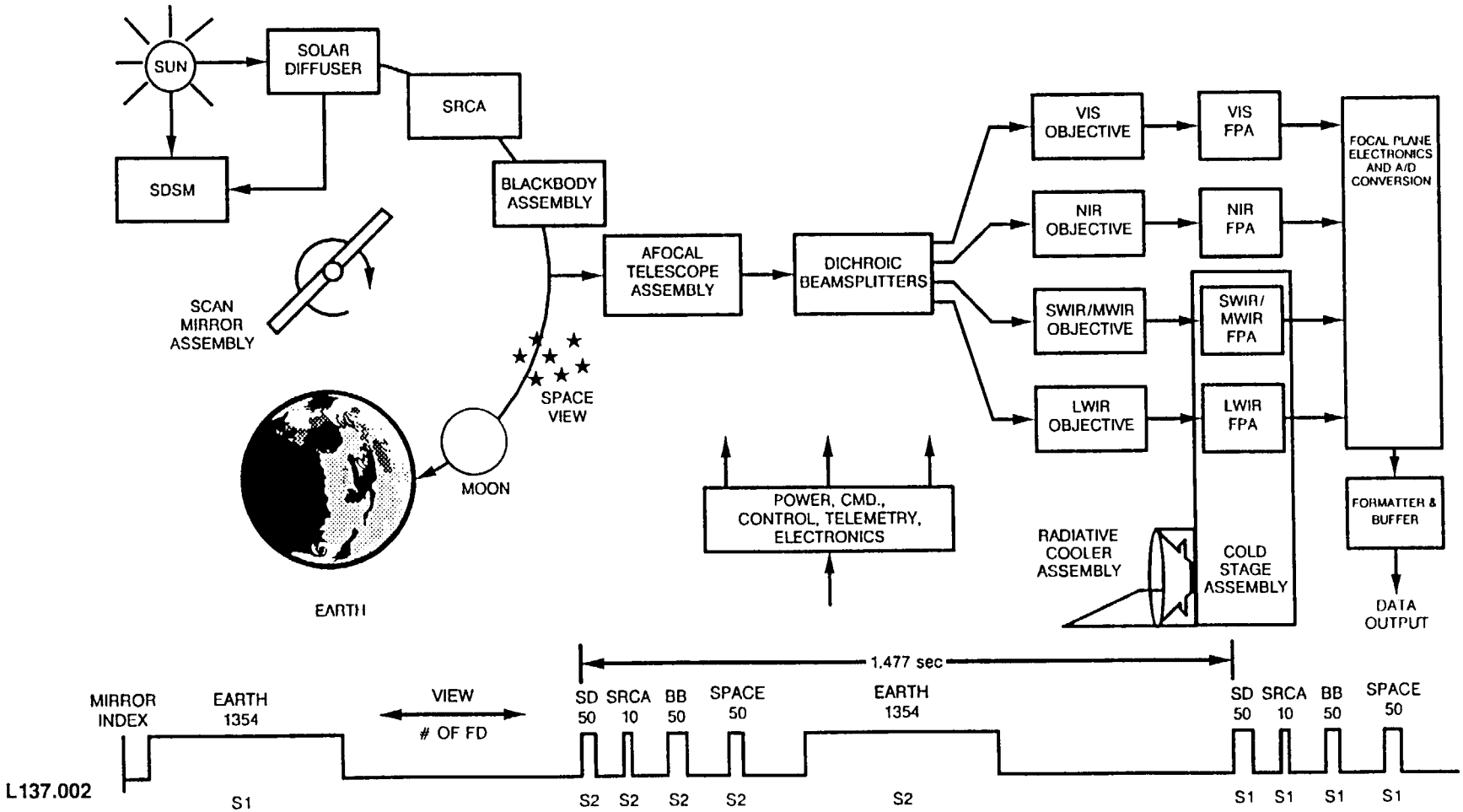
MODERATE RESOLUTION IMAGING SPECTRORADIOMETER

CALIBRATION PEER REVIEW

APRIL 13, 1994

L137.001

MODIS DESIGN FROM PHOTONS TO DATA



MODIS VIS/NIR/SWIR SPECTRAL BANDS

BAND	λ	IFOV	Δλ	PURPOSE (EXAMPLES)
LAND AND CLOUD BOUNDARIES BANDS				
1	659nm	250 m	50 nm	VEG CHLOROPHYLL ABS LAND COVER TRANS.
2	865 nm	250 m	40 nm	CLOUD AND VEGETATION LAND COVER TRANSF.
LAND AND CLOUD PROPERTIES BANDS				
3	470 nm	500 m	20 nm	SOIL, VEGETATION DIFFERENCES
4	555 nm	500 m	20 nm	GREEN VEGETATION
5	1240 nm	500 m	20 nm	LEAF/CANOPY DIFFERENCES
6	1640 nm	500 m	20 nm	SNOW/CLOUD DIFFERENCES
7	2130 nm	500 m	50 nm	LAND AND CLOUD PROPERTIES
OCEAN COLOR BANDS				
8	415 nm	1000 m	15 nm	CHLOROPHYLL
9	443 nm	1000 m	10 nm	CHLOROPHYLL
10	490 nm	1000 m	10 nm	CHLOROPHYLL
11	531 nm	1000 m	10 nm	CHLOROPHYLL
12	555 nm	1000 m	10 nm	SEDIMENTS
13	667 nm	1000 m	10 nm	SEDIMENTS, ATMOSPHERE
14	681 nm	1000 m	10 nm	CHLOROPHYLL FLOURESCENCE
15	750 nm	1000 m	10 nm	AEROSOL PROPERTIES
16	865 nm	1000 m	15 nm	AEROSOL/ATMOSPHERIC PROPERTIES
ATMOSPHERE/CLOUD BANDS				
17	905 nm	1000 m	30 nm	CLOUD/ATMOSPHERIC PROPERTIES
18	936 nm	1000 m	10 nm	CLOUD/ATMOSPHERIC PROPERTIES
19	940 nm	1000 m	50 nm	CLOUD/ATMOSPHERIC PROPERTIES
26	1375 nm	1000 m	30 nm	CIRRUS CLOUDS

