurements was taken viewing the small sphere (mirror in place). The TM calibrator with MTF source acted as the collimator/small sphere for the PF tests. A laboratory collimator and a separate small sphere were used for the F tests.

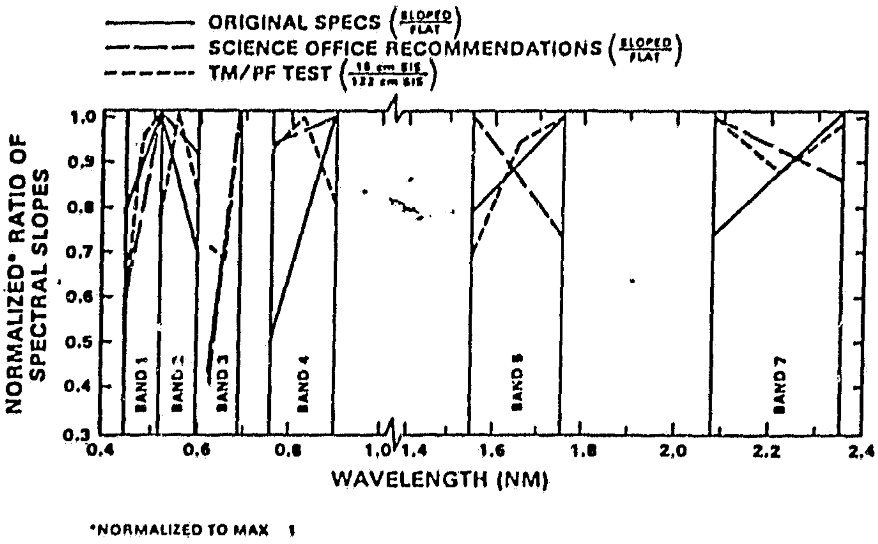

Figure 15. Ratio of spectral slopes of Spherical Integration Sources (SIS) used for TM/PF spectral matching tests in relation to specifications and science office recommendations. TM/F tests simulated the original specifications.

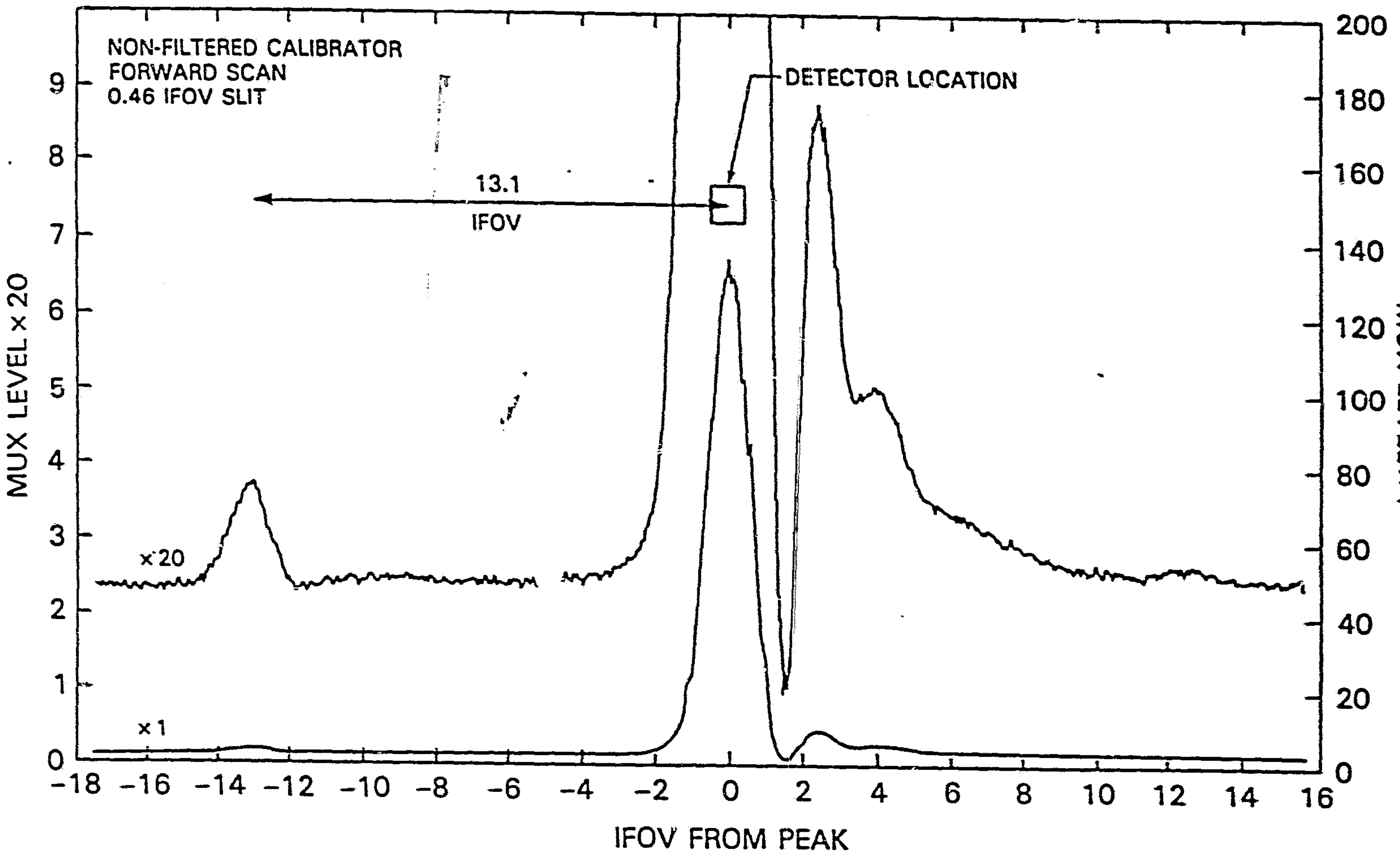

Figure 16. TM/F band 1 odd-channel forward scan line spread function showing location of light leak at 13.1 IFOV off of detector center.

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Table 1.
TM Integrated Out-of-Band Responses in Relation to Specifications

BAND	OUT-OF-BAND RESPONSES: CALCULATED FROM FILTER TRANSMISSION	(%) SPECIFICATION
1	1.64%	5 (MAX)
2	1.30%	5 (MAX)
3	2.87%	5 (MAX)
4	0.78%*	5 (MAX)
5	0.79%	5 (MAX)
7	1.25%	5 (MAX)
6	0.81%*	5 (MAX)

*DETECTOR RSR AND SOLAR IRRADIANCE CONSIDERED IN CALCULATION

Table 2.
TM/F Peak Responses to Filtered Slit Light Source

BAND IN WHICH OUTPUT MEASURED	SOURCE LIGHT FILTER (BAND #)			
	1	2	3	4
1	120.0	6.6	0.0	1.2
2	2.7	82.0	1.2	0.2
3	<0.2	1.5	105.0	0.2
4	~0.2	~0.2	<0.1	115.0

Table 3.
TM/PF Spectral Matching Results — Large and Filtered Small Integrating Spheres

BAND	MAXIMUM BETWEEN CHANNEL SPECTRAL MISMATCH: PERCENT OF OUTPUT (%)	PERCENT OF MINIMUM SATURATION LEVEL (%)	SPECIFICATION (% MSL)
1	2.9	$\boxed{1.8}$ *	0.5
2	5.9	$\boxed{2.0}$ *	0.5
3	1.3	0.2	0.5
4	0.8	$\boxed{0.6}$ *	0.5
5	1.6	$\boxed{1.2}$ *	0.5
7	2.6	$\boxed{1.2}$ *	0.5

*OUT OF SPECIFICATION

Table 4.
TM/F Spectral Matching Results Test 1 — Large and Filtered Small Integrating Spheres

BAND	MAXIMUM BETWEEN CHANNEL SPECTRAL MISMATCH: PERCENT OF OUTPUT (%)	PERCENT OF MINIMUM SATURATION LEVEL (%)	SPECIFICATION (% MSL)
1	1.67	$\boxed{0.89}$ *	0.50
2	1.20	0.45	0.50
3	1.50	0.35	0.50
4	2.58	$\boxed{1.50}$ *	0.50
5	0.92	$\boxed{0.73}$ *	0.50
7	0.85	0.42	0.50

* OUT OF SPECIFICATION

Table 5.
TM/F Spectral Matching Results Test 2 — Small Integrating Sphere With and Without Filters

BAND	MAXIMUM BETWEEN CHANNEL SPECTRAL MISMATCH: PERCENT OF OUTPUT (%)	PERCENT OF MINIMUM SATURATION LEVEL (%)	SPECIFICATION (% MSL)
1	0.89	0.46	0.50
2	...*	...*	0.50
3	1.50	0.34	0.50
4	3.00	$\boxed{1.74}$ +	0.50
5	0.09	0.07	0.50
7	0.22	0.11	0.50

* VALID TEST COULD NOT BE CONDUCTED
+OUT OF SPECIFICATION

Table 6.
Comparison of MSS to TM/F Spectral Mismatch

MSS BAND	COMPARABLE TM BAND	RANGE OF MSS* SPECTRAL MISMATCHES (% OF SIGNAL)	FLIGHT MODEL TM SPECTRAL MISMATCH (% OF SIGNAL)
1	2	1-5	1.2
2	3	3-10	1.5
3	4	1-4	3.0
4	4	1-5	3.0

*CALCULATED FROM MSS 1, 2, 3, 4 (PF), F CHANNEL-BY-CHANNEL RELATIVE SPECTRAL RESPONSE MEASUREMENTS USING THE COMPARABLE TM BAND SPECIFIED SLOPING RADIANCE

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Table 7.
Principal TM/F Primary Focal Plane Light Leaks (Magnitudes > 0.2 MUX with MTF Slit Source)

HALF-BAND	LEAK POSITION RELATIVE TO CENTRAL MAX (IFOV'S)	LEAK AMPLITUDE (MUX)	LEAK AMPLITUDE (% PEAK RESPONSE)
1–ODD	−13.1	1.3	1.10
1 – EVEN	−15.6	0.45	0.37
	14.7	0.20	0.16
2 – ODD	−12.0	0.20	0.18
2 – EVEN	–	–	–
3 – ODD	−12.0	0.30	0.27
	12.3	0.90	0.80
3 – EVEN	−14.8	0.25	0.21
	9.7	0.30	0.26
4 – ODD	−11.7	0.30	0.24
	12.6	0.20	0.16
4 – EVEN	−14.0	0.60	0.53
	−7.4	0.30	0.26
	10.1	0.20	0.18

