MILITARY STANDARD

RECONNAISSANCE/MAPPING

DATA MARKING

NO DELIVERABLE DATA REQUIRED BY THIS DOCUMENT

FSC MISC

MIL-STD-782D

DEPARTMENT OF DEFENSE

Washington, D.C. 20301

RECONNAISSANCE/MAPPING DATA MARKING

MIL-STD-782D

1.   This Military Standard is approved for use by all
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2.   Beneficial comments (recommendations, additions, de-
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FOREWORD

This standard establishes a common reconnaissance/mapping data
marking system to be used by the Army, Navy, Air Force and Marine
Corps as directed by the Department of Defense. All existing data
marking systems are to be converted to the binary-coded-decimal
system described herein. No film types, developers or gammas are
specified in this standard.

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FIGURES

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1. SCOPE

1.1 <u>General.</u> This standard establishes the dimensions, coding methods, quality of dot image, and number character positions for the code matrix block utilized in the Department of Defense Reconnaissance/Mapping Data Marking System.

2. REFERENCED DOCUMENTS

2.1 <u>Issues of documents.</u> The following documents of the issue in effect on date of invitation for bids or request for proposal, form a part of this standard to the extent specified herein.

REGULATION

DEFENSE INTELLIGENCE AGENCY

No. 55-2 - Data Recorded on Reconnaissance/Mapping Imagery

(Copies of specifications, standards, drawings, and publications required by contractors in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer).

3. DEFINITIONS

3.1 <u>Code Matrix Block.</u> A code matrix block (CMB) is a pattern of dots recorded on film simultaneously with sensor operation. The CMB provides digital information pertaining to the location and orientation of the sensor and/or vehicle which exposed the imagery, the sensing group, and time of exposure.

3.2 <u>Isolated Dot.</u> Any dot is an isolated dot if its center is at least 0.0574 centimeters (cm) [0.0226 inches (in)] away from all other dot centers.

3.3 <u>Film Analyzer.</u> The film analyzer is an instrument used to measure and record change in dot density as a function of displacement across the dot. The film analyzer shall resolve a 25.4 micrometers (μm)[1 mil (0.001 inch)] spot diameter at the sample film plane. The film analyzer shall utilize a photomultiplier sensor of S-4 spectral response, collimated to measure light received within a conical angle of acceptance of 0.008725 radian (rad)(0.5 degree). This 0.008725 rad (0.5 degree) acceptance angle shall subtend, through an objective of suitable magnification, the 25.4 μm (1 mil) spot-diameter resolved at the film plane.

Density is herein defined as Log 10 1/T where T equals the percent
light transmission through the 25.4 µm (1 mil) spot-T diameter
resolved at the film plane. Calibration of density shall be
accomplished by interposing neutral density filters at the film
sample plane. Density increments of 0.50 throughout a range of
0.00 to 3.00 are suggested for use in calibration.

4. GENERAL REQUIREMENTS

4.1 <u>Intended requirements of this standard</u>. It is intended that
the requirements of this standard be met for whatever film types,
developers or gamma are required by a particular reconnaissance
sensor.

5. DETAILED REQUIREMENTS

5.1 <u>Code Matrix Block Format</u>. The information and specific for-
mat of characters within the CMB shall be as shown in latest
revision DIAR 55-2.

5.2 <u>Coding Method</u>. The information in the CMB shall be coded
digitally in excess three binary coded decimal (BCD) as shown in
Figure 1.

5.3 <u>Data Matrix</u>. The data shall be arranged in three columns
of 32 BCD characters per column as shown in Figure 2.

5.4 <u>Interpretation of Code Matrix Data</u>. The method of inter-
pretation of the code matrix data shall be as follows: Each
character consists of an index bit, four excess three BCD bits,
and an odd parity bit. Odd parity is correctly indicated when
the count of dots across one column is an even number. The bit
order is Index, D4, D3, D2, D1, and parity where D4 is the teen
possibilities shown in Figure 1. Identification of a particular
character shall be by column-letter and row number as shown in
Figure 2.