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MODIS MWIR/LWIR SPECTRAL BANDS

BAND	λ	IFOV	Δλ	PURPOSE (EXAMPLES)
	THERMAL BANDS			
20	3.75 μm	1000m	0.18 μm	SEA SURFACE TEMPERATURE
21	3.96 μm	1000m	0.06 μm	FOREST FIRES/VOLCANOES
22	3.96 μm	1000m	0.06 μm	CLOUD/SURFACE TEMPERATURE
23	4.05 μm	1000m	0.06 μm	CLOUD/SURFACE TEMPERATURE
24	4.47 μm	1000m	0.07 μm	TROPOSPHERIC TEMPERATURE/CLOUD FRACTION
25	4.52 μm	1000m	0.07 μm	TROPOSPHERIC TEMPERATURE/CLOUD FRACTION
27	6.72 μm	1000m	0.36 μm	MID-TROPOSPHERIC HUMIDITY
28	7.33 μm	1000m	0.30 μm	UPPER-TROPOSPHERIC HUMIDITY
29	8.55 μm	1000m	0.30 μm	SURFACE TEMPERATURE
30	9.73 μm	1000m	0.30 μm	TOTAL OZONE
31	11.03 μm	1000m	0.50 μm	CLOUD/SURFACE TEMPERATURE
32	12.02 μm	1000m	0.50 μm	CLOUD HEIGHT AND SURFACE TEMPERATURE
33	13.34 μm	1000m	0.30 μm	CLOUD HEIGHT AND FRACTION
34	13.64 μm	1000m	0.30 μm	CLOUD HEIGHT AND FRACTION
35	13.94 μm	1000m	0.30 μm	CLOUD HEIGHT AND FRACTION
36	14.24 μm	1000m	0.30 μm	CLOUD HEIGHT AND FRACTION

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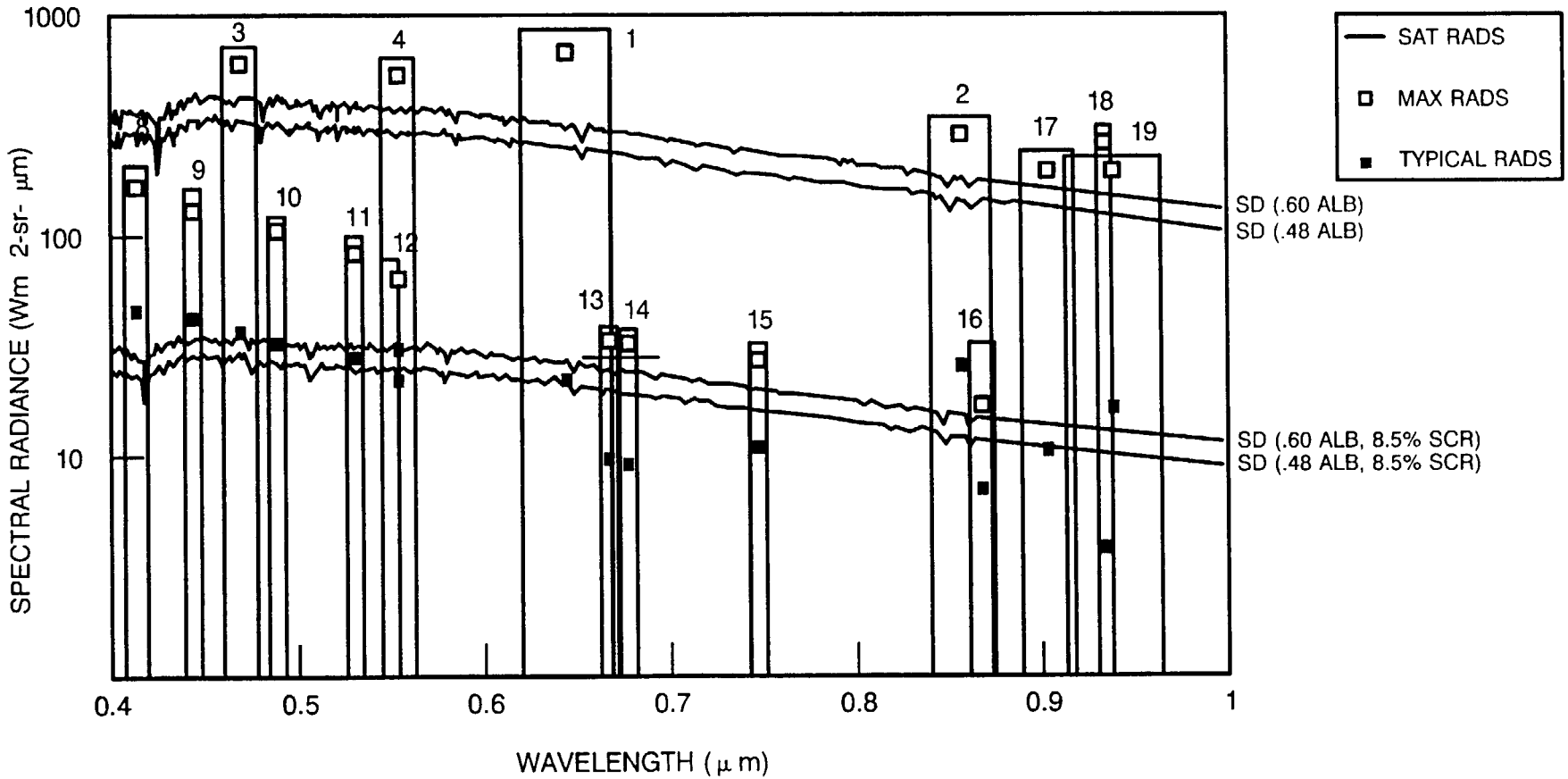
BAND LOCATIONS
VIS/NIR