APPENDIX A

Table A1

THEMATIC MAPPER RELATIVE SPECTRAL RESPONSE - BAND 1

WAVELENGTH (NM)	PF	F	WAVELENGTH (NM)	PF	F	WAVELENGTH (NM)	PF	F	WAVELENGTH (NM)	PF	F
412	0.0005	******	453	0.5788	0.5366	494	0.9476	0.9761	535	0.0309	0.0296
413	0.0006	******	454	0.6282	0.5856	495	0.9519	0.9775	536	0.0273	0.0261
414	0.0006	******	455	0.7114	0.6667	496	0.9563	0.9788	537	0.0237	0.0227
415	0.0007	******	456	0.7318	0.6880	497	0.9607	0.9802	538	0.0215	0.0205
416	0.0007	******	457	0.7415	0.6993	498	0.9651	0.9815	539	0.0192	0.0184
417	0.0008	******	458	0.7500	0.7095	499	0.9703	0.9837	540	0.0170	0.0162
418	0.0008	******	459	0.7550	0.7165	500	0.9789	0.9891	541	0.0147	0.0140
419	0.0009	******	460	0.7564	0.7200	501	0.9866	0.9935	542	0.0125	0.0118
420	0.0009	0.0007	461	0.7663	0.7326	502	0.9943	0.9978	543	0.0110	0.0105
421	0.0010	0.0008	462	0.7763	0.7454	503	1.0000	1.0000	544	0.0098	0.0093
422	0.0010	0.0008	463	0.7864	0.7583	504	0.9986	0.9952	545	0.0086	0.0081
423	0.0011	0.0009	464	0.7965	0.7714	505	0.9897	0.9828	546	0.0073	0.0069
424	0.0012	0.0009	465	0.8067	0.7847	506	0.9629	0.9524	547	0.0061	0.0058
425	0.0012	0.0010	466	0.8117	0.7924	507	0.9356	0.9219	548	0.0059	0.0056
426	0.0016	0.0013	467	0.8168	0.8002	508	0.9085	0.8914	549	0.0057	0.0054
427	0.0020	0.0016	468	0.8219	0.8080	509	0.8806	0.8607	550	0.0055	0.0052
428	0.0024	0.0020	469	0.8266	0.8156	510	0.8519	0.8293	551	0.0053	0.0050
429	0.0028	0.0023	470	0.8288	0.8206	511	0.8244	0.8021	552	0.0051	0.0048
430	0.0032	0.0027	471	0.8309	0.8257	512	0.8101	0.7877	553	0.0048	0.0046
431	0.0051	0.0042	472	0.8331	0.8308	513	0.7956	0.7732	554	0.0046	0.0044
432	0.0072	0.0060	473	0.8351	0.8359	514	0.7788	0.7565	555	0.0044	0.0042
433	0.0103	0.0086	474	0.8383	0.8421	515	0.7559	0.7339	556	0.0042	0.0040
434	0.0134	0.0113	475	0.8457	0.8526	516	0.7068	0.6859	557	0.0040	0.0038
435	0.0166	0.0141	476	0.8532	0.8624	517	0.5964	0.5784	558	0.0038	0.0036
436	0.0199	0.0170	477	0.8607	0.8724	518	0.4966	0.4813	559	0.0036	0.0033
437	0.0252	0.0216	478	0.8682	0.8824	519	0.4132	0.4002	560	0.0034	0.0031
438	0.0310	0.0268	479	0.8758	0.8925	520	0.3292	0.3187	561	0.0031	******
439	0.0367	0.0321	480	0.8835	0.9026	521	0.2447	0.2367	562	0.0029	******
440	0.0421	0.0370	481	0.8860	0.9069	522	0.1369	0.1324	563	0.0027	******
441	0.0476	0.0420	482	0.8885	0.9111	523	0.1054	0.1018	564	0.0025	******
442	0.0531	0.0471	483	0.8910	0.9154	524	0.0945	0.0911	565	0.0023	******
443	0.0588	0.0524	484	0.8934	0.9196	525	0.0834	0.0804	566	0.0020	******
444	0.0645	0.0577	485	0.8959	0.9238	526	0.0723	0.0696	567	0.0018	******
445	0.0704	0.0633	486	0.8983	0.9285	527	0.0612	0.0588	568	0.0016	******
446	0.0827	0.0746	487	0.9007	0.9332	528	0.0554	0.0532	569	0.0014	******
447	0.1213	0.1097	488	0.9031	0.9379	529	0.0520	0.0498	570	0.0011	******
448	0.1725	0.1564	489	0.9054	0.9425	530	0.0485	0.0465	571	0.0009	******
449	0.2730	0.2483	490	0.9078	0.9472	531	0.0450	0.0431	572	0.0007	******
450	0.3718	0.3391	491	0.9179	0.9548	532	0.0415	0.0397	573	0.0005	******
451	0.4425	0.4058	492	0.9281	0.9623	533	0.0380	0.0364	574	0.0002	******
452	0.5142	0.4741	493	0.9384	0.9698	534	0.0344	0.0330			

Table A2

THEMATIC MAPPER RELATIVE SPECTRAL RESPONSE - BAND 2

WAVELENGTH (NM)	PF	F	WAVELENGTH (NM)	PF	F	WAVELENGTH (NM)	PF	F	WAVELENGTH (NM)	PF	F
501	0.0006	0.0007	539	0.6754	0.7163	577	0.8869	0.9047	614	0.2487	0.2464
502	0.0019	0.0021	40	0.6899	0.7312	578	0.8914	0.9073	615	0.2057	0.2039
503	0.0032	0.0036	41	0.7003	0.7416	579	0.8958	0.9098	616	0.1810	0.1796
504	0.0065	0.0072	42	0.7107	0.7520	580	0.9002	0.9124	617	0.1562	0.1552
505	0.0089	0.0098	43	0.7213	0.7625	581	0.9047	0.9155	618	0.1313	0.1306
506	0.0114	0.0125	544	0.7319	0.7730	582	0.9092	0.9186	619	0.1078	0.1072
507	0.0139	0.0152	545	0.7426	0.7836	583	0.9136	0.9218	620	0.0973	0.0969
508	0.0164	0.0179	546	0.7533	0.7941	584	0.9323	0.9392	621	0.0868	0.0865
509	0.0190	0.0206	547	0.7642	0.8047	585	0.9444	0.9500	622	0.0763	0.0760
510	0.0215	0.0233	548	0.7751	0.8153	586	0.9536	0.9591	623	0.0657	0.0655
511	0.0241	0.0261	549	0.7861	0.8260	587	0.9630	0.9683	624	0.0550	0.0549
512	0.0268	0.0290	550	0.7971	0.8367	588	0.9715	0.9768	625	0.0518	0.0517
513	0.0295	0.0318	551	0.8031	0.8425	589	0.9768	0.9819	626	0.0486	0.0485
514	0.0322	0.0347	552	0.8091	0.8483	590	0.9820	0.9871	627	0.0454	0.0454
515	0.0349	0.0377	553	0.8152	0.8541	591	0.9875	0.9913	628	0.0422	0.0422
516	0.0504	0.0544	554	0.8206	0.8594	592	0.9941	0.9967	629	0.0390	0.0389
517	0.0662	0.0713	555	0.8261	0.8646	593	0.9986	0.9999	630	0.0357	0.0357
518	0.0912	0.0982	556	0.8316	0.8695	594	1.0000	1.0000	631	0.0324	0.0324
519	0.1205	0.1297	557	0.8371	0.8743	595	0.9991	0.9978	632	0.0291	0.0292
520	0.1520	0.1635	558	0.8427	0.8792	596	0.9984	0.9961	633	0.0258	0.0259
521	0.1912	0.2055	559	0.8482	0.8841	597	0.9953	0.9920	634	0.0225	0.0226
522	0.2309	0.2479	560	0.8538	0.8890	598	0.9799	0.9757	635	0.0207	0.0207
523	0.2711	0.2908	561	0.8593	0.8937	599	0.9644	0.9592	636	0.0188	0.0189
524	0.3117	0.3341	562	0.8650	0.8983	600	0.9488	0.9428	637	0.0170	0.0171
525	0.3529	0.3779	563	0.8706	0.9029	601	0.9265	0.9199	638	0.0151	0.0152
526	0.3917	0.4190	564	0.8731	0.9044	602	0.8941	0.8870	639	0.0132	0.0133
527	0.4299	0.4593	565	0.8743	0.9044	603	0.8616	0.8540	640	0.0114	0.0115
528	0.4685	0.4999	566	0.8754	0.9050	604	0.8288	0.8210	641	0.0102	0.0103
529	0.5075	0.5409	567	0.8766	0.9056	605	0.7959	0.7878	642	0.0091	0.0092
530	0.5372	0.5718	568	0.8777	0.9063	606	0.7466	0.7367	643	0.0080	0.0081
531	0.5606	0.5967	569	0.8788	0.9068	607	0.6721	0.6647	644	0.0069	0.0069
532	0.5772	0.6142	570	0.8799	0.9074	608	0.5970	0.5901	645	0.0057	0.0058
533	0.5909	0.6286	571	0.8809	0.9073	609	0.5215	0.5153	646	0.0046	0.0046
534	0.6046	0.6431	572	0.8820	0.9072	610	0.4674	0.4616	647	0.0034	0.0035
535	0.6186	0.6578	573	0.8830	0.9070	611	0.4131	0.4083	648	0.0023	0.0023
536	0.6326	0.6722	574	0.8840	0.9069	612	0.3586	0.3547	649	0.0012	0.0012
537	0.6467	0.6868	575	0.8850	0.9067	613	0.3038	0.3007	650	******	0.0000
538	0.6610	0.7015	576	0.8860	0.9057						

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Table A3

THEMATIC MAPPER RELATIVE SPECTRAL RESPONSE - BAND 3

WAVELENGTH (NM)	PF	F	WAVELENGTH (NM)	PF	F	WAVELENGTH (NM)	PF	F	WAVELENGTH (NM)	PF	F
559	0.0007	******	607	0.0304	0.0272	655	0.9397	0.9052	703	0.0844	0.0864
560	0.0008	******	608	0.0341	0.0306	656	0.9388	0.9055	704	0.0737	0.0756
561	0.0009	******	609	0.0378	0.0340	657	0.9379	0.9058	705	0.0629	0.0646
562	0.0009	******	610	0.0415	0.0375	658	0.9370	0.9060	706	0.0569	0.0584
563	0.0010	******	611	0.0453	0.0409	659	0.9360	0.9062	707	0.0539	0.0555
564	0.0011	******	612	0.0616	0.0555	660	0.9351	0.9064	708	0.0510	0.0525
565	0.0012	******	613	0.0811	0.0730	661	0.9372	0.9104	709	0.0480	0.0494
566	0.0013	******	614	0.1007	0.0906	662	0.9394	0.9143	710	0.0450	0.0464
567	0.0014	******	615	0.1204	0.1082	663	0.9429	0.9195	711	0.0420	0.0433
568	0.0014	******	616	0.1402	0.1262	664	0.9483	0.9266	712	0.0390	0.0402
569	0.0015	******	617	0.1602	0.1444	665	0.9537	0.9338	713	0.0360	0.0371
570	0.0016	******	618	0.1803	0.1626	666	0.9591	0.9412	714	0.0330	0.0340
571	0.0017	******	619	0.2402	0.2169	667	0.9646	0.9488	715	0.0300	0.0309
572	0.0017	******	620	0.3271	0.2958	668	0.9700	0.9563	716	0.0270	0.0277
573	0.0017	******	621	0.4145	0.3759	669	0.9755	0.9640	717	0.0239	0.0246
574	0.0018	******	622	0.4491	0.4086	670	0.9793	0.9699	718	0.0224	0.0230
575	0.0018	******	623	0.4706	0.4293	671	0.9831	0.9749	719	0.0210	0.0215
576	0.0019	0.0017	624	0.4921	0.4503	672	0.9869	0.9799	720	0.0195	0.0200
577	0.0019	0.0017	625	0.5138	0.4715	673	0.9904	0.9847	721	0.0180	0.0185
578	0.0020	0.0017	626	0.5354	0.4923	674	0.9969	0.9895	722	0.0166	0.0169
579	0.0020	0.0018	627	0.5572	0.5132	675	0.9964	0.9932	723	0.0151	0.0154
580	0.0021	0.0018	628	0.5790	0.5343	676	0.9982	0.9966	724	0.0136	0.0139
581	0.0021	0.0019	629	0.6010	0.5555	677	1.0000	1.0000	725	0.0121	0.0123
582	0.0022	0.0019	630	0.6235	0.5774	678	0.9977	0.9995	726	0.0109	0.0111
583	0.0022	0.0020	631	0.6504	0.6031	679	0.9957	0.9989	727	0.0097	0.0099
584	0.0023	0.0020	632	0.6866	0.6374	680	0.9936	0.9983	728	0.0085	0.0087
585	0.0023	0.0020	633	0.7366	0.6848	681	0.9725	0.9784	729	0.0073	0.0074
586	0.0024	0.0021	634	0.7869	0.7325	682	0.9734	0.9806	730	0.0061	0.0062
587	0.0024	0.0021	635	0.8027	0.7482	683	0.9742	0.9827	731	0.0058	0.0059
588	0.0025	0.0022	636	0.8185	0.7642	684	0.9635	0.9732	732	0.0055	0.0056
589	0.0025	0.0022	637	0.8345	0.7802	685	0.9451	0.9558	733	0.0052	0.0053
590	0.0026	0.0023	638	0.8485	0.7947	686	0.9265	0.9384	734	0.0049	0.0050
591	0.0029	0.0026	639	0.8598	0.8065	687	0.9078	0.9209	735	0.0046	0.0047
592	0.0033	0.0029	640	0.8711	0.8184	688	0.8710	0.8850	736	0.0043	0.0044
593	0.0037	0.0032	641	0.8826	0.8304	689	0.8220	0.8364	737	0.0040	0.0040
594	0.0040	0.0035	642	0.8941	0.8424	690	0.7727	0.7874	738	0.0037	0.0037
595	0.0044	0.0039	643	0.9056	0.8545	691	0.6869	0.7000	739	0.0034	0.0034
596	0.0053	0.0046	644	0.9116	0.8614	692	0.5940	0.6052	740	0.0031	0.0031
597	0.0062	0.0054	645	0.9170	0.8678	693	0.5049	0.5144	741	0.0028	******
598	0.0071	0.0062	646	0.9224	0.8743	694	0.4333	0.4413	742	0.0025	******
599	0.0080	0.0070	647	0.9278	0.8809	695	0.3612	0.3678	743	0.0022	******
600	0.0089	0.0079	648	0.9332	0.8875	696	0.2888	0.2942	744	0.0019	******
601	0.0114	0.0101	649	0.9386	0.8971	697	0.2235	0.2277	745	0.0016	******
602	0.0139	0.0123	650	0.9441	0.9008	698	0.1879	0.1916	746	0.0012	******
603	0.0165	0.0146	651	0.9433	0.9017	699	0.1522	0.1552	747	0.0009	******
604	0.0194	0.0173	652	0.9424	0.9026	700	0.1162	0.1186	748	0.0006	******
605	0.0231	0.0205	653	0.9415	0.9035	701	0.1056	0.1079	749	0.0003	******
606	0.0267	0.0238	654	0.9406	0.9044	702	0.0950	0.0972			