5.5 <u>Code Matrix Block Dimensions</u>. The dimensions for a static
recording of the CMB shall be in accordance with those shown in
Figure 2 and the information contained in a, b, c, d, e, f, g,
and h below:

    a. Reference line A is a best fit straight line as shown
in Figure 2. No dot on the reference line shall have its center
depart from the reference line by more than 0.00508 cm (0.002
inch).

b.   Within any given digit, no bit dot center shall depart more than 0.00508 cm (0.002 inch) from a line drawn through the center of its index dot parallel to reference line A.

c.   Reference line B is a best fit straight line as shown in Figure 2.   No index dot center in column Y shall depart from the reference line by more than 0.03048 cm (0.012 inch).

d.   Also as in (c.) above, no index dot center shall depart more than 0.03048 cm (0.012 inch) from a line drawn parallel to reference line B through the index dot files of column X or column Z.   In addition, no index dot center shall depart from the adjacent index dot center by more than 0.00762 cm (0.003 inch).

e.   The data matrix shall be aligned so that reference line A is parallel to within 0.05235 rad (3 degrees) of the edge of the film.   Reference lines A on all data matrices recorded on a continuous roll of film shall not depart more than 0.00349 rad (0.2 degrees) from the first data matrix.

f.   Skew of the CMB, as a result of Forward Motion Compensation (FMC), shall not exceed 0.150 cm (0.059 inch) for the displacement of the dots in row 1 with respect to the dots in row 32 within the same column.   This 0.150 cm (0.059 inch) is in addition to the tolerances already specified.   Skew of the CMB shall be such that row 1 is in a clockwise rotation about row 32.   The maximum FMC condition is illustrated in Figure 3.

g.   The 1.356 $\pm$ .152 cm (0.534 $\pm$ 0.060 in) and 0.841 $\pm$ 0.094 cm (0.331 $\pm$ 0.037 in) dimensions as shown in Figures 2 and 3 have precedence over all other dimensions in determining the acceptable maximum or minimum size of CMB.

h.   No index dot center shall be closer to an adjacent index dot center than 0.0381 cm (0.015 inch).

5.6   Position of Code Matrix Block.   The position of the CMB in early insensor recording systems was positioned from the edge of the film as shown in Figures 4A, 4B, 4C, 4D, and 5.   Unless future designs prohibit this placement, the location of the CMB shall be as shown in the above figures.   In any event the CMB to edge of film tolerance specified in the above figures must be maintained. The minimum distance shown between successive data blocks in the various figures denotes dwell periods in which the search circuits of an automatic reader may be inactive.   This separation when established shall be consistent throughout the entire length of the film.   It shall be a requirement that all dots of the CMB maintain a minimum separation of 0.0457 cm (0.018 inch) from the boundary of the uniform background density area.   In Figure 4B,

4C and 4D the dashed line from the CMB indicates the photography for which the CMB refers.

5.7 <u>Shape and Density of an Isolated Dot</u>. The shape of an isolated dot is based upon scanning through the center of an isolated dot with a film analyzer (see 3.3) with a 1 mil spot size. The dot is assumed circular, so that the direction of the scan is unimportant. Figure 7 shows a portion of such a recording. That recording must then be shown to fall within the envelope of Figure 8 (the non-shaded area). There may be one spike extending downward into Area "A" which might result from a fiber optic or phosphor blemish. The spike shall not exceed 0.0381 millimeters (mm) (0.0015 inch) in diameter at the point of entry into area "A". Any other excursion outside the envelope is cause for rejection of the isolated dot. In this case, Figure 8 was scaled onto Figure 7 and the isolated dot is seen to be not acceptable. The prescribed shape is on an absolute distance scale. But a relative density scale, with 100% being the change in density between the peak density of the dot and the background density (see Figure 6). The exact center of an isolated dot is defined when Figure 8 is scaled onto the film analyzer tracing (see Figure 7). The relationship between the peak dot density and the background density is extremely important. Certain minimum standards are shown in Figure 9. This figure shows the dot density as a function of the background density for both negative and positive film. Figure 9 depicts an area for dots on negative film bounded by a 0.4 minimum density difference. The area for dots on positive film is similarly bounded by a 0.5 minimum density difference. Therefore, to be acceptable, an isolated dot must fall within the proper area (negative and positive) otherwise it will be rejected even though it meets the shape criteria of Figure 8. Figure 8 is the envelope for negative dots. Variation between the maximum peak density recorded in the CMB to the minimum peak density recorded in the CMB shall not exceed 30% of the maximum peak density. This is to insure reasonable uniformity over the entire CMB.

5.8 <u>Minimum Density</u>. The minimum density difference between center dot density and interdot density shall be 0.3.