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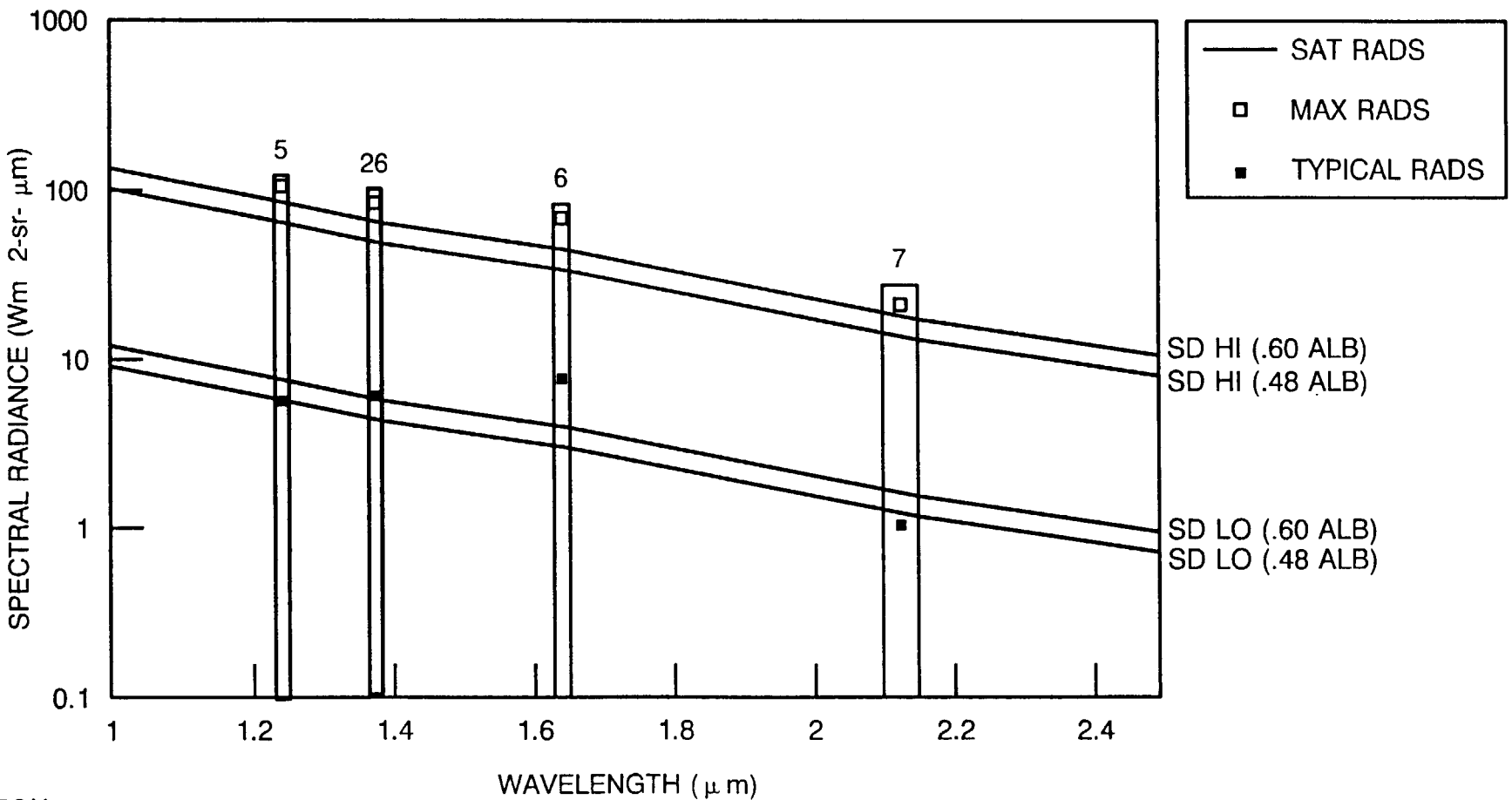
BAND LOCATIONS
SWIR