Table A4

THEMATIC MAPPER RELATIVE SPECTRAL RESPONSE - BAND 4

WAVELENGTH (NM)	PF	F	WAVELENGTH (NM)	PF	F	WAVELENGTH (NM)	PF	F	WAVELENGTH (NM)	PF	F
726	0.0005	******	783	0.7950	0.7745	839	0.9578	0.9194	895	0.8344	0.7592
727	0.0010	******	784	0.8218	0.8017	840	0.9598	0.9196	896	0.8229	0.7495
728	0.0014	******	785	0.8487	0.8290	841	0.9618	0.9202	897	0.8114	0.7398
729	0.0019	******	786	0.8756	0.8564	842	0.9638	0.9208	898	0.8000	0.7302
730	0.0024	0.0023	787	0.9025	0.8838	843	0.9658	0.9214	899	0.7889	0.7208
731	0.0029	0.0028	788	0.9170	0.8992	844	0.9677	0.9220	900	0.7786	0.7152
732	0.0033	0.0032	789	0.9315	0.9146	845	0.9697	0.9226	901	0.7333	0.6710
733	0.0038	0.0037	790	0.9460	0.9300	846	0.9717	0.9232	902	0.6882	0.6299
734	0.0043	0.0042	791	0.9564	0.9418	847	0.9737	0.9237	903	0.6434	0.5891
735	0.0048	0.0046	792	0.9629	0.9499	848	0.9756	0.9243	904	0.5785	0.5299
736	0.0053	0.0051	793	0.9695	0.9580	849	0.9776	0.9249	905	0.5090	0.4664
737	0.0058	0.0056	794	0.9760	0.9661	850	0.9796	0.9254	906	0.4400	0.4033
738	0.0063	0.0060	795	0.9826	0.9743	851	0.9782	0.9217	907	0.3714	0.3405
739	0.0067	0.0065	796	0.9861	0.9794	852	0.9768	0.9179	908	0.3211	0.2945
740	0.0072	0.0070	797	0.9896	0.9845	853	0.9754	0.9141	909	0.2755	0.2528
741	0.0077	0.0074	798	0.9930	0.9897	854	0.9740	0.9104	910	0.2303	0.2114
742	0.0082	0.0079	799	0.9965	0.9948	855	0.9726	0.9067	911	0.1853	0.1702
743	0.0087	0.0084	800	1.0000	1.0000	856	0.9711	0.9029	912	0.1557	0.1430
744	0.0092	0.0088	801	0.9973	0.9982	857	0.9697	0.8992	913	0.1301	0.1195
745	0.0097	0.0093	802	0.9945	0.9964	858	0.9674	0.8947	914	0.1047	0.0962
746	0.0116	0.0112	803	0.9918	0.9946	859	0.9651	0.8901	915	0.0840	0.0772
747	0.0136	0.0130	804	0.9891	0.9928	860	0.9627	0.8856	916	0.0738	0.0679
748	0.0156	0.0149	805	0.9863	0.9910	861	0.9604	0.8831	917	0.0638	0.0587
749	0.0175	0.0168	806	0.9833	0.9889	862	0.9591	0.8815	918	0.0538	0.0495
750	0.0195	0.0186	807	0.9803	0.9868	863	0.9589	0.8810	919	0.0439	0.0404
751	0.0224	0.0214	808	0.9772	0.9846	864	0.9587	0.8804	920	0.0341	0.0314
752	0.0254	0.0242	809	0.9742	0.9825	865	0.9599	0.8811	921	0.0306	0.0281
753	0.0283	0.0270	810	0.9712	0.9804	866	0.9610	0.8818	922	0.0271	0.0249
754	0.0313	0.0298	811	0.9682	0.9758	867	0.9621	0.8824	923	0.0236	0.0217
755	0.0343	0.0326	812	0.9651	0.9712	868	0.9632	0.8831	924	0.0201	0.0186
756	0.0422	0.0402	813	0.9621	0.9666	869	0.9643	0.8838	925	0.0167	0.0154
757	0.0503	0.0478	814	0.9591	0.9620	870	0.9655	0.8844	926	0.0150	0.0138
758	0.0583	0.0554	815	0.9561	0.9574	871	0.9666	0.8858	927	0.0132	0.0122
759	0.0663	0.0630	816	0.9530	0.9529	872	0.9677	0.8871	928	0.0115	0.0106
760	0.0744	0.070[illegible]	817	0.9500	0.9483	873	0.9653	0.8853	929	0.0098	0.0090
761	0.0825	0.078	818	0.9474	0.9442	874	0.9626	0.8832	930	0.0081	0.0075
762	0.0905	0.086	819	0.9447	0.9400	875	0.9599	0.8810	931	0.0077	0.0071
763	0.0987	0.094	820	0.9420	0.9359	876	0.9549	0.8768	932	0.0072	0.0067
764	0.1207	0.1152	821	0.9391	0.9313	877	0.9499	0.8725	933	0.0068	0.0063
765	0.1428	0.1364	822	0.9362	0.9268	878	0.9449	0.8683	934	0.0063	0.0059
766	0.1649	0.1577	823	0.9333	0.9223	879	0.9400	0.8641	935	0.0059	0.0055
767	0.1871	0.1791	824	0.9304	0.9178	880	0.9350	0.8599	936	0.0055	0.0051
768	0.2158	0.2069	825	0.9304	0.9161	881	0.9290	0.8530	937	0.0051	0.0047
769	0.2511	0.2409	826	0.9320	0.9160	882	0.9218	0.8451	938	0.0046	0.0043
770	0.2864	0.2752	827	0.9340	0.9164	883	0.9147	0.8372	939	0.0042	0.0039
771	0.3219	0.3095	828	0.9360	0.9167	884	0.9077	0.8294	940	0.0038	0.0035
772	0.3573	0.3440	829	0.9380	0.9170	885	0.9006	0.8217	941	0.0033	0.0032
773	0.3929	0.3786	830	0.9399	0.9173	886	0.8936	0.8139	942	0.0028	0.0028
774	0.4285	0.4133	831	0.9419	0.9176	887	0.8866	0.8063	943	0.0024	0.0024
775	0.4642	0.4482	832	0.9439	0.9178	888	0.8796	0.7986	944	0.0019	0.0021
776	0.5000	0.4833	833	0.9459	0.9181	889	0.8726	0.7910	945	0.0015	0.0017
777	0.5436	0.5259	834	0.9479	0.9183	890	0.8657	0.7835	946	0.0012	0.0014
778	0.5868	0.5683	835	0.9499	0.9185	891	0.8648	0.7835	947	0.0008	0.0010
779	0.6301	0.6108	836	0.9519	0.9188	892	0.8640	0.7836	948	0.0005	0.0007
780	0.6733	0.6534	837	0.9539	0.9190	893	0.8577	0.7787	949	0.0003	0.0003
781	0.7166	0.6963	838	0.9558	0.9192	894	0.8460	0.7690	950	******	0.0000
782	0.7599	0.7393									

Table A5

THEMATIC MAPPER RELATIVE SPECTRAL RESPONSE - BAND 5

WAVELENGTH (NM)	PF	F	WAVELENGTH (NM)	PF	F	WAVELENGTH (NM)	PF	F	WAVELENGTH (NM)	PF	F
1501	0.0000	0.0001	1561	0.3120	0.3179	1621	0.9719	0.9718	1681	0.9788	0.9854
1502	0.0001	0.0002	1562	0.3399	0.3454	1622	0.9747	0.9733	1682	0.9783	0.9844
1503	0.0002	0.0002	1563	0.3680	0.3732	1623	0.9775	0.9747	1683	0.9778	0.9835
1504	0.0002	0.0003	1564	0.3963	0.4012	1624	0.9803	0.9762	1684	0.9772	0.9825
1505	0.0003	0.0004	1565	0.4248	0.4294	1625	0.9831	0.9777	1685	0.9767	0.9815
1506	0.0004	0.0005	1566	0.4536	0.4578	1626	0.9855	0.9791	1686	0.9762	0.9805
1507	0.0005	0.0006	1567	0.4826	0.4865	1627	0.9877	0.9806	1687	0.9757	0.9796
1508	0.0006	0.0006	1568	0.5118	0.5154	1628	0.9894	0.9821	1688	0.9752	0.9786
1509	0.0007	0.0007	1569	0.5412	0.5446	1629	0.9888	0.9835	1689	0.9746	0.9776
1510	0.0008	0.0008	1570	0.5709	0.5739	1630	0.9882	0.9850	1690	0.9741	0.9766
1511	0.0009	0.0009	1571	0.5980	0.5989	1631	0.9871	0.9842	1691	0.9751	0.9784
1512	0.0010	0.0010	1572	0.6252	0.6239	1632	0.9859	0.9835	1692	0.9767	0.9802
1513	0.0010	0.0011	1573	0.6526	0.6492	1633	0.9848	0.9827	1693	0.9784	0.9820
1514	0.0011	0.0012	1574	0.6801	0.6746	1634	0.9836	0.9820	1694	0.9800	0.9838
1515	0.0012	0.0013	1575	0.7077	0.7002	1635	0.9825	0.9813	1695	0.9816	0.9857
1516	0.0013	0.0014	1576	0.7319	0.7260	1636	0.9813	0.9805	1696	0.9833	0.9875
1517	0.0014	0.0014	1577	0.7546	0.7519	1637	0.9802	0.9798	1697	0.9849	0.9893
1518	0.0015	0.0015	1578	0.7775	0.7781	1638	0.9790	0.9790	1698	0.9865	0.9911
1519	0.0016	0.0016	1579	0.8005	0.8044	1639	0.9778	0.9783	1699	0.9882	0.9926
1520	0.0017	0.0017	1580	0.8236	0.8308	1640	0.9767	0.9776	1700	0.9898	0.9947
1521	0.0022	0.0024	1581	0.8417	0.8430	1641	0.9758	0.9763	1701	0.9905	0.9953
1522	0.0029	0.0031	1582	0.8578	0.8553	1642	0.9749	0.9750	1702	0.9912	0.9958
1523	0.0036	0.0039	1583	0.8740	0.8676	1643	0.9740	0.9737	1703	0.9918	0.9963
1524	0.0044	0.0046	1584	0.8903	0.8800	1644	0.9730	0.9724	1704	0.9925	0.9969
1525	0.0051	0.0054	1585	0.9066	0.8925	1645	0.9721	0.9711	1705	0.9932	0.9974
1526	0.0059	0.0061	1586	0.9165	0.9050	1646	0.9712	0.9699	1706	0.9939	0.9979
1527	0.0066	0.0069	1587	0.9236	0.9175	1647	0.9703	0.9686	1707	0.9946	0.9985
1528	0.0074	0.0077	1588	0.9302	0.9301	1648	0.9694	0.9673	1708	0.9952	0.9990
1529	0.0082	0.0085	1589	0.9344	0.9428	1649	0.9685	0.9660	1709	0.9961	0.9995
1530	0.0090	0.0093	1590	0.9387	0.9555	1650	0.9676	0.9648	1710	0.9971	1.0000
1531	0.0102	0.0104	1591	0.9428	0.9540	1651	0.9672	0.9661	1711	0.9978	0.9997
1532	0.0116	0.0116	1592	0.9468	0.9526	1652	0.9668	0.9674	1712	0.9985	0.9994
1533	0.0131	0.0128	1593	0.9459	0.9511	1653	0.9679	0.9687	1713	0.9990	0.9991
1534	0.0146	0.0140	1594	0.9429	0.9497	1654	0.9697	0.9701	1714	0.9995	0.9988
1535	0.0161	0.0152	1595	0.9398	0.9482	1655	0.9715	0.9714	1715	1.0000	0.9984
1536	0.0176	0.0165	1596	0.9368	0.9467	1656	0.9732	0.9727	1716	0.9991	0.9981
1537	0.0191	0.0177	1597	0.9337	0.9453	1657	0.9750	0.9740	1717	0.9976	0.9978
1538	0.0207	0.0190	1598	0.9327	0.9438	1658	0.9768	0.9753	1718	0.9962	0.9975
1539	0.0222	0.0203	1599	0.9326	0.9423	1659	0.9786	0.9767	1719	0.9947	0.9972
1540	0.0238	0.0216	1600	0.9325	0.9409	1660	0.9803	0.9780	1720	0.9932	0.9968
1541	0.0278	0.0283	1601	0.9308	0.9412	1661	0.9819	0.9785	1721	0.9915	0.9945
1542	0.0327	0.0351	1602	0.9290	0.9415	1662	0.9833	0.9790	1722	0.9896	0.9922
1543	0.0378	0.0419	1603	0.9285	0.9418	1663	0.9847	0.9795	1723	0.9878	0.9899
1544	0.0428	0.0488	1604	0.9284	0.9421	1664	0.9861	0.9800	1724	0.9859	0.9877
1545	0.0479	0.0557	1605	0.9283	0.9424	1665	0.9876	0.9805	1725	0.9740	0.9854
1546	0.0566	0.0626	1606	0.9282	0.9428	1666	0.9875	0.9810	1726	0.9821	0.9831
1547	0.0667	0.0696	1607	0.9281	0.9431	1667	0.9867	0.9815	1727	0.9802	0.9808
1548	0.0770	0.0767	1608	0.9280	0.9434	1668	0.9859	0.9820	1728	0.9784	0.9785
1549	0.0873	0.0837	1609	0.9328	0.9437	1669	0.9852	0.9825	1729	0.9765	0.9763
1550	0.0977	0.0909	1610	0.9396	0.9440	1670	0.9844	0.9830	1730	0.9746	0.9740
1551	0.1138	0.1104	1611	0.9436	0.9467	1671	0.9839	0.9833	1731	0.9727	0.9723
1552	0.1325	0.1300	1612	0.9465	0.9493	1672	0.9834	0.9837	1732	0.9709	0.9706
1553	0.1513	0.1497	1613	0.9493	0.9519	1673	0.9829	0.9840	1733	0.9690	0.9688
1554	0.1702	0.1695	1614	0.9521	0.9546	1674	0.9824	0.9844	1734	0.9671	0.9671
1555	0.1893	0.1894	1615	0.9550	0.9572	1675	0.9819	0.9847	1735	0.9652	0.9654
1556	0.2085	0.2094	1616	0.9578	0.9598	1676	0.9813	0.9850	1736	0.9634	0.9637
1557	0.2278	0.2295	1617	0.9606	0.9625	1677	0.9808	0.9854	1737	0.9615	0.9620
1558	0.2473	0.2498	1618	0.9634	0.9651	1678	0.9803	0.9857	1738	0.9597	0.9603
1559	0.2669	0.2701	1619	0.9662	0.9677	1679	0.9798	0.9861	1739	0.9578	0.9586
1560	0.2867	0.2906	1620	0.9691	0.9703	1680	0.9793	0.9864	1740	0.9559	0.9569