DATA MATRIX CODING

The data matrix is coded in excess three binary coded decimal.
This system uses decimal numbering but it is recorded in a
coded binary form as listed below. It is read as a normal binary
system, that is right to left, making a summation of the signif-
icant bits, then subtracting three to obtain the decimal values
tabulated below:

DECIMAL VALUE	INDEX BIT	D4 8*	D3 4*	D2 2*	D1 1*	PARITY BIT	NUMERIC VALUE OR MEANING
-3	o					o	Not Used
-2	o				o		Minus Sign
-1	o			o			Error
0	o			o	o	o	Zero
1	o		o				One
2	o		o		o	o	Two
3	o		o	o		o	Three
4	o		o	o	o		Four
5	o	o					Five
6	o	o			o	o	Six
7	o	o		o		o	Seven
8	o	o		o	o		Eight
9	o	o	o			o	Nine
10	o	o	o		o		Plus Sign
11	o	o	o	o			Special
12	o	o	o	o	o	o	Divider

NOTES:

1. The numerical figure by the asterisk (*) indicates the binary
value of the recorded bit in that column.
2. The index mark is always present.
3. The parity bit is present to cause the total count of dots
across one column (six dot positions) to be an even number. This
provides the "parity check" to insure that the bit recording is
correct.
4. The divider is used as a visual indicator to separate major
groups of characters within the Code Matrix Block.
5. Significant bits progress from D4 (most significant) through
D1 (least significant).
6. "Not Used" (decimal value -3) indicates that data is not
available for recording.
7. "Error" (decimal value -1) indicates the information generated
for recording is outside the range of the particular sensing
device in use.

FIGURE 1

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8. "Special" (decimal value 11) indicates that the information normally presented in this location will be recorded by some other recording device.

9. A plus or minus code may occur in the code matrix block. This is an acceptable coded digit. The plus and minus convention is as follows:

Latitude: +North -South   Longitude: + East   -West

Drift/Yaw: +A/C Nose Left of Ground Track; -A/C Nose Right of Ground Track

Roll: +Right Wing Down; -Right Wing Up   Pitch: +Nose Up; -Nose Down
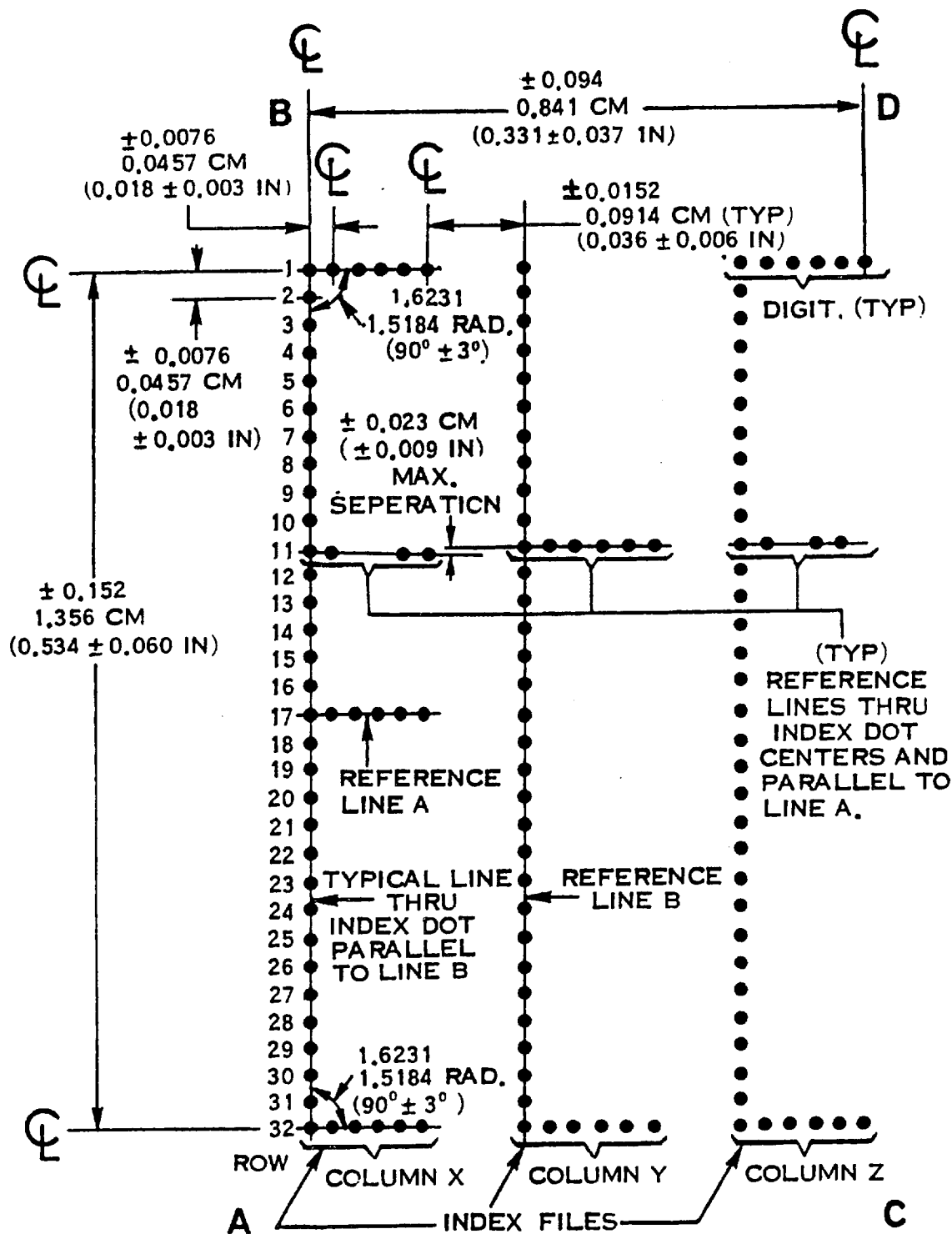
FIGURE 1 Data Matrix Coding - Continued