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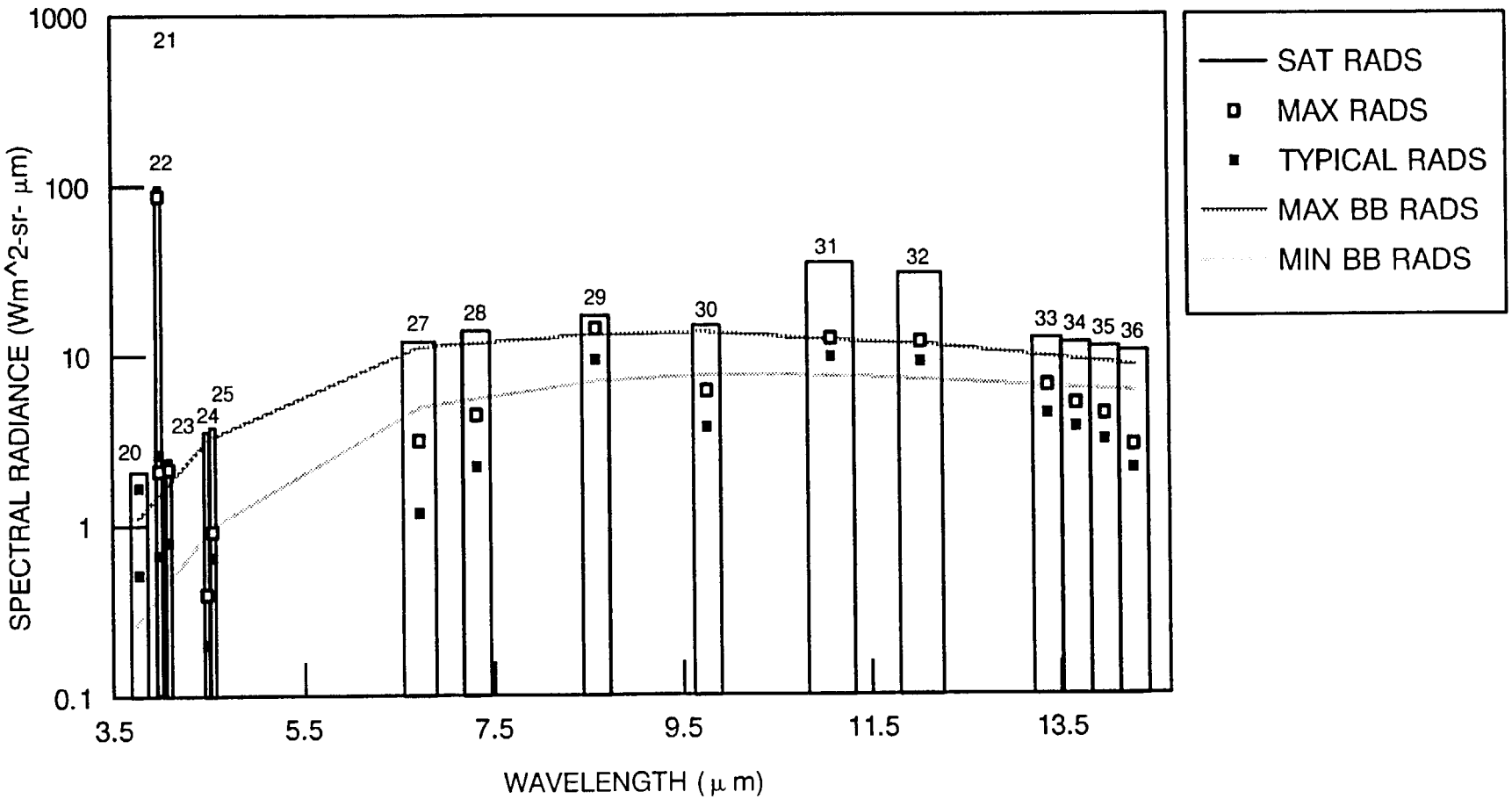
BAND LOCATIONS
MWIR/LWIR



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INSTRUMENT REQUIREMENTS

• SPECTRAL COVERAGE	0.407μm - 14.385μm, 36 BANDS
• SPECTRAL RESOLUTION	10 nm $\leq \Delta\lambda \leq$ 500 nm
• SPECTRAL STABILITY	λ AND $\Delta\lambda$ STABLE TO $\leq$ 2 nm (VIS, NIR) λ AND $\Delta\lambda$ STABLE TO $\leq$ 1% (ALL OTHER BANDS)
• SPATIAL COVERAGE	±55, 2330 km SWATH LENGTH AT 705 km (CONTINGUOUS SCANS AT NADIR)
• SPATIAL RESOLUTION	250m; 500m; 1000m (AT NADIR)
• SPATIAL REGISTRATION	0.2 IFOV (0.1 IFOV GOAL)
• IFOV	0.354 mr, 0.709 mr, 1.418 mr (ALL ±6%)
• RADIOMETRIC RANGE	0.002% $\leq \rho \leq$ 100%, 3K $<$ T $<$ 500K
• DYNAMIC RANGE	NEΔL TO L_{max} (REQUIRES 12 BITS)
• RADIOMETRIC PERFORMANCE SNR	$\geq$ 57 TO 1087, NEΔT $\leq$ 5.0 TO 0.05K
• POLARIZATION ISOLATION	$\leq$2%, 0.43μm $\leq \lambda \leq$ 2.2μm
• CALIBRATION ACCURACY	ABSOLUTE CALIBRATION: ±1%$\lambda >$ 3μm; ±5%$\lambda <$ 3μm; ±0.75% (BAND 20), ±0.5% (BANDS 31, 32) ±2% REFLECTANCE ($\lambda <$ 3μm)

J734.002

MODIS BASELINE INSTRUMENT PARAMETERS

SCANNING	360° SCAN, DOUBLE-SIDED, 20.3 RPM, 2.954 sec PERIOD
IFOV	0.354 mr (0.25 km), 0.709 mr (0.50 km), 1.418 mr (1.0 km)
DWELL TIME	83.3 μs (0.25 km), 166.7 μs (0.50 km), 333.3 μs (1.0 km)
TELESCOPE	2-MIRROR OFF-AXIS AFOCAL GREGORIAN, 4X MAGNIFICATION, EFD 17.8 CM
REIMAGING OPTICS	REFRACTIVE, EFL 380.8 mm, 282.1 mm (LWIR ONLY)
SPECTAL	36 BANDS FROM 0.41 μm to 14.3 μm, DICHROIC BEAMSPLITTERS, BANDPASS FILTERS
SPATIAL	ALL BANDS REGISTERED TO 0.2 IFOV

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MODIS BASELINE INSTRUMENT PARAMETERS

FOCAL PLANES	SILICON (0.4 μm $\leq \lambda \leq$ 1 μm), PV HgCdTe (1 μm $\leq \lambda \leq$ 10 μm) PC HgCdTe ($\lambda >$ 10 μm), CTIA READOUTS FOR PV, BIPOLAR PREAMPS FOR PC
DETECTOR SIZES	NOMINALLY SQUARE: 135 μm (0.25 km), 270 μm (0.5 km), 540(400 LWIR) μm (1.0 km)
DETECTOR COOLING	THEMATIC MAPPER-TYPE RADIATIVE, T $\sim$ 85K
CALIBRATION	LABORATORY, GROUND TRUTH, MOON, ON-BOARD BLACKBODY, SOLAR DIFFUSER, SRCA, AND SDSM
DATA RATES	10.6 MBPS (DAY MODE), 3.2 MBPS (NIGHT MODE) WITH CAL AND OVERHEAD
SIZE, WEIGHTS POWER	1.11 m x 1.61 m x 1.17 m, 234 kg, 180 W