Table A5
(CONTINUED)

WAVELENGTH (NM)	PF	F	WAVELENGTH (NM)	PF	F	WAVELENGTH (NM)	PF	F	WAVELENGTH (NM)	PF	F
1741	0.9549	0.9562	1779	0.6658	0.6542	1816	0.0569	0.0546	1853	0.0098	0.0073
1742	0.9541	0.9555	1780	0.6370	0.6277	1817	0.0538	0.0518	1854	0.0094	0.0068
1743	0.9534	0.9549	1781	0.6072	0.5968	1818	0.0507	0.0491	1855	0.0091	0.0064
1744	0.9526	0.9542	1782	0.5769	0.5659	1819	0.0476	0.0463	1856	0.0087	0.0060
1745	0.9519	0.9536	1783	0.5466	0.5350	1820	0.0446	0.0436	1857	0.0083	0.0055
1746	0.9511	0.9529	1784	0.5163	0.5041	1821	0.0421	0.0414	1858	0.0080	0.0051
1747	0.9504	0.9523	1785	0.4860	0.4732	1822	0.0399	0.0392	1859	0.0076	0.0047
1748	0.9496	0.9516	1786	0.4557	0.4423	1823	0.0377	0.0370	1860	0.0073	0.0043
1749	0.9489	0.9509	1787	0.4254	0.4114	1824	0.0355	0.0348	1861	0.0069	0.0041
1750	0.9482	0.9503	1788	0.3950	0.3806	1825	0.0333	0.0326	1862	0.0065	0.0040
1751	0.9505	0.9505	1789	0.3647	0.3497	1826	0.0311	0.0304	1863	0.0062	0.0039
1752	0.9538	0.9507	1790	0.3344	0.3190	1827	0.0290	0.0282	1864	0.0058	0.0038
1753	0.9572	0.9508	1791	0.3134	0.3026	1828	0.0268	0.0260	1865	0.0055	0.0037
1754	0.9605	0.9510	1792	0.2963	0.2862	1829	0.0246	0.0239	1866	0.0051	0.0036
1755	0.9638	0.9512	1793	0.2792	0.2698	1830	0.0224	0.0217	1867	0.0047	0.0035
1756	0.9645	0.9514	1794	0.2621	0.2533	1831	0.0214	0.0208	1868	0.0044	0.0034
1757	0.9635	0.9516	1795	0.2450	0.2369	1832	0.0208	0.0199	1869	0.0040	0.0033
1758	0.9624	0.9517	1796	0.2279	0.2204	1833	0.0202	0.0190	1870	0.0037	0.0032
1759	0.9614	0.9519	1797	0.2108	0.2040	1834	0.0197	0.0182	1871	0.0033	0.0031
1760	0.9604	0.9520	1798	0.1938	0.1875	1835	0.0191	0.0173	1872	0.0030	0.0030
1761	0.9570	0.9460	1799	0.1767	0.1710	1836	0.0186	0.0164	1873	0.0026	0.0028
1762	0.9527	0.9400	1800	0.1596	0.1546	1837	0.0180	0.0155	1874	0.0022	0.0027
1763	0.9483	0.9339	1801	0.1488	0.1462	1838	0.0175	0.0146	1875	0.0019	0.0026
1764	0.9440	0.9279	1802	0.1407	0.1378	1839	0.0169	0.0138	1876	0.0015	0.0025
1765	0.9397	0.9219	1803	0.1327	0.1294	1840	0.0164	0.0129	1877	0.0012	0.0024
1766	0.9307	0.9159	1804	0.1247	0.1210	1841	0.0158	0.0125	1878	0.0008	0.0023
1767	0.9197	0.9098	1805	0.1167	0.1127	1842	0.0153	0.0120	1879	0.0005	0.0022
1768	0.9088	0.9038	1806	0.1087	0.1044	1843	0.0147	0.0116	1880	0.0001	0.0021
1769	0.8978	0.8978	1807	0.1007	0.0960	1844	0.0142	0.0112	1881	******	0.0019
1770	0.8869	0.8915	1808	0.0927	0.0877	1845	0.0137	0.0107	1882	******	0.0017
1771	0.8679	0.8651	1809	0.0847	0.0794	1846	0.0131	0.0103	1883	******	0.0015
1772	0.8457	0.8388	1810	0.0768	0.0712	1847	0.0126	0.0099	1884	******	0.0013
1773	0.8235	0.8124	1811	0.0723	0.0684	1848	0.0120	0.0094	1885	******	0.0010
1774	0.8012	0.7861	1812	0.0692	0.0657	1849	0.0115	0.0090	1886	******	0.0008
1775	0.7790	0.7597	1813	0.0661	0.0629	1850	0.0109	0.0086	1887	******	0.0006
1776	0.7522	0.7333	1814	0.0630	0.0601	1851	0.0105	0.0081	1888	******	0.0004
1777	0.7234	0.7069	1815	0.0599	0.0574	1852	0.0102	0.0077	1889	******	0.0002
1778	0.6946	0.6806									

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Table A6

THEMATIC MAPPER RELATIVE SPECTRAL RESPONSE - BAND 7

WAVELENGTH (NM)	PF	F	WAVELENGTH (NM)	PF	F	WAVELENGTH (NM)	PF	F	WAVELENGTH (NM)	PF	F
1951	0.0002	******	2011	0.0148	0.0151	2071	0.1600	0.1732	2131	0.9387	0.9070
1952	0.0003	******	2012	0.0153	0.0156	2072	0.1701	0.1798	2132	0.9414	0.9120
1953	0.0005	******	2013	0.0158	0.0160	2073	0.1802	0.1865	2133	0.9441	0.9170
1954	0.0007	******	2014	0.0163	0.0165	2074	0.1903	0.1931	2134	0.9469	0.9219
1955	0.0009	******	2015	0.0168	0.0170	2075	0.2004	0.1998	2135	0.9496	0.9269
1956	0.0010	******	2016	0.0173	0.0175	2076	0.2106	0.2065	2136	0.9498	0.9319
1957	0.0012	******	2017	0.0178	0.0180	2077	0.2207	0.2132	2137	0.9500	0.9369
1958	0.0014	******	2018	0.0183	0.0185	2078	0.2309	0.2199	2138	0.9502	0.9419
1959	0.0016	******	2019	0.0188	0.0190	2079	0.2410	0.2266	2139	0.9504	0.9469
1960	0.0017	******	2020	0.0193	0.0194	2080	0.2512	0.2333	2140	0.9506	0.9519
1961	0.0019	0.0001	2021	0.0209	0.0207	2081	0.2654	0.2486	2141	0.9503	0.9519
1962	0.0021	0.0002	2022	0.0225	0.0219	2082	0.2797	0.2640	2142	0.9500	0.9518
1963	0.0023	0.0003	2023	0.0241	0.0231	2083	0.2940	0.2794	2143	0.9497	0.9517
1964	0.0025	0.0004	2024	0.0258	0.0244	2084	0.3084	0.2949	2144	0.9494	0.9517
1965	0.0026	0.0004	2025	0.0274	0.0256	2085	0.3227	0.3103	2145	0.9491	0.9516
1966	0.0028	0.0005	2026	0.0290	0.0269	2086	0.3371	0.3258	2146	0.9464	0.9515
1967	0.0030	0.0006	2027	0.0307	0.0281	2087	0.3515	0.3413	2147	0.9437	0.9515
1968	0.0032	0.0007	2028	0.0323	0.0294	2088	0.3659	0.3568	2148	0.9411	0.9514
1969	0.0034	0.0008	2029	0.0340	0.0306	2089	0.3803	0.3723	2149	0.9384	0.9513
1970	0.0036	0.0009	2030	0.0356	0.0319	2090	0.3947	0.3878	2150	0.9357	0.9512
1971	0.0037	0.0010	2031	0.0373	0.0331	2091	0.4092	0.4034	2151	0.9373	0.9512
1972	0.0039	0.0011	2032	0.0389	0.0344	2092	0.4237	0.4190	2152	0.9389	0.9511
1973	0.0041	0.0012	2033	0.0406	0.0356	2093	0.4382	0.4346	2153	0.9405	0.9510
1974	0.0043	0.0013	2034	0.0423	0.0367	2094	0.4528	0.4502	2154	0.9421	0.9509
1975	0.0045	0.0014	2035	0.0439	0.0381	[illegible]	0.4673	0.4658	2155	0.9437	0.9509
1976	0.0047	0.0015	2036	0.0456	0.0394	2096	0.4819	0.4814	2156	0.9442	0.9508
1977	0.0049	0.0016	2037	0.0473	0.0407	2097	0.4965	0.4971	2157	0.9447	0.9507
1978	0.0050	0.0017	2038	0.0489	0.0419	2098	0.5111	0.5128	2158	0.9453	0.9506
1979	0.0052	0.0018	2039	0.0506	0.0432	2099	0.5257	0.5285	2159	0.9458	0.9505
1980	0.0054	0.0018	2040	0.0523	0.0445	2100	0.5404	0.5442	2160	0.9463	0.9505
1981	0.0056	0.0022	2041	0.0540	0.0472	2101	0.5557	0.5593	2161	0.9466	0.9526
1982	0.0058	0.0026	2042	0.0557	0.0500	2102	0.5710	0.5744	2162	0.9470	0.9548
1983	0.0060	0.0030	2043	0.0574	0.0527	2103	0.5864	0.5896	2163	0.9473	0.9570
1984	0.0062	0.0034	2044	0.0591	0.0555	2104	0.6018	0.6048	2164	0.9476	0.9592
1985	0.0064	0.0037	2045	0.0608	0.0583	2105	0.6172	0.6200	2165	0.9480	0.9614
1986	0.0066	0.0041	2046	0.0625	0.0611	2106	0.6327	0.6353	2166	0.9507	0.9636
1987	0.0068	0.0045	2047	0.0642	0.0638	2107	0.6482	0.6506	2167	0.9534	0.9658
1988	0.0070	0.0049	2048	0.0659	0.0666	2108	0.6637	0.6659	2168	0.9562	0.9680
1989	0.0072	0.0053	2049	0.0676	0.0694	2109	0.6792	0.6813	2169	0.9589	0.9702
1990	0.0074	0.0057	2050	0.0693	0.0722	2110	0.6948	0.6967	2170	0.9617	0.9724
1991	0.0076	0.0061	2051	0.0723	0.0750	2111	0.7104	0.7121	2171	0.9646	0.9747
1992	0.0078	0.0065	2052	0.0753	0.0778	2112	0.7261	0.7276	2172	0.9675	0.9769
1993	0.0080	0.0069	2053	0.0783	0.0806	2113	0.7418	0.7431	2173	0.9704	0.9791
1994	0.0082	0.0073	2054	0.0813	0.0834	2114	0.7576	0.7587	2174	0.9733	0.9813
1995	0.0084	0.0077	2055	0.0843	0.0862	2115	0.7733	0.7743	2175	0.9762	0.9835
1996	0.0086	0.0081	2056	0.0874	0.0891	2116	0.7891	0.7899	2176	0.9792	0.9857
1997	0.0088	0.0085	2057	0.0904	0.0919	2117	0.8050	0.8056	2177	0.9821	0.9880
1998	0.0090	0.0089	2058	0.0934	0.0947	2118	0.8209	0.8213	2178	0.9850	0.9902
1999	0.0092	0.0093	2059	0.0964	0.0975	2119	0.8368	0.8370	2179	0.9879	0.9924
2000	0.0094	0.0097	2060	0.0995	0.1004	2120	0.8527	0.8528	2180	0.9909	0.9947
2001	0.0099	0.0102	2061	0.1045	0.1070	2121	0.8641	0.8578	2181	0.9936	0.9949
2002	0.0104	0.0107	2062	0.1095	0.1136	2122	0.8755	0.8627	2182	0.9964	0.9952
2003	0.0109	[illegible]	2063	0.1146	0.1201	2123	0.8869	0.8676	2183	0.9968	0.9955
2004	0.0114	[illegible]	2064	0.1196	0.1267	2124	0.8983	0.8725	2184	0.9971	0.9957
2005	0.0118	0.0121	2065	0.1247	0.1334	2125	0.9098	0.8774	2185	0.9975	0.9960
2006	0.0123	[illegible]	2066	0.1297	0.1400	2126	0.9150	0.8823	2186	0.9979	0.9963
2007	0.0128	[illegible]	2067	0.1348	0.1466	2127	0.9202	0.8873	2187	0.9982	0.9966
2008	0.0133	[illegible]	2068	0.1398	0.1532	2128	0.9255	0.8922	2188	0.9986	0.9968
2009	0.0138	[illegible]	2069	0.1449	0.1599	2129	0.9307	0.8971	2189	0.9989	0.9971
2010	0.0143	0.0146	2070	0.1500	0.1665	2130	0.9359	0.9021	2190	0.9993	0.9974