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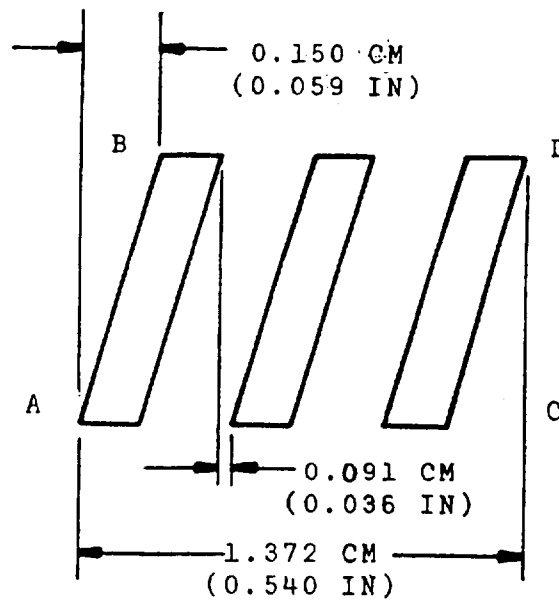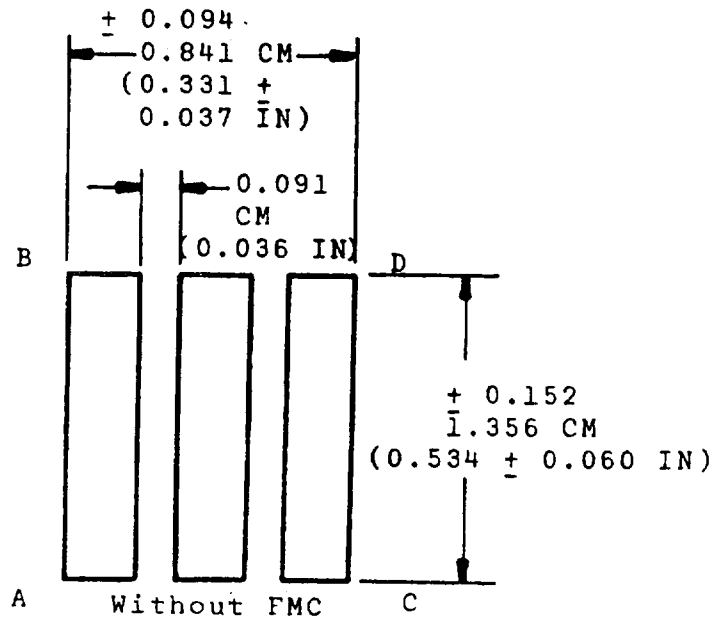# CODE MATRIX BLOCK DIMENSIONS