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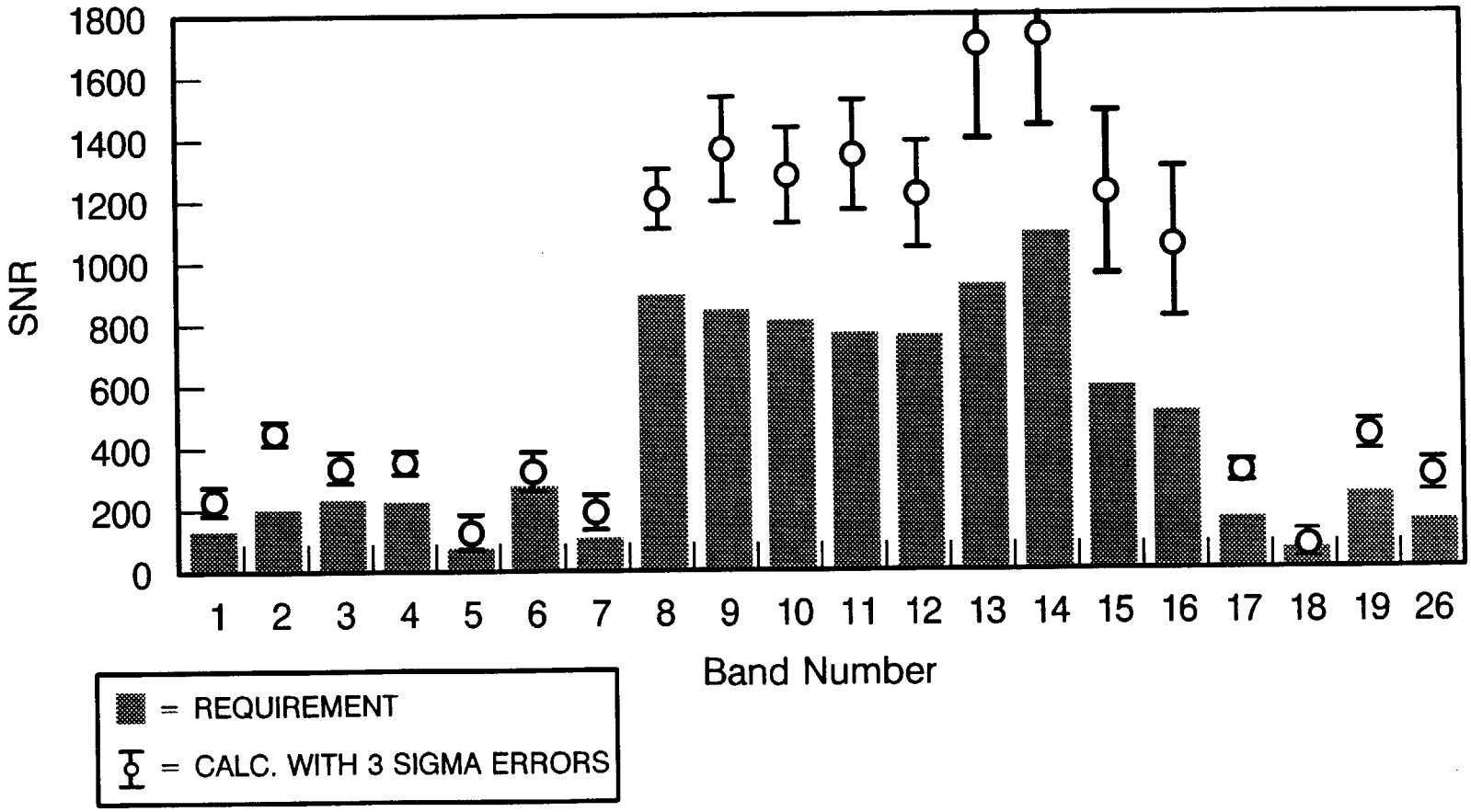
CALCULATED SNR'S FOR BANDS 1-19 AND 26



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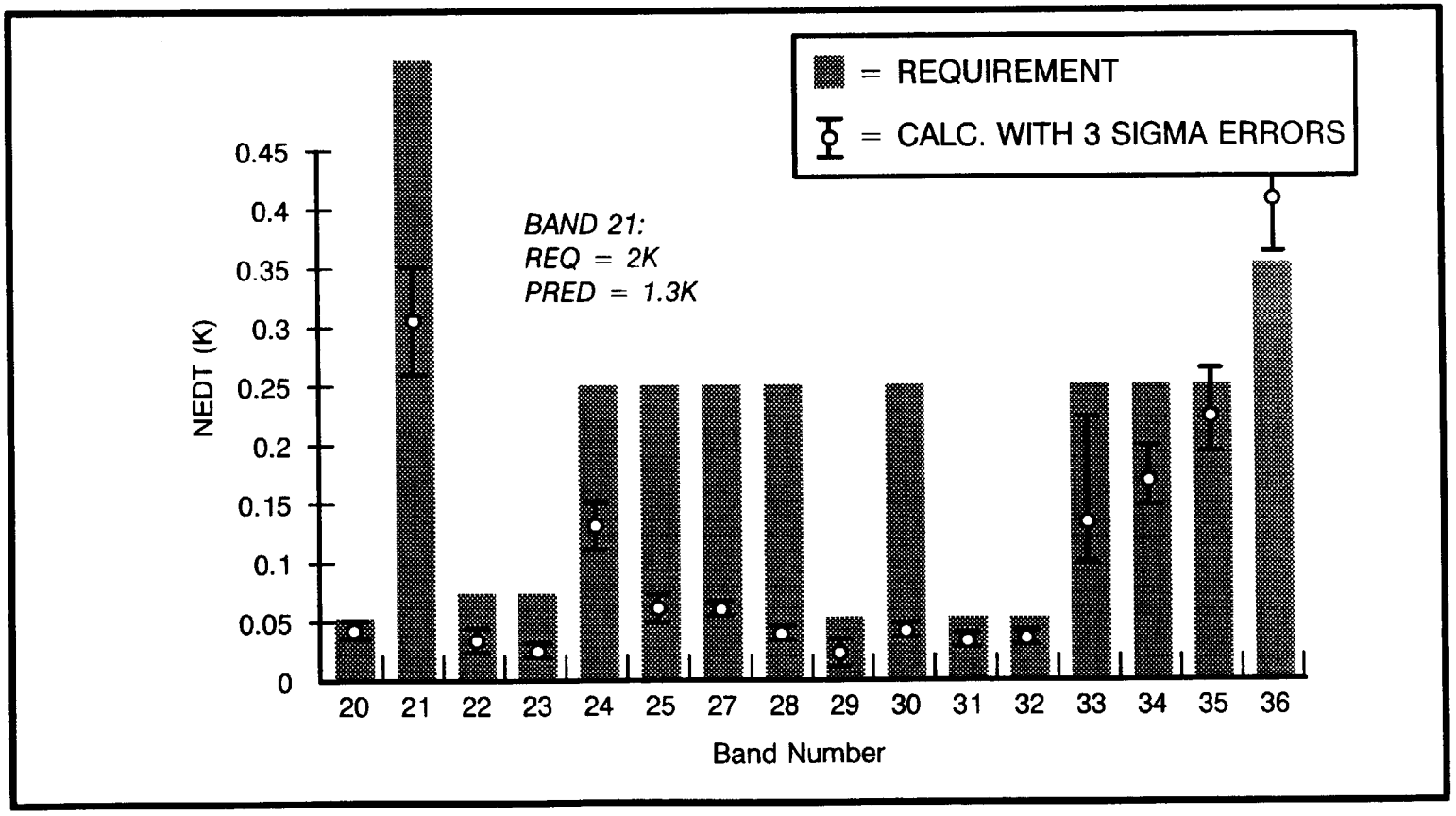
CALCULATED NEΔT'S FOR BANDS 20-36