Table A6
(CONTINUED)

WAVELENGTH (NM)	PF	F	WAVELENGTH (NM)	PF	F	WAVELENGTH (NM)	PF	F	WAVELENGTH (NM)	PF	F
2191	0.9996	0.9976	2246	0.9300	0.9348	2301	0.7514	0.7523	2356	0.2964	0.3060
2192	1.0000	0.9979	2247	0.9281	0.9347	2302	0.7455	0.7561	2357	0.2738	0.2781
2193	0.9994	0.9982	2248	0.9261	0.9345	2303	0.7396	0.7598	2358	0.2512	0.2502
2194	0.9989	0.9984	2249	0.9242	0.9343	2304	0.7337	0.7636	2359	0.2286	0.2223
2195	0.9983	0.9987	2250	0.9223	0.9342	2305	0.7278	0.7673	2360	0.2060	0.1943
2196	0.9977	0.9989	2251	0.9217	0.9340	2306	0.7278	0.7710	2361	0.1930	0.1856
2197	0.9972	0.9992	2252	0.9211	0.9338	2307	0.7279	0.7748	2362	0.1801	0.1774
2198	0.9966	0.9995	2253	0.9205	0.9336	2308	0.7343	0.7785	2363	0.1672	0.1692
2199	0.9960	0.9997	2254	0.9198	0.9335	2309	0.7407	0.7822	2364	0.1542	0.1609
2200	0.9954	1.0000	2255	0.9192	0.9333	2310	0.7471	0.7860	2365	0.1413	0.1526
2201	0.9952	0.9996	2256	0.9186	0.9331	2311	0.7536	0.7897	2366	0.1283	0.1444
2202	0.9949	0.9991	2257	0.9180	0.9329	2312	0.7600	0.7935	2367	0.1153	0.1361
2203	0.9946	0.9987	2258	0.9174	0.9328	2313	0.7660	0.7972	2368	0.1023	0.1278
2204	0.9943	0.9983	2259	0.9168	0.9326	2314	0.7721	0.8009	2369	0.0893	0.1195
2205	0.9940	0.9978	2260	0.9162	0.9324	2315	0.7781	0.8047	2370	0.0763	0.1112
2206	0.9937	0.9974	2261	0.9153	0.9302	2316	0.7841	0.8084	2371	0.0720	0.1028
2207	0.9934	0.9970	2262	0.9145	0.9280	2317	0.7902	0.8121	2372	0.0676	0.0945
2208	0.9931	0.9965	2263	0.9136	0.9258	2318	0.7962	0.8159	2373	0.0633	0.0862
2209	0.9928	0.9961	2264	0.9128	0.9235	2319	0.8022	0.8196	2374	0.0590	0.0778
2210	0.9925	0.9956	2265	0.9119	0.9213	2320	0.8083	0.8233	2375	0.0546	0.0694
2211	0.9922	0.9952	2266	0.9110	0.9191	2321	0.8191	0.8199	2376	0.0503	0.0611
2212	0.9919	0.9948	2267	0.9102	0.9169	2322	0.8300	0.8162	2377	0.0459	0.0527
2213	0.9916	0.9943	2268	0.9093	0.9147	2323	0.8408	0.8126	2378	0.0416	0.0443
2214	0.9913	0.9939	2269	0.9077	0.9125	2324	0.8517	0.8089	2379	0.0372	0.0359
2215	0.9910	0.9934	2270	0.9061	0.9103	2325	0.8572	0.8053	2380	0.0329	0.0274
2216	0.9907	0.9930	2271	0.9045	0.9081	2326	0.8627	0.8016	2381	0.0307	0.0259
2217	0.9904	0.9926	2272	0.9028	0.9059	2327	0.8683	0.7980	2382	0.0285	0.0245
2218	0.9901	0.9921	2273	0.9012	0.9037	2328	0.8738	0.7943	2383	0.0263	0.0232
2219	0.9898	0.9917	2274	0.8996	0.9015	2329	0.8740	0.7907	2384	0.0241	0.0218
2220	0.9895	0.9912	2275	0.8980	0.8993	2330	0.8743	0.7870	2385	0.0219	0.0205
2221	0.9891	0.9885	2276	0.8964	0.8971	2331	0.8745	0.7834	2386	0.0197	0.0191
2222	0.9886	0.9857	2277	0.8948	0.8949	2332	0.8747	0.7797	2387	0.0175	0.0178
2223	0.9882	0.9829	2278	0.8932	0.8927	2333	0.8678	0.7761	2388	0.0153	0.0164
2224	0.9877	0.9802	2279	0.8916	0.8906	2334	0.8609	0.7724	2389	0.0132	0.0150
2225	0.9872	0.9774	2280	0.8900	0.8884	2335	0.8540	0.7688	2390	0.0110	0.0137
2226	0.9811	0.9746	2281	0.8832	0.8814	2336	0.8364	0.7651	2391	0.0104	0.0123
2227	0.9749	0.9718	2282	0.8764	0.8744	2337	0.8188	0.7615	2392	0.0099	0.0110
2228	0.9687	0.9691	2283	0.8696	0.8673	2338	0.8012	0.7578	2393	0.0093	0.0096
2229	0.9625	0.9663	2284	0.8627	0.8603	2339	0.7480	0.7542	2394	0.0088	0.0082
2230	0.9563	0.9635	2285	0.8560	0.8532	2340	0.6947	0.7505	2395	0.0082	0.0069
2231	0.9548	0.9608	2286	0.8492	0.8462	2341	0.6686	0.7233	2396	0.0077	0.0055
2232	0.9533	0.9580	2287	0.8424	0.8392	2342	0.6424	0.6955	2397	0.0071	0.0041
2233	0.9519	0.9552	2288	0.8357	0.8322	2343	0.6162	0.6678	2398	0.0066	0.0028
2234	0.9504	0.9525	2289	0.8290	0.8252	2344	0.5899	0.6400	2399	0.0060	0.0014
2235	0.9490	0.9497	2290	0.8222	0.8182	2345	0.5636	0.6122	2400	0.0055	0.0000
2236	0.9475	0.9470	2291	0.8157	0.8112	2346	0.5372	0.5845	2401	0.0049	******
2237	0.9460	0.9442	2292	0.8092	0.8043	2347	0.5108	0.5567	2402	0.0044	******
2238	0.9446	0.9414	2293	0.8027	0.7973	2348	0.4844	0.5288	2403	0.0038	******
2239	0.9431	0.9387	2294	0.7961	0.7904	2349	0.4579	0.5010	2404	0.0033	******
2240	0.9416	0.9359	2295	0.7896	0.7834	2350	0.4313	0.4732	2405	0.0027	******
2241	0.9397	0.9357	2296	0.7832	0.7765	2351	0.4059	0.4454	2406	0.0022	******
2242	0.9377	0.9355	2297	0.7767	0.7695	2352	0.3864	0.4175	2407	0.0016	******
2243	0.9358	0.9354	2298	0.7702	0.7626	2353	0.3640	0.3896	2408	0.0011	******
2244	0.9339	0.9352	2299	0.7637	0.7557	2354	0.3415	0.3618	2409	0.0005	******
2245	0.9319	0.9350	2300	0.7573	0.7488	2355	0.3189	0.3339			