FIGURE 2

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CODE MATRIX BLOCK WITH

FORWARD MOTION COMPENSATION

Without FMC

With Max, FMC

FIGURE 3

NEGATIVE-EMULSION DOWN
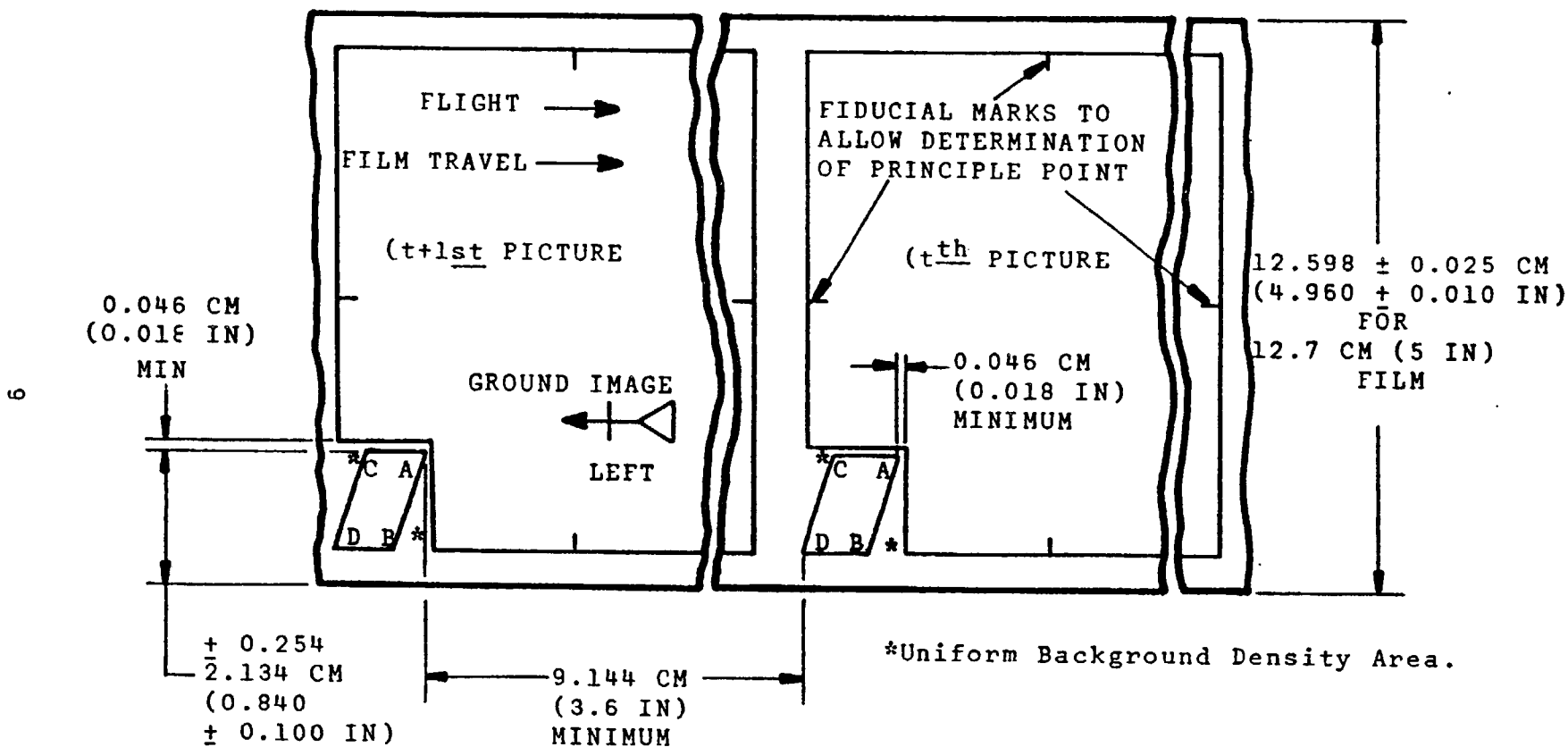
FIGURE 4A.   Frame Photography - Reconnaissance

NEGATIVE-EMULSION DOWN

FLIGHT ⟶

FILM TRAVEL ⟶

(t+1ˢᵗ PICTURE)

GROUND IMAGE

LEFT

FIDUCIAL MARKS TO ALLOW
DETERMINATION OF
PRINCIPLE POINT

(tᵗʰ PICTURE)

24.028 ±
0.025 CM
(9.460 +
0.010 IN)
FOR 24.13 CM
(9.5 IN)
FILM

± 0.254
2.134 CM
(0.840
± 0.100 IN)