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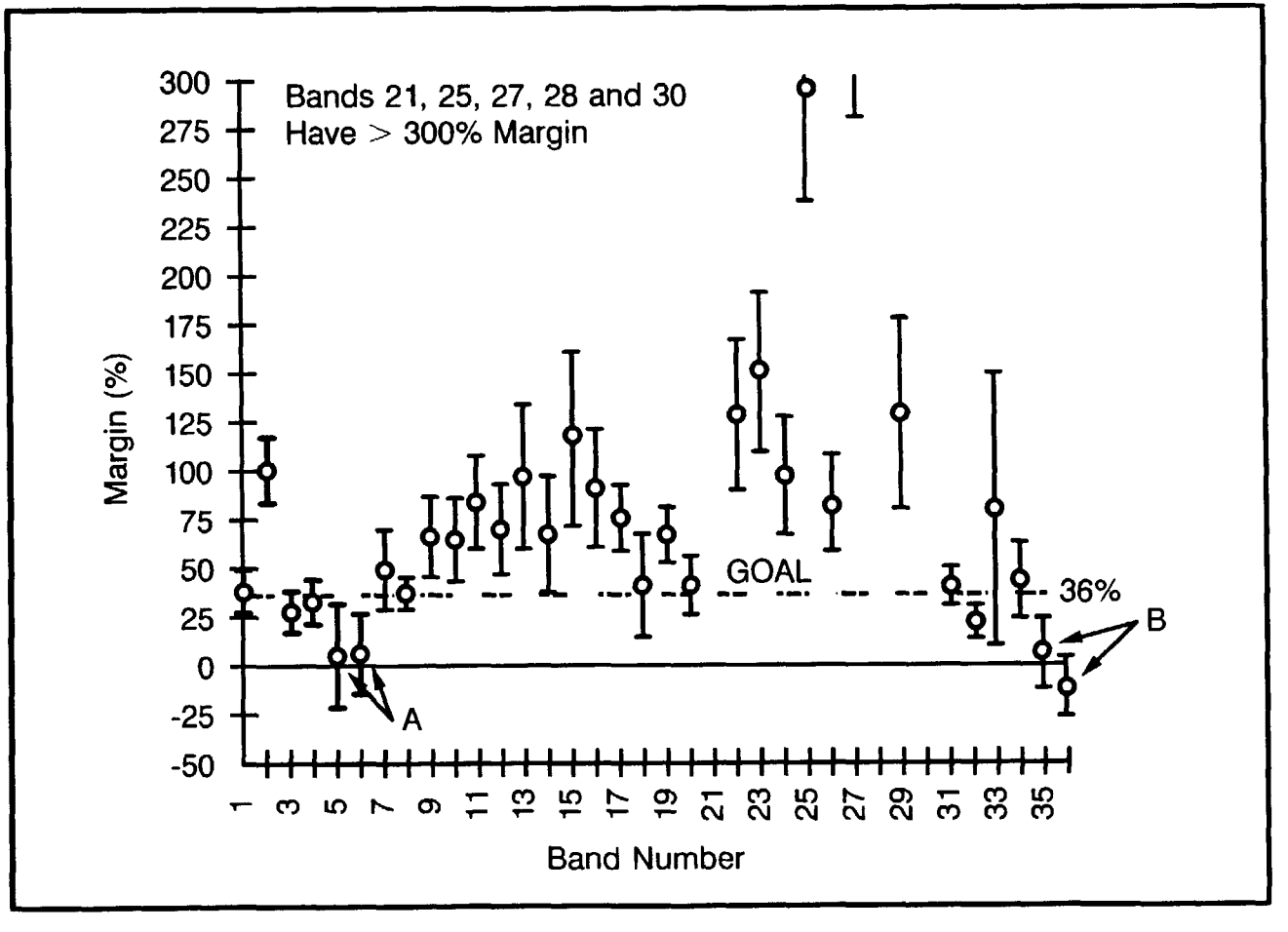
MODIS PERFORMANCE MARGINS