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Table A7a

THEMATIC MAPPER RELATVE SPECTRAL RESPONSE - BAND 6 *** DETECTOR 1

WAVELENGTH (NM)	PF	F	WAVELENGTH (NM)	PF	F	WAVELENGTH (NM)	PF	F	WAVELENGTH (NM)	PF	F
9760	0.0004	******	10360	0.2821	0.2209	10960	0.9874	0.8613	11560	0.5421	0.9636
9770	0.0008	******	10370	0.3157	0.2461	10970	0.9896	0.8661	11570	0.5311	0.9575
9780	0.0011	******	10380	0.3495	0.2715	10980	0.9918	0.8709	11580	0.5203	0.9515
9790	0.0015	******	10390	0.3835	0.2971	10990	0.9941	0.8758	11590	0.5095	0.9454
9800	0.0019	******	10400	0.4184	0.3230	11000	0.9963	0.8806	11600	0.5003	0.9393
9810	0.0023	******	10410	0.4535	0.3566	11010	0.9966	0.8832	11610	0.4912	0.9403
9820	0.0027	******	10420	0.4920	0.3903	11020	0.9968	0.8859	11620	0.4820	0.9412
9830	0.0031	******	10430	0.5378	0.4241	11030	0.9970	0.8885	11630	0.4740	0.9422
9840	0.0035	******	10440	0.5839	0.4581	11040	0.9973	0.8912	11640	0.4673	0.9431
9850	0.0038	******	10450	0.6306	0.4922	11050	0.9975	0.8938	11650	0.4606	0.9440
9860	0.0042	******	10460	0.6777	0.5263	11060	0.9984	0.8965	11660	0.4538	0.9449
9870	0.0046	******	10470	0.7252	0.5606	11070	0.9992	0.8991	11670	0.4471	0.9458
9880	0.0050	******	10480	0.7532	0.5950	11080	1.0000	0.9018	11680	0.4402	0.9467
9890	0.0054	******	10490	0.7760	0.6295	11090	0.9992	0.9044	11690	0.4326	0.9476
9900	0.0058	******	10500	0.7990	0.6641	11100	0.9985	0.9071	11700	0.4253	0.9485
9910	0.0062	******	10510	0.8225	0.6726	11110	0.9957	0.9064	11710	0.4188	0.9491
9920	0.0066	******	10520	0.8403	0.6812	11120	0.9883	0.9056	11720	0.4106	0.9496
9930	0.0070	******	10530	0.8531	0.6898	11130	0.9807	0.9049	11730	0.4024	0.9502
9940	0.0074	******	10540	0.8568	0.6985	11140	0.9731	0.9042	11740	0.3942	0.9507
9950	0.0078	******	10550	0.8604	0.7072	11150	0.9656	0.9034	11750	0.3860	0.9513
9960	0.0082	******	10560	0.8618	0.7160	11160	0.9505	0.9026	11760	0.3778	0.9518
9970	0.0086	******	10570	0.8617	0.7248	11170	0.9355	0.9019	11770	0.3695	0.9523
9980	0.0090	******	10580	0.8615	0.7338	11180	0.9207	0.9011	11780	0.3610	0.9528
9990	0.0094	******	10590	0.8570	0.7427	11190	0.9059	0.9003	11790	0.3525	0.9533
10000	0.0098	0.0056	10600	0.8514	0.7507	11200	0.8913	0.8995	11800	0.3441	0.9538
10010	0.0101	0.0063	10610	0.8542	0.7516	11210	0.8821	0.9089	11810	0.3371	0.9522
10020	0.0105	0.0071	10620	0.8571	0.7515	11220	0.8730	0.9083	11820	0.3301	0.9506
10030	0.0109	0.0078	10630	0.8599	0.7514	11230	0.8638	0.9128	11830	0.3230	0.9490
10040	0.0113	0.0085	10640	0.8625	0.7513	11240	0.8553	0.9172	11840	0.3152	0.9474
10050	0.0117	0.0093	10650	0.8639	0.7512	11250	0.8480	0.9217	11850	0.3069	0.9458
10060	0.0121	0.0100	10660	0.8652	0.7511	11260	0.8405	0.9262	11860	0.2986	0.9442
10070	0.0125	0.0108	10670	0.8665	0.7509	11270	0.8330	0.9307	11870	0.2901	0.9426
10080	0.0129	0.0116	10680	0.8678	0.7507	11280	0.8254	0.9352	11880	0.2815	0.9409
10090	0.0132	0.0123	10690	0.8690	0.7505	11290	0.8177	0.9398	11890	0.2729	0.9394
10100	0.0136	0.0131	10700	0.8710	0.7503	11300	0.8072	0.9443	11900	0.2647	0.9378
10110	0.0154	0.0146	10710	0.8745	0.7537	11310	0.7967	0.9468	11910	0.2564	0.9354
10120	0.0172	0.0160	10720	0.8780	0.7571	11320	0.7891	0.9493	11920	0.2482	0.9331
10130	0.0190	0.0175	10730	0.8812	0.7605	11330	0.7808	0.9518	11930	0.2401	0.9307
10140	0.0208	0.0189	10740	0.8844	0.7639	11340	0.7725	0.9542	11940	0.2323	0.9284
10150	0.0225	0.0204	10750	0.8876	0.7673	11350	0.7641	0.9567	11950	0.2245	0.9260
10160	0.0243	0.0219	10760	0.8911	0.7707	11360	0.7556	0.9591	11960	0.2168	0.9236
10170	0.0262	0.0234	10770	0.8946	0.7741	11370	0.7457	0.9616	11970	0.2091	0.9212
10180	0.0280	0.0249	10780	0.9002	0.7776	11380	0.7350	0.9640	11980	0.2014	0.9189
10190	0.0298	0.0264	10790	0.9079	0.7810	11390	0.7255	0.9664	11990	0.1932	0.9165
10200	0.0316	0.0280	10800	0.9156	0.7845	11400	0.7160	0.9688	12000	0.1851	0.9141
10210	0.0369	0.0325	10810	0.9233	0.7892	11410	0.7064	0.9719	12010	0.1827	0.9127
10220	0.0445	0.0371	10820	0.9285	0.7940	11420	0.6992	0.9751	12020	0.1797	0.9113
10230	0.0522	0.0417	10830	0.9337	0.7988	11430	0.6917	0.9782	12030	0.1767	0.9099
10240	0.0599	0.0464	10840	0.9389	0.8037	11440	0.6839	0.9813	12040	0.1737	0.9085
10250	0.0677	0.0511	10850	0.9440	0.8085	11450	0.6760	0.9844	12050	0.1708	0.9072
10260	0.0756	0.0558	10860	0.9497	0.8134	11460	0.6663	0.9875	12060	0.1678	0.9058
10270	0.0834	0.0606	10870	0.9552	0.8182	11470	0.6548	0.9907	12070	0.1649	0.9044
10280	0.0914	0.0654	10880	0.9581	0.8231	11480	0.6434	0.9938	12080	0.1621	0.9030
10290	0.0994	0.0702	10890	0.9610	0.8280	11490	0.6319	0.9969	12090	0.1592	0.9016
10300	0.1074	0.0751	10900	0.9638	0.8330	11500	0.6196	1.0000	12100	0.1564	0.9002
10310	0.1172	0.0988	10910	0.9689	0.8376	11510	0.6063	0.9939	12110	0.1553	0.8986
10320	0.1498	0.1228	10920	0.9739	0.8423	11520	0.5932	0.9879	12120	0.1541	0.8970
10330	0.1825	0.1470	10930	0.9788	0.8470	11530	0.5802	0.9818	12130	0.1525	0.8955
10340	0.2155	0.1714	10940	0.9820	0.8518	11540	0.5673	0.9758	12140	0.1507	0.8939
10350	0.2487	0.1980	10950	0.9852	0.8565	11550	0.5546	0.9697	12150	0.1490	0.8923

Table A7a
(CONTINUED)

WAVELENGTH (NM)	PF	F	WAVELENGTH (NM)	PF	F	WAVELENGTH (NM)	PF	F	WAVELENGTH (NM)	PF	F
12160	0.1472	0.8907	12380	0.0707	0.5991	12600	0.0034	0.0422	12820	0.0005	0.0076
12170	0.1454	0.8891	12390	0.0656	0.5721	12610	0.0032	0.0400	12830	0.0005	0.0073
12180	0.1437	0.8875	12400	0.0606	0.5451	12620	0.0030	0.0377	12840	0.0004	0.0070
12190	0.1419	0.8859	12410	0.0561	0.5149	12630	0.0028	0.0356	12850	0.0004	0.0067
12200	0.1396	0.8843	12420	0.0517	0.4846	12640	0.0026	0.0334	12860	0.0004	0.0064
12210	0.1371	0.8774	12430	0.0473	0.4543	12650	0.0024	0.0312	12870	0.0004	0.0061
12220	0.1346	0.8706	12440	0.0430	0.4238	12660	0.0022	0.0291	12880	0.0004	0.0058
12230	0.1320	0.8638	12450	0.0389	0.3934	12670	0.0020	0.0270	12890	0.0003	0.0055
12240	0.1295	0.8571	12460	0.0349	0.3628	12680	0.0018	0.0248	12900	0.0003	0.0051
12250	0.1269	0.8503	12470	0.0311	0.3322	12690	0.0016	0.0228	12910	0.0003	0.0047
12260	0.1244	0.8435	12480	0.0274	0.3015	12700	0.0015	0.0207	12920	0.0002	0.0043
12270	0.1219	0.8368	12490	0.0238	0.2708	12710	0.0014	0.0194	12930	0.0002	0.0039
12280	0.1177	0.8301	12500	0.0205	0.2400	12720	0.0013	0.0182	12940	0.0002	0.0035
12290	0.1134	0.8234	12510	0.0186	0.2197	12730	0.0012	0.0170	12950	0.0002	0.0031
12300	0.1092	0.8166	12520	0.0167	0.1996	12740	0.0011	0.0157	12960	0.0001	0.0026
12310	0.1051	0.7893	12530	0.0149	0.1795	12750	0.0010	0.0145	12970	0.0001	0.0022
12320	0.1006	0.7620	12540	0.0130	0.159[illegible]	12760	0.0009	0.0132	12980	0.0001	0.0018
12330	0.0963	0.7347	12550	0.0112	0.139[illegible]	12770	0.0008	0.0120	12990	0.0001	0.0014
12340	0.0921	0.7075	12560	0.0095	0.1200	12780	0.0007	0.0107	13000	0.0001	******
12350	0.0872	0.6803	12570	0.0077	0.1004	12790	0.0006	0.0095	13010	0.0000	******
12360	0.0815	0.6532	12580	0.0061	0.0808	12800	0.0005	0.0083	13020	0.0000	******
12370	0.0760	0.6261	12590	0.0047	0.0614	12810	0.0005	0.0079			

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Table A7b

THEMATIC MAPPER RELATVE SPECTRAL RESPONSE - BAND 6 *** DETECTOR 2

WAVELENGTH (NM)	PF	F	WAVELENGTH (NM)	PF	F	WAVELENGTH (NM)	PF	F	WAVELENGTH (NM)	PF	F
9760	0.0004	******	10360	0.2893	0.2256	10960	0.9914	0.9479	11560	0.5876	0.9524
9770	0.0008	******	10370	0.3237	0.2511	10970	0.9933	0.9547	11570	0.5761	0.9446
9780	0.0002	******	10380	0.3585	0.2769	10980	0.9951	0.9614	11580	0.5649	0.9368
9790	0.0015	******	10390	0.3934	0.3029	10990	0.9969	0.9683	11590	0.5537	0.9290
9800	0.0019	******	10400	0.4290	0.3292	11000	0.9988	0.9751	11600	0.5422	0.9213
9810	0.0023	******	10410	0.4648	0.3633	11010	0.9990	0.9759	11610	0.5309	0.9243
9820	0.0027	******	10420	0.5042	0.3974	11020	0.9992	0.9768	11620	0.5197	0.9272
9830	0.0031	******	10430	0.5506	0.4317	11030	0.9995	0.9776	11630	0.5087	0.9302
9840	0.0035	******	10440	0.5974	0.4661	11040	0.9997	0.9784	11640	0.4954	0.9332
9850	0.0039	******	10450	0.6447	0.5005	11050	1.0000	0.9793	11650	0.4900	0.9361
9860	0.0043	******	10460	0.6923	0.5350	11060	0.9978	0.9801	11660	0.4807	0.9391
9870	0.0047	******	10470	0.7403	0.5696	11070	0.9956	0.9809	11670	0.4715	0.9420
9880	0.0051	******	10480	0.7683	0.6043	11080	0.9934	0.9818	11680	0.4623	0.9450
9890	0.0055	******	10490	0.7915	0.6391	11090	0.9878	0.9828	11690	0.4539	0.9480
9900	0.0059	******	10500	0.8147	0.6739	11100	0.9823	0.9834	11700	0.4460	0.9509
9910	0.0083	******	10510	0.8384	0.6839	11110	0.9724	0.9806	11710	0.4388	0.9536
9920	0.0067	******	10520	0.8574	0.6940	11120	0.9547	0.9778	11720	0.4331	0.9562
9930	0.0071	******	10530	0.8709	0.7042	11130	0.9370	0.9750	11730	0.4273	0.9589
9940	0.0075	******	10540	0.8753	0.7145	11140	0.9195	0.9721	11740	0.4215	0.9615
9950	0.0080	******	10550	0.8797	0.7248	11150	0.9023	0.9693	11750	0.4156	0.9642
9960	0.0084	******	10560	0.8818	0.7353	11160	0.8852	0.9665	11760	0.4096	0.9688
9970	0.0088	******	10570	0.8823	0.7458	11170	0.8683	0.9637	11770	0.4033	0.9694
9980	0.0092	******	10580	0.8828	0.7584	11180	0.8518	0.9608	11780	0.3968	0.9721
9990	0.0096	******	10590	0.8788	0.7671	11190	0.8354	0.9580	11790	0.3902	0.9747
10000	0.0100	0.0058	10600	0.8737	0.7779	11200	0.8193	0.9552	11800	0.3836	0.9773
10010	0.0104	0.0066	10610	0.8761	0.7793	11210	0.8173	0.9579	11810	0.3765	0.9778
10020	0.0108	0.0073	10620	0.8784	0.7806	11220	0.8153	0.9608	11820	0.3693	0.9782
10030	0.0112	0.0081	10630	0.8806	0.7820	11230	0.8131	0.9635	11830	0.3621	0.9787
10040	0.0116	0.0088	10640	0.8826	0.7833	11240	0.8115	0.9661	11840	0.3541	0.9792
10050	0.0120	0.0096	10650	0.8834	0.7846	11250	0.8110	0.9688	11850	0.3456	0.9797
10060	0.0124	0.0104	10660	0.8842	0.7859	11260	0.8104	0.9716	11860	0.3370	0.9801
10070	0.0128	0.0112	10670	0.8849	0.7872	11270	0.8098	0.9743	11870	0.3281	0.9806
10080	0.0132	0.0120	10680	0.8856	0.7884	11280	0.8090	0.9771	11880	0.3192	0.9810
10090	0.0136	0.0128	10690	0.8862	0.7896	11290	0.8081	0.9798	11890	0.3103	0.9815
10100	0.0140	0.0136	10700	0.8845	0.7908	11300	0.8016	0.9826	11900	0.3018	0.9819
10110	0.0158	0.0150	10710	0.8852	0.7958	11310	0.7950	0.9832	11910	0.2932	0.9816
10120	0.0176	0.0165	10720	0.8859	0.8008	11320	0.7913	0.9838	11920	0.2847	0.9813
10130	0.0194	0.0018	10730	0.8847	0.8058	11330	0.7855	0.9844	11930	0.2764	0.9809
10140	0.0213	0.0195	10740	0.8835	0.8108	11340	0.7797	0.9849	11940	0.2683	0.9805
10150	0.0231	0.0210	10750	0.8822	0.8158	11350	0.7789	0.9855	11950	0.2603	0.9801
10160	0.0250	0.0226	10760	0.8809	0.8209	11360	0.7679	0.9860	11960	0.2524	0.9797
10170	0.0268	0.0241	10770	0.8797	0.8260	11370	0.7606	0.9866	11970	0.2444	0.9793
10180	0.0287	0.0256	10780	0.8803	0.8311	11380	0.7525	0.9871	11980	0.2365	0.9788
10190	0.0305	0.0272	10790	0.8862	0.8362	11390	0.7456	0.9876	11990	0.2280	0.9784
10200	0.0324	0.0288	10800	0.8921	0.8413	11400	0.7387	0.9881	12000	0.2196	0.9779
10210	0.0378	0.0334	10810	0.8974	0.8479	11410	0.7317	0.9893	12010	0.2167	0.9769
10220	0.0456	0.0381	10820	0.9068	0.8544	11420	0.7271	0.9905	12020	0.2130	0.9759
10230	0.0535	0.0428	10830	0.9162	0.8610	11430	0.7224	0.9917	12030	0.2094	0.9749
10240	0.0614	0.0476	10840	0.9257	0.8677	11440	0.7174	0.9929	12040	0.2057	0.9739
10250	0.0693	0.0524	10850	0.9352	0.8743	11450	0.7123	0.9941	12050	0.2022	0.9725
10260	0.0774	0.0572	10860	0.9448	0.8810	11460	0.7052	0.9953	12060	0.1986	0.9715
10270	0.0854	0.0621	10870	0.9543	0.8877	11470	0.6963	0.9965	12070	0.1951	0.9708
10280	0.0936	0.0670	10880	0.9612	0.8945	11480	0.6875	0.9977	12080	0.1916	0.9698
10290	0.1018	0.0719	10890	0.9681	0.9013	11490	0.6786	0.9989	12090	0.1881	0.9688
10300	0.1100	0.0769	10900	0.9750	0.9081	11500	0.6689	1.0000	12100	0.1846	0.9677
10310	0.1201	0.1011	10910	0.9787	0.9146	11510	0.6549	0.9920	12110	0.1832	0.9665
10320	0.1535	0.1256	10920	0.9824	0.9212	11520	0.6412	0.9840	12120	0.1818	0.9653
10330	0.1871	0.1502	10930	0.9859	0.9278	11530	0.6276	0.9761	12130	0.1797	0.9640
10340	0.2209	0.1751	10940	0.9878	0.9345	11540	0.6141	0.9682	12140	0.1775	0.9627
10350	0.2550	0.2002	10950	0.9896	0.9412	11550	0.6008	0.9603	12150	0.1754	0.9615