0.046 CM
(0.018 IN)
MINIMUM

21.59 CM
(8.5 IN)
MINIMUM
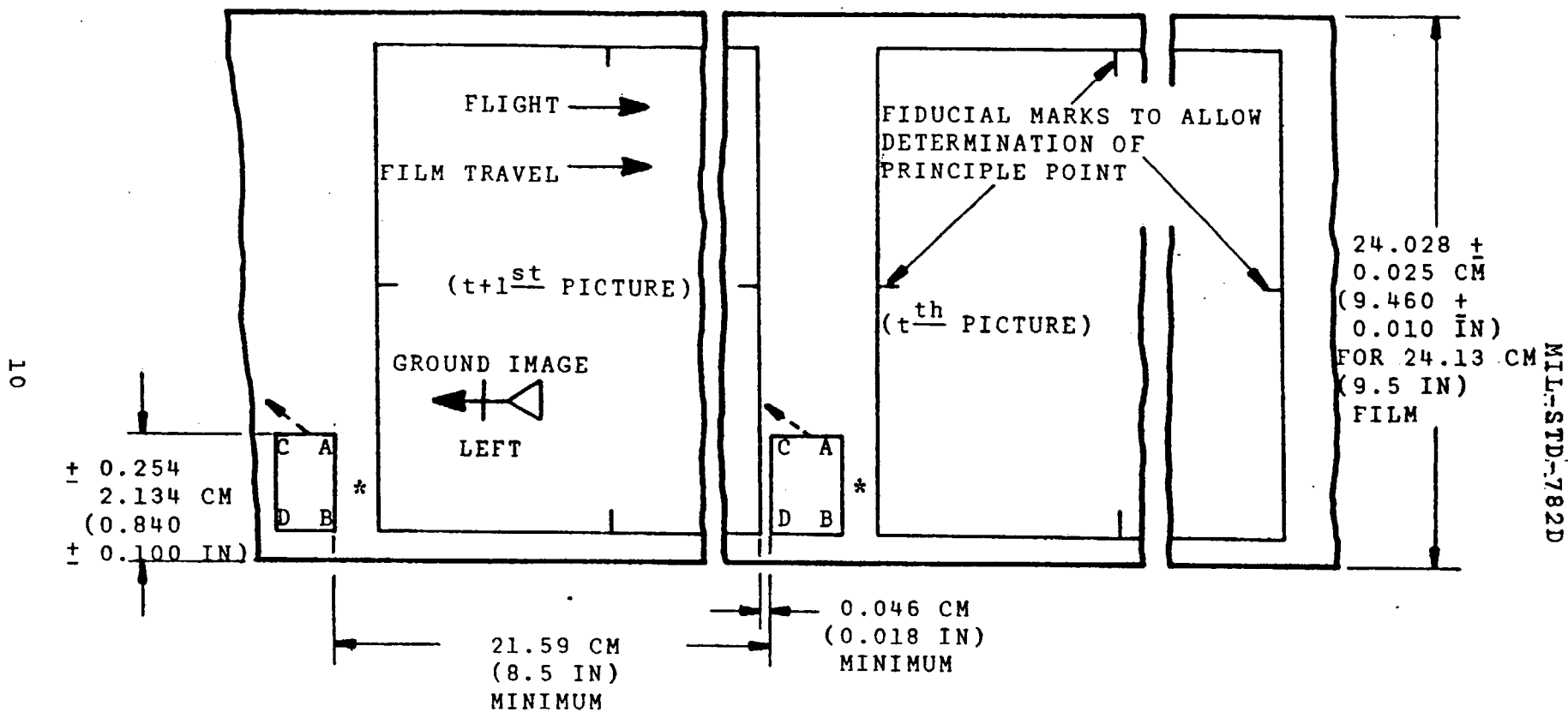
DIMENSIONS REFERRING TO THE CODE BLOCK ARE   *UNIFORM BACKGROUND DENSITY AREA
BASED UPON DOT CENTERS & OR ROW LINES.

FIGURE 4B.   Frame Photography - Mapping

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NEGATIVE - EMULSION DOWN

a - THE DIRECTION OF FILM TRAVEL AND THE MINIMUM DISTANCE OF 21.366 CM (8.4 IN) ARE FOR INFORMATION ONLY AS THE VARIOUS PANORAMIC CAMERAS HAVE DIFFERENT FORMAT LENGTHS.

DIMENSIONS REFERRING TO THE CODE BLOCK ARE BASED UPON DOT CENTERS AND/OR ROW LINES.