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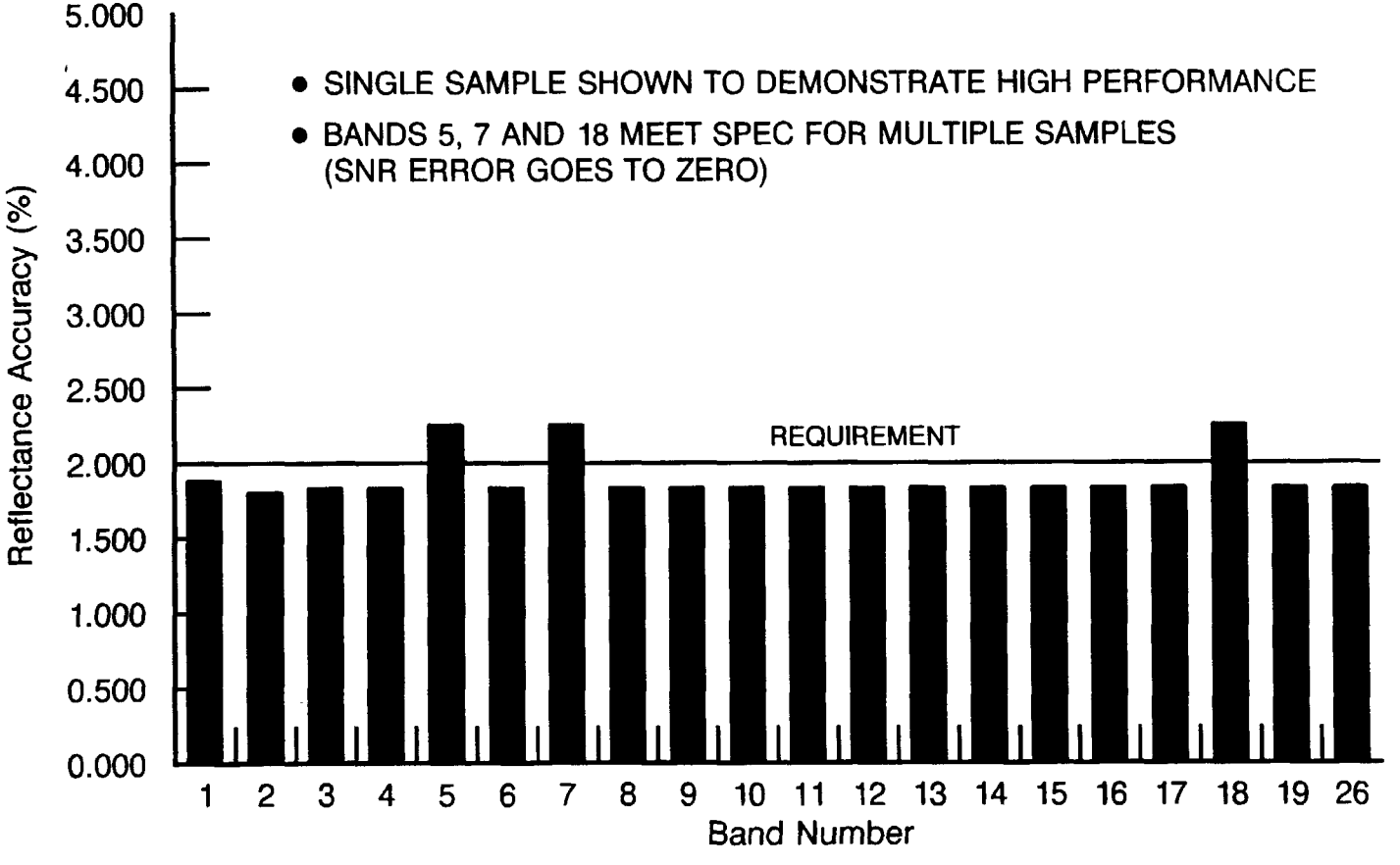
REFLECTANCE ACCURACY REQUIREMENTS



- SINGLE SAMPLE SHOWN TO DEMONSTRATE HIGH PERFORMANCE
- BANDS 5, 7 AND 18 MEET SPEC FOR MULTIPLE SAMPLES (SNR ERROR GOES TO ZERO)