Table A7b
(CONTINUED)

WAVELENGTH (NM)	PF	F	WAVELENGTH (NM)	PF	F	WAVELENGTH (NM)	PF	F	WAVELENGTH (NM)	PF	F
12160	0.1732	0.9602	12380	0.0814	0.6523	12600	0.0038	0.0458	12820	0.0005	0.0081
12170	0.1710	0.9589	12390	0.0754	0.6232	12610	0.0036	0.0433	12830	0.0005	0.0078
12180	0.1688	0.9577	12400	0.0696	0.5940	12620	0.0033	0.0409	12840	0.0005	0.0074
12190	0.1565	0.9564	12410	0.0643	0.5614	12630	0.0031	0.0385	12850	0.0004	0.0071
12200	0.1638	0.9551	12420	0.0591	0.5286	12640	0.0028	0.0361	12860	0.0004	0.0068
12210	0.1607	0.9481	12430	0.0540	0.4957	12650	0.0026	0.0337	12870	0.0004	0.0064
12220	0.1576	0.9412	12440	0.0490	0.4627	12660	0.0024	0.0314	12880	0.0004	0.0061
12230	0.1545	0.9343	12450	0.0442	0.4296	12670	0.0022	0.0291	12890	0.0003	0.0058
12240	0.1514	0.9274	12460	0.0396	0.3964	12680	0.0020	0.0268	12900	0.0003	0.0054
12250	0.1483	0.9205	12470	0.0352	0.3631	12690	0.0018	0.0245	12910	0.0003	0.0050
12260	0.1452	0.9136	12480	0.0309	0.3297	12700	0.0016	0.0223	12920	0.0003	0.0045
12270	0.1422	0.9067	12490	0.0269	0.2962	12710	0.0015	0.0209	12930	0.0002	0.0041
12280	0.1372	0.8999	12500	0.0230	0.2627	12720	0.0014	0.0195	12940	0.0002	0.0037
12290	0.1320	0.8930	12510	0.0209	0.2403	12730	0.0013	0.0182	12950	0.0002	0.0032
12300	0.1270	0.8861	12520	0.0187	0.2181	12740	0.0012	0.0168	12960	0.0002	0.0028
12310	0.1220	0.8568	12530	0.0166	0.1960	12750	0.0011	0.0155	12970	0.0001	0.0023
12320	0.1168	0.8275	12540	0.0146	0.1741	12760	0.0010	0.0141	12980	0.0001	0.0019
12330	0.1116	0.7982	12550	0.0126	0.1523	12770	0.0009	0.0128	12990	0.0001	0.0015
12340	0.1066	0.7690	12560	0.0106	0.1307	12780	0.0008	0.0115	13000	0.0001	******
12350	0.1009	0.7398	12570	0.0086	0.1092	12790	0.0007	0.0101	13010	0.0000	******
12360	0.0941	0.7136	12580	0.0068	0.0879	12800	0.0005	0.0088	13020	0.0000	******
12370	0.0877	0.6814	12590	0.0053	0.0667	12810	0.0006	0.0085			

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Table A7c

THEMATIC MAPPER RELATVE SPECTRAL RESPONSE - BAND 6 --- DETECTOR 3

WAVELENGTH (NM)	PF	F	WAVELENGTH (NM)	PF	F	WAVELENGTH (NM)	PF	F	WAVELENGTH (NM)	PF	F
9760	0.0004	******	10360	0.2830	0.2209	10960	0.9906	0.8613	11560	0.6197	0.9636
9770	0.0008	******	10370	0.3167	0.2461	10970	0.9927	0.8661	11570	0.6072	0.9575
9780	0.0011	******	10380	0.3507	0.2715	10980	0.9947	0.8709	11580	0.5950	0.9515
9790	0.0015	******	10390	0.3849	0.2971	10990	0.9967	0.8758	11590	0.5829	0.9454
9800	0.0019	******	10400	0.4203	0.3230	11000	0.9988	0.8806	11600	0.5706	0.9393
9810	0.0023	******	10410	0.4561	0.3566	11010	0.9990	0.8832	11610	0.5583	0.9403
9820	0.0027	******	10420	0.4954	0.3903	11020	0.9992	0.8859	11620	0.5462	0.9412
9830	0.0031	******	10430	0.5415	0.4241	11030	0.9995	0.8885	11630	0.5344	0.9422
9840	0.0035	******	10440	0.5880	0.4581	11040	0.9997	0.8912	11640	0.5242	0.9431
9850	0.0038	******	10450	0.6350	0.4922	11050	1.0000	0.8938	11650	0.5141	0.9440
9860	0.0042	******	10460	0.6825	0.5263	11060	0.9988	0.8965	11660	0.5040	0.9449
9870	0.0046	******	10470	0.7304	0.5606	11070	0.9976	0.8991	11670	0.4940	0.9458
9880	0.0050	******	10480	0.7586	0.5950	11080	0.9964	0.9018	11680	0.4840	0.9467
9890	0.0054	******	10490	0.7816	0.6295	11090	0.9936	0.9044	11690	0.4748	0.9476
9900	0.0058	******	10500	0.8047	0.6641	11100	0.9908	0.9071	11700	0.4663	0.9485
9910	0.0062	******	10510	0.8286	0.6726	11110	0.9835	0.9064	11710	0.4584	0.9491
9920	0.0066	******	10520	0.8468	0.6812	11120	0.9717	0.9056	11720	0.4521	0.9496
9930	0.0070	******	10530	0.8596	0.6898	11130	0.9597	0.9049	11730	0.4457	0.9502
9940	0.0074	******	10540	0.8633	0.6985	11140	0.9478	0.9042	11740	0.4392	0.9507
9950	0.0078	******	10550	0.8670	0.7072	11150	0.9360	0.9034	11750	0.4326	0.9513
9960	0.0082	******	10560	0.8685	0.7160	11160	0.9243	0.9026	11760	0.4260	0.9518
9970	0.0086	******	10570	0.8684	0.7248	11170	0.9126	0.9019	11770	0.4199	0.9523
9980	0.0090	******	10580	0.8683	0.7338	11180	0.9010	0.9011	11780	0.4119	0.9528
9990	0.0094	******	10590	0.8688	0.7427	11190	0.8895	0.9003	11790	0.4046	0.9533
10000	0.0098	0.0056	10600	0.8582	0.7507	11200	0.8781	0.8995	11800	0.3973	0.9538
10010	0.0102	0.0063	10610	0.8613	0.7516	11210	0.8722	0.9089	11810	0.3895	0.9522
10020	0.0108	0.0071	10620	0.8645	0.7515	11220	0.8662	0.9083	11820	0.3816	0.9506
10030	0.0108	0.0078	10630	0.8677	0.7514	11230	0.8602	0.9128	11830	0.3737	0.9490
10040	0.0111	0.0085	10640	0.8705	0.7513	11240	0.8549	0.9172	11840	0.3650	0.9474
10050	0.0115	0.0093	10650	0.8722	0.7512	11250	0.8507	0.9217	11850	0.3557	0.9468
10060	0.0118	0.0100	10660	0.8738	0.7511	11260	0.8465	0.9262	11860	0.3463	0.9442
10070	0.0121	0.0108	10670	0.8754	0.7509	11270	0.8422	0.9307	11870	0.3367	0.9426
10080	0.0124	0.0116	10680	0.8770	0.7507	11280	0.8379	0.9352	11880	0.3270	0.9409
10090	0.0127	0.0123	10690	0.8786	0.7505	11290	0.8335	0.9398	11890	0.3174	0.9394
10100	0.0131	0.0131	10700	0.8777	0.7503	11300	0.8262	0.9443	11900	0.3081	0.9378
10110	0.0148	0.0146	10710	0.8784	0.7537	11310	0.8190	0.9468	11910	0.2988	0.9354
10120	0.0165	0.0160	10720	0.8792	0.7571	11320	0.8147	0.9493	11920	0.2896	0.9331
10130	0.0183	0.0175	10730	0.8779	0.7605	11330	0.8098	0.9518	11930	0.2805	0.9307
10140	0.0202	0.0189	10740	0.8767	0.7639	11340	0.8048	0.9542	11940	0.2717	0.9284
10150	0.0220	0.0204	10750	0.8755	0.7673	11350	0.7988	0.9567	11950	0.2630	0.9260
10160	0.0239	0.0219	10760	0.8742	0.7707	11360	0.7947	0.9591	11960	0.2543	0.9236
10170	0.0258	0.0234	10770	0.8729	0.7741	11370	0.7882	0.9616	11970	0.2457	0.9212
10180	0.0278	0.0249	10780	0.8736	0.7776	11380	0.7808	0.9640	11980	0.2370	0.9189
10190	0.0297	0.0264	10790	0.8794	0.7810	11390	0.7747	0.9664	11990	0.2278	0.9165
10200	0.0316	0.0280	10800	0.8853	0.7845	11400	0.7686	0.9688	12000	0.2187	0.9141
10210	0.0370	0.0325	10810	0.8912	0.7892	11410	0.7625	0.9719	12010	0.2158	0.9127
10220	0.0447	0.0371	10820	0.9011	0.7940	11420	0.7589	0.9751	12020	0.2121	0.9113
10230	0.0524	0.0417	10830	0.9109	0.7988	11430	0.7551	0.9782	12030	0.2085	0.9099
10240	0.0601	0.0464	10840	0.9209	0.8037	11440	0.7510	0.9813	12040	0.2050	0.9085
10250	0.0678	0.0511	10850	0.9309	0.8085	11450	0.7468	0.9844	12050	0.2014	0.9072
10260	0.0757	0.0558	10860	0.9406	0.8134	11460	0.7406	0.9875	12060	0.1979	0.9058
10270	0.0836	0.0606	10870	0.9502	0.8182	11470	0.7325	0.9907	12070	0.1944	0.9044
10280	0.0916	0.0654	10880	0.9571	0.8231	11480	0.7244	0.9938	12080	0.1909	0.9030
10290	0.0996	0.0702	10890	0.9641	0.8280	11490	0.7163	0.9969	12090	0.1875	0.9016
10300	0.1077	0.0751	10900	0.9711	0.8330	11500	0.7072	1.0000	12100	0.1841	0.9002
10310	0.1175	0.0988	10910	0.9754	0.8376	11510	0.6922	0.9939	12110	0.1827	0.8986
10320	0.1502	0.122[illegible]	10920	0.9797	0.8423	11520	0.6774	0.9879	12120	0.1813	0.8970
10330	0.1830	0.1470	10930	0.9838	0.8470	11530	0.6627	0.9818	12130	0.1793	0.8955
10340	0.2161	0.1714	10940	0.9862	0.8518	11540	0.6482	0.9758	12140	0.1771	0.8939
10350	0.2495	0.1960	10950	0.9856	0.8565	11550	0.6338	0.9697	12150	0.1750	0.8923

Table A7c
(CONTINUED)