b - MINIMUM BACKGROUND DENSITY AREA

c - DATA BLOCK REFERS TO FRAME EITHER ON LEFT OR RIGHT
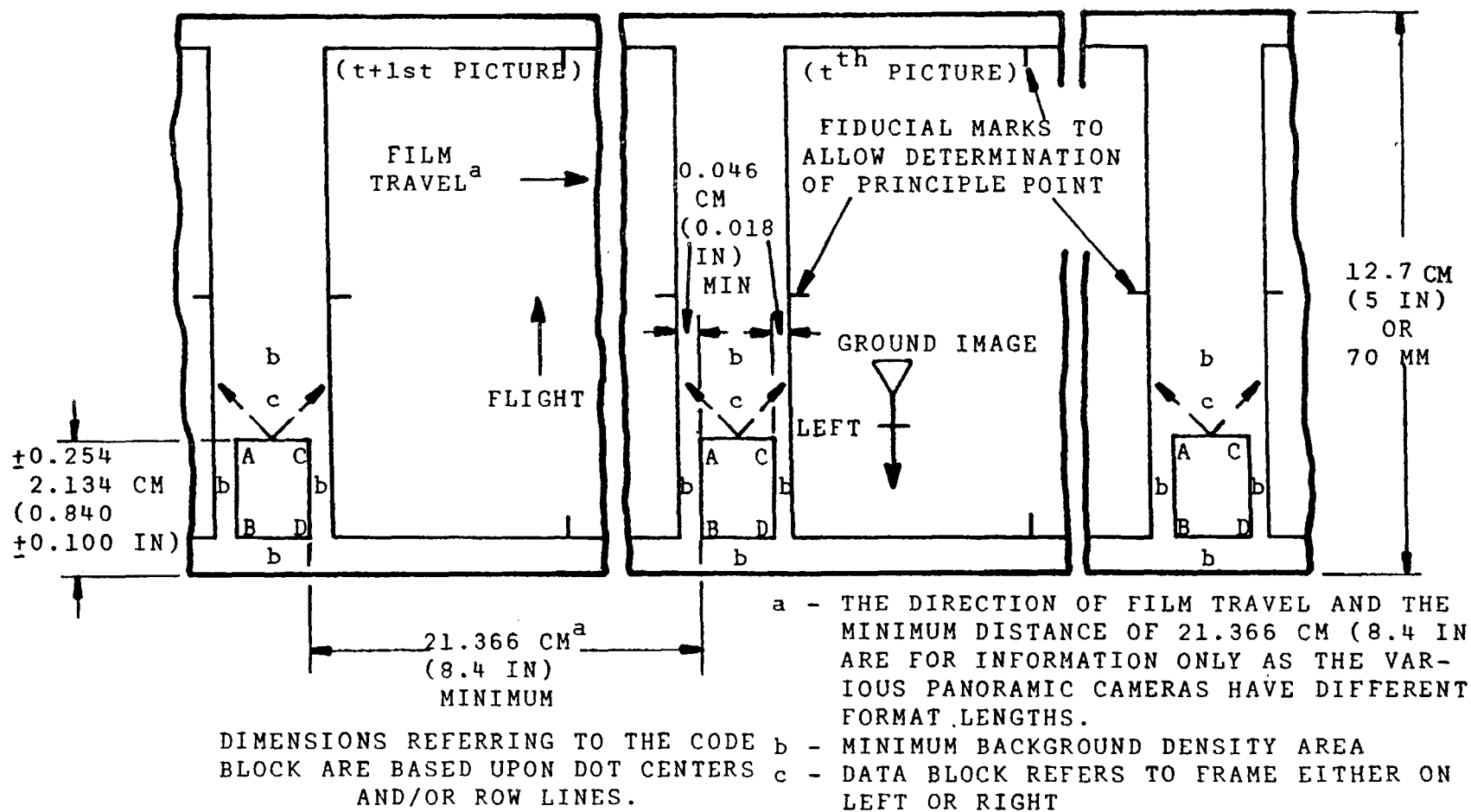
FIGURE 4C.   PANORAMIC CAMERA (MIRROR IMAGE)