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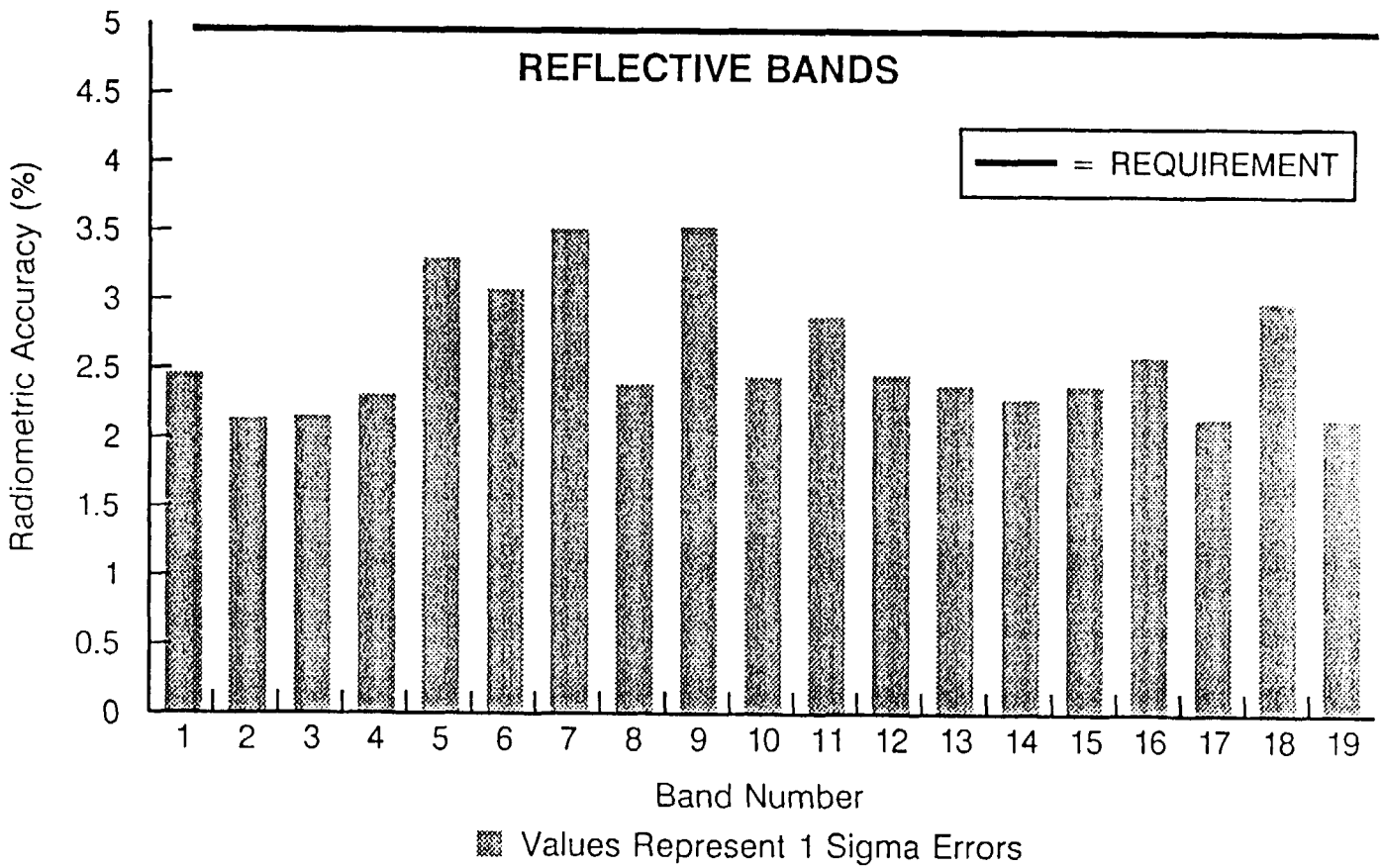
MARGINS FOR MODIS IN-FLIGHT RADIOMETRIC ACCURACY



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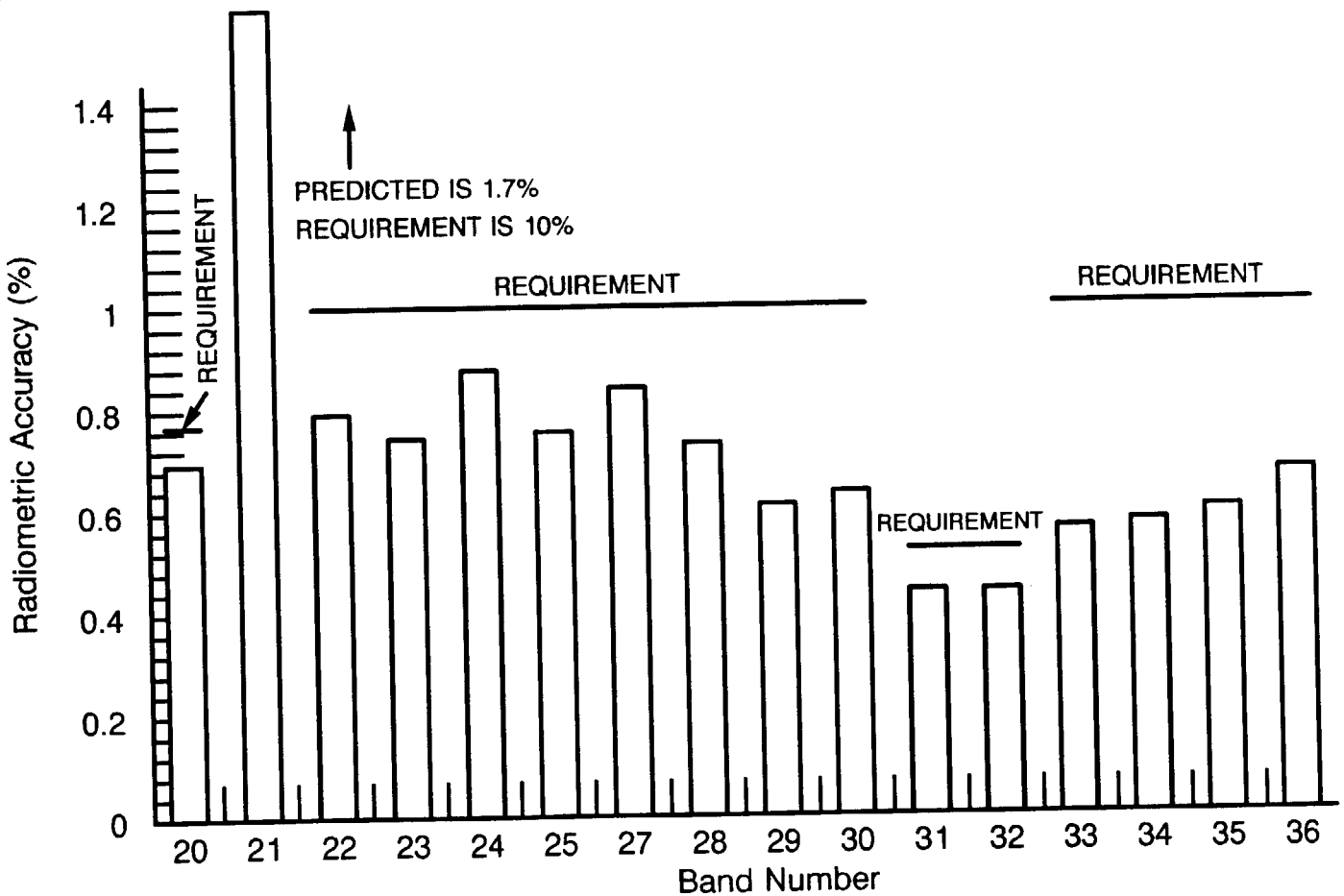
MARGINS FOR MODIS IN-FLIGHT RADIOMETRIC ACCURACY



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