WAVELENGTH (NM)	PF	F	WAVELENGTH (NM)	PF	F	WAVELENGTH (NM)	PF	F	WAVELENGTH (NM)	PF	F
12160	0.1728	0.8907	12380	0.0817	0.5391	12600	0.0038	0.0422	12820	0.0005	0.0076
12170	0.1707	0.8891	12390	0.0757	0.5721	12610	0.0036	0.0400	12830	0.0005	0.0073
12180	0.1685	0.8875	12400	0.0699	0.5451	12620	0.0033	0.0377	12840	0.0005	0.0070
12190	0.1663	0.8859	12410	0.0646	0.5149	12630	0.0031	0.0356	12850	0.0004	0.0067
12200	0.1636	0.8843	12420	0.0595	0.4846	12640	0.0028	0.0334	12860	0.0004	0.0064
12210	0.1606	0.8774	12430	0.0544	0.4543	12650	0.0026	0.0312	12870	0.0004	0.0061
12220	0.1575	0.8706	12440	0.0494	0.4238	12660	0.0024	0.0291	12880	0.0004	0.0058
12230	0.1544	0.8638	12450	0.0446	0.3934	12670	0.0022	0.0270	12890	0.0003	0.0055
12240	0.1514	0.8571	12460	0.0399	0.3628	12680	0.0020	0.0248	12900	0.0003	0.0051
12250	0.1483	0.8503	12470	0.0355	0.3322	12690	0.0018	0.0228	12910	0.0003	0.0047
12260	0.1453	0.8435	12480	0.0312	0.3015	12700	0.0016	0.0207	12920	0.0003	0.0043
12270	0.1422	0.8368	12490	0.0272	0.2708	12710	0.0015	0.0194	12930	0.0002	0.0039
12280	0.1373	0.8301	12500	0.0233	0.2400	12720	0.0014	0.0182	12940	0.0002	0.0035
12290	0.1322	0.8234	12510	0.0211	0.2197	12730	0.0013	0.0170	12950	0.0002	0.0031
12300	0.1271	0.8166	12520	0.0189	0.1996	12740	0.0012	0.0157	12960	0.0001	0.0026
12310	0.1222	0.7893	12530	0.0168	0.1795	12750	0.0011	0.0145	12970	0.0001	0.0022
12320	0.1170	0.7620	12540	0.0147	0.1596	12760	0.0010	0.0132	12980	0.0001	0.0018
12330	0.1119	0.7347	12550	0.0127	0.1397	12770	0.0009	0.0120	12990	0.0001	0.0014
12340	0.1069	0.7075	12560	0.0107	0.1200	12780	0.0008	0.0107	13000	0.0001	******
12350	0.1012	0.6803	12570	0.0087	0.1004	12790	0.0007	0.0095	13010	0.0000	******
12360	0.0945	0.6532	12580	0.0068	0.0808	12800	0.0006	0.0083	13020	0.0000	******
12370	0.0880	0.6261	12590	0.0053	0.0614	12810	0.0005	0.0079			

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Table A7d

THEMATIC MAPPER RELATIVE SPECTRAL RESPONSE - BAND 6 *** DETECTOR 4

WAVELENGTH (NM)	PF	F	WAVELENGTH (NM)	PF	F	WAVELENGTH (NM)	PF	F	WAVELENGTH (NM)	PF	F
10000	0.0094	0.0058	10600	0.8375	0.7779	11200	0.8728	0.9552	11800	0.4297	0.9773
10010	0.0097	0.0066	10610	0.8411	0.7793	11210	0.8682	0.9579	11810	0.4215	0.9778
10020	0.0100	0.0073	10620	0.8447	0.7806	11220	0.8637	0.9608	11820	0.4133	0.9782
10030	0.0103	0.0081	10630	0.8483	0.7820	11230	0.8591	0.9635	11830	0.4050	0.9787
10040	0.0107	0.0088	10640	0.8516	0.7833	11240	0.8552	0.9661	11840	0.3958	0.9792
10050	0.0110	0.0096	10650	0.8538	0.7846	11250	0.8524	0.9688	11850	0.3859	0.9797
10060	0.0113	0.0104	10660	0.8559	0.7859	11260	0.8496	0.9716	11860	0.3761	0.9801
10070	0.0116	0.0112	10670	0.8579	0.7872	11270	0.8468	0.9743	11870	0.3659	0.9806
10080	0.0119	0.0120	10680	0.8600	0.7884	11280	0.8439	0.9771	11880	0.3557	0.9810
10090	0.0122	0.0128	10690	0.8620	0.7896	11290	0.8410	0.9798	11890	0.3455	0.9815
10100	0.0126	0.0136	10700	0.8647	0.7908	11300	0.8352	0.9826	11900	0.3357	0.9819
10110	0.0142	0.0150	10710	0.8694	0.7958	11310	0.8294	0.9832	11910	0.3274	0.9816
10120	0.0159	0.0165	10720	0.8742	0.8008	11320	0.8266	0.9838	11920	0.3190	0.9813
10130	0.0177	0.0018	10730	0.8786	0.8058	11330	0.8232	0.9844	11930	0.3109	0.9809
10140	0.0194	0.0195	10740	0.8830	0.8108	11340	0.8197	0.9849	11940	0.3030	0.9805
10150	0.0212	0.0210	10750	0.8875	0.8158	11350	0.8162	0.9855	11950	0.2953	0.9801
10160	0.0230	0.0226	10760	0.8919	0.8209	11360	0.8126	0.9860	11960	0.2876	0.9797
10170	0.0249	0.0241	10770	0.8964	0.8260	11370	0.8075	0.9866	11970	0.2799	0.9793
10180	0.0267	0.0256	10780	0.9029	0.8311	11380	0.8017	0.9871	11980	0.2722	0.9788
10190	0.0286	0.0272	10790	0.9115	0.8362	11390	0.7971	0.9876	11990	0.2639	0.9784
10200	0.0305	0.0288	10800	0.9202	0.8413	11400	0.7925	0.9881	12000	0.2556	0.9779
10210	0.0357	0.0334	10810	0.9285	0.8479	11410	0.7984	0.9893	12010	0.2524	0.9769
10220	0.0431	0.0381	10820	0.9342	0.8544	11420	0.7889	0.9905	12020	0.2484	0.9759
10230	0.0506	0.0428	10830	0.9398	0.8610	11430	0.7884	0.9917	12030	0.2444	0.9749
10240	0.0581	0.0476	10840	0.9455	0.8677	11440	0.7875	0.9929	12040	0.2404	0.9739
10250	0.0607	0.0524	10850	0.9512	0.8743	11450	0.7865	0.9941	12050	0.2335	0.9729
10260	0.0733	0.0572	10860	0.9569	0.8810	11460	0.7834	0.9953	12060	0.2326	0.9719
10270	0.0811	0.0621	10870	0.9625	0.8877	11470	0.7784	0.9965	12070	0.2287	0.9708
10280	0.0888	0.0670	10880	0.9654	0.8945	11480	0.7733	0.9977	12080	0.2248	0.9698
10290	0.0967	0.0719	10890	0.9682	0.5013	11490	0.7683	0.9989	12090	0.2210	0.9688
10300	0.1046	0.0769	10900	0.9711	0.9081	11500	0.7622	1.0000	12100	0.2172	0.9677
10310	0.1141	0.1011	10910	0.9752	0.9146	11510	0.7521	0.9920	12110	0.2126	0.9665
10320	0.1459	0.1256	10920	0.9793	0.9212	11520	0.7421	0.9840	12120	0.2080	0.9653
10330	0.1780	0.1502	10930	0.9832	0.9278	11530	0.7322	0.9761	12130	0.2026	0.9640
10340	0.2103	0.1751	10940	0.9854	0.9345	11540	0.7223	0.9682	12140	0.1971	0.9627
10350	0.2426	0.2002	10950	0.9876	0.9412	11550	0.7126	0.9603	12150	0.1915	0.9615
10360	0.2755	0.2256	10960	0.9898	0.9479	11560	0.7029	0.957[illegible]	12160	0.1859	0.9602
10370	0.3085	0.2511	10970	0.9921	0.9547	11570	0.6951	0.9446	12170	0.1803	0.9589
10380	0.3417	0.2769	10980	0.9943	0.9614	11580	0.6875	0.9368	12180	0.1747	0.9577
10390	0.3752	0.3029	10990	0.9965	0.9683	11590	0.6799	0.9290	12190	0.1690	0.9564
10400	0.4095	0.3292	11000	0.9988	0.9751	11600	0.6743	0.9213	12200	0.1629	0.9551
10410	0.4438	0.3633	11010	0.9990	0.9759	11610	0.6592	0.9243	12210	0.1591	0.9481
10420	0.4815	0.3974	11020	0.9992	0.9768	11620	0.6442	0.9272	12220	0.1554	0.9412
10430	0.5262	0.4317	11030	0.9995	0.9776	11630	0.6306	0.9302	12230	0.1517	0.9343
10440	0.5713	0.4661	11040	0.9997	0.9784	11640	0.6188	0.9332	12240	0.1479	0.9274
10450	0.6168	0.5005	11050	1.0000	0.9793	11650	0.6070	0.9361	12250	0.1442	0.9205
10460	0.6629	0.5350	11060	0.9968	0.9801	11660	0.5951	0.9391	12260	0.1405	0.9136
10470	0.7093	0.5696	11070	0.9936	0.9809	11670	0.5831	0.9420	12270	0.1368	0.9067
10480	0.7365	0.6043	11080	0.9903	0.9818	11680	0.5711	0.9450	12280	0.1313	0.8999
10490	0.7588	0.6391	11090	0.9855	0.9828	11690	0.5579	0.9480	12290	0.1256	0.8930
10500	0.7812	0.6739	11100	0.9807	0.9834	11700	0.5454	0.9509	12300	0.1207	0.8861
10510	0.8047	0.6839	11110	0.9739	0.9806	11710	0.5358	0.9536	12310	0.1156	0.8568
10520	0.8228	0.6940	11120	0.9625	0.9778	11720	0.5241	0.9562	12320	0.1107	0.8275
10530	0.8307	0.7042	11130	0.9510	0.9750	11730	0.5124	0.9589	12330	0.1059	0.7982
10540	0.8398	0.7145	11140	0.9396	0.9721	11740	0.5008	0.9615	12340	0.1013	0.7690
10550	0.8439	0.7248	11150	0.9283	0.9693	11750	0.4891	0.9642	12350	0.0960	0.7398
10560	0.8458	0.7353	11160	0.9170	0.9665	11760	0.4775	0.9668	12360	0.0897	0.7136
10570	0.8461	0.7458	11170	0.9059	0.9637	11770	0.4656	0.9694	12370	0.0836	0.6814
10580	0.8464	0.7584	11180	0.8948	0.9608	11780	0.4536	0.9721	12380	0.0778	0.6523
10590	0.8425	0.7671	11190	0.8837	0.9580	11790	0.4417	0.9747	12390	0.0721	0.6232

ORIGINAL PAGE IS OF POOR QUALITY

Table A7d
(CONTINUED)

WAVELENGTH (NM)	PF	F	WAVELENGTH (NM)	PF	F	WAVELENGTH (NM)	PF	F	WAVELENGTH (NM)	PF	F
12400	0.0667	0.5940	12560	0.0105	0.1307	12720	0.0014	0.0195	12880	0.0004	0.0061
12410	0.0617	0.5614	12570	0.0086	0.1092	12730	0.0013	0.0182	12890	0.0004	0.0058
12420	0.0570	0.5286	12580	0.0067	0.0879	12740	0.0012	[illegible]	12900	0.0003	0.0054
12430	0.0522	0.4957	12590	0.0052	0.0667	12750	0.0011	0.0155	12910	0.0003	0.0050
12440	0.0475	0.4627	12600	0.0038	0.0458	12760	0.0010	0.0141	12920	0.0003	0.0045
12450	0.0430	0.4296	12610	0.0035	0.0433	12770	0.0009	0.0128	12930	0.0002	0.0041
12460	0.0386	0.3964	12620	0.0033	0.0409	12780	0.0008	0.0115	12940	0.0002	0.0037
12470	0.0344	0.3631	12630	0.0031	0.0385	12790	0.0007	0.0101	12950	0.0002	0.0032
12480	0.0304	0.3297	12640	0.0028	0.0361	12800	0.0006	0.0088	12960	0.0002	0.0028
12490	0.0265	0.2962	12650	0.0026	0.0337	12810	0.0006	0.0085	12970	0.0001	0.0023
12500	0.0228	0.2627	12660	0.0024	0.0314	12820	0.0005	0.0081	12980	0.0001	0.0019
12510	0.0206	0.2403	12670	0.0022	0.0291	12830	0.0005	0.0078	12990	0.0001	0.0015
12520	0.0185	0.2181	12680	0.0020	0.0268	12840	0.0005	0.0074	13000	0.0001	******
12530	0.0165	0.1960	12690	0.0018	0.0245	12850	0.0005	0.0071	13010	0.0000	******
12540	0.0145	0.1741	12700	0.0016	0.0223	12860	0.0004	0.0068	13020	0.0000	******
12550	0.0125	0.1523	12710	0.0015	0.0209	12870	0.0004	0.0064			