NEGATIVE - EMULSION DOWN
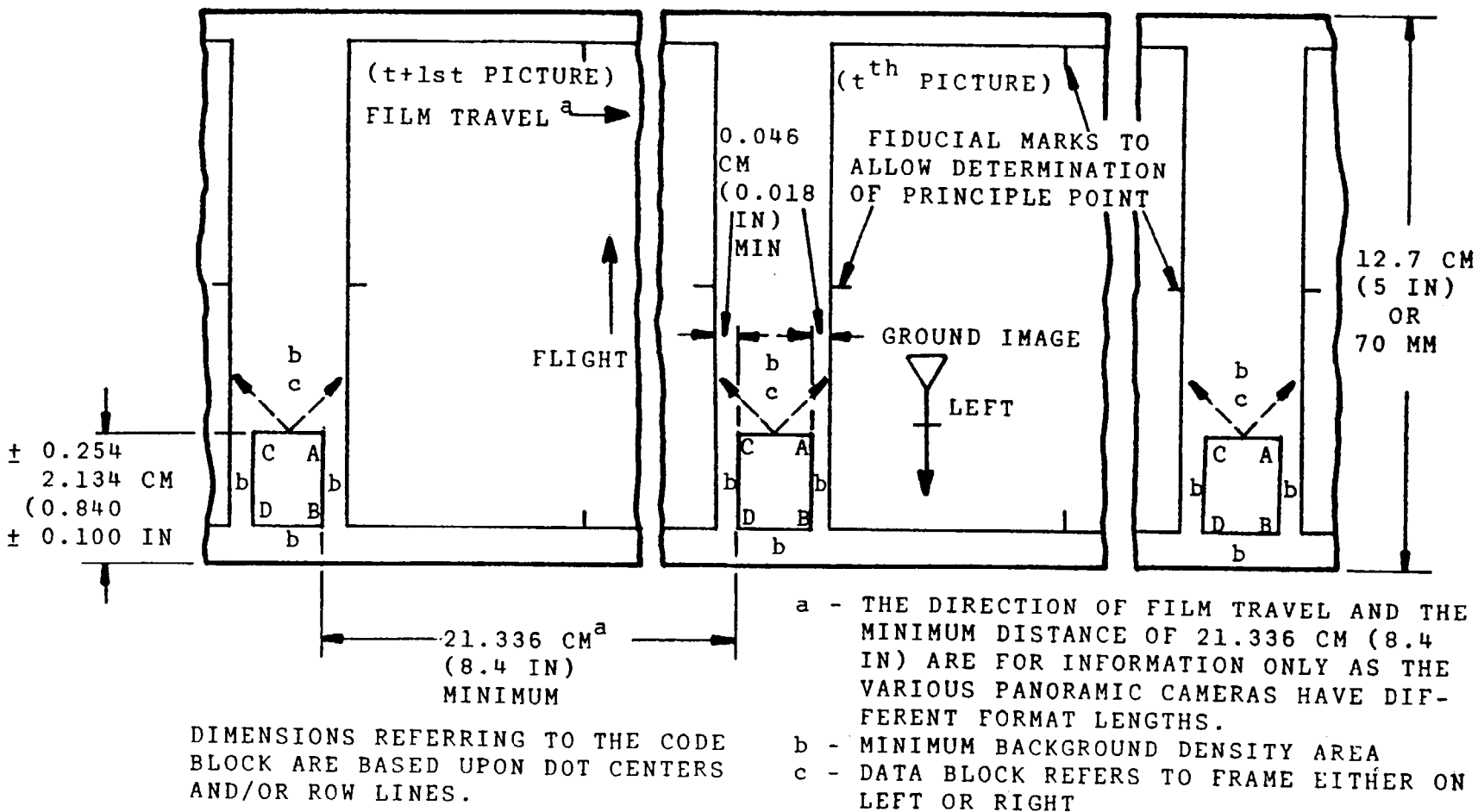
FIGURE 4D.   PANORAMIC CAMERA

a - THE DIRECTION OF FILM TRAVEL AND THE
    MINIMUM DISTANCE OF 21.336 CM (8.4
    IN) ARE FOR INFORMATION ONLY AS THE
    VARIOUS PANORAMIC CAMERAS HAVE DIF-
    FERENT FORMAT LENGTHS.
b - MINIMUM BACKGROUND DENSITY AREA
c - DATA BLOCK REFERS TO FRAME EITHER ON
    LEFT OR RIGHT

DIMENSIONS REFERRING TO THE CODE
BLOCK ARE BASED UPON DOT CENTERS
AND/OR ROW LINES.

NEGATIVE-EMULSION DOWN

12.598 ± 0.025 CM
(4.960 ± 0.010 IN)
FOR
12.7 CM (5 IN)
FILM

0.046 CM
(0.018 IN)
MIN

FILM TRAVEL   FLIGHT

GROUND
TRACK

CENTER CORRELATION MARKS INDICATE THE PRECISE
INSTANT AT WHICH THE CODE DATA MATRIX WAS
TRIGGERED FOR EXPOSURE

C A
D B

C A
D B

*UNIFORM BACK-
GROUND DENSITY
AREA

1.828 ± 0.127 CM
(0.720 ± 0.050 IN)

0.102 CM
(0.040 IN)
MINIMUM

NOTE: On this example correlation
marks are placed at 3.175 CM (1.25 IN) intervals
whereas on other systems they occur more often.
The two image areas on some systems are separated
so that the CMB must be placed along center line of
film.

DIMENSIONS REFERRING TO THE CODE BLOCK
ARE BASED UPON DOT CENTERS & OR ROW LINES

FIGURE 5. Continuous Strip Recording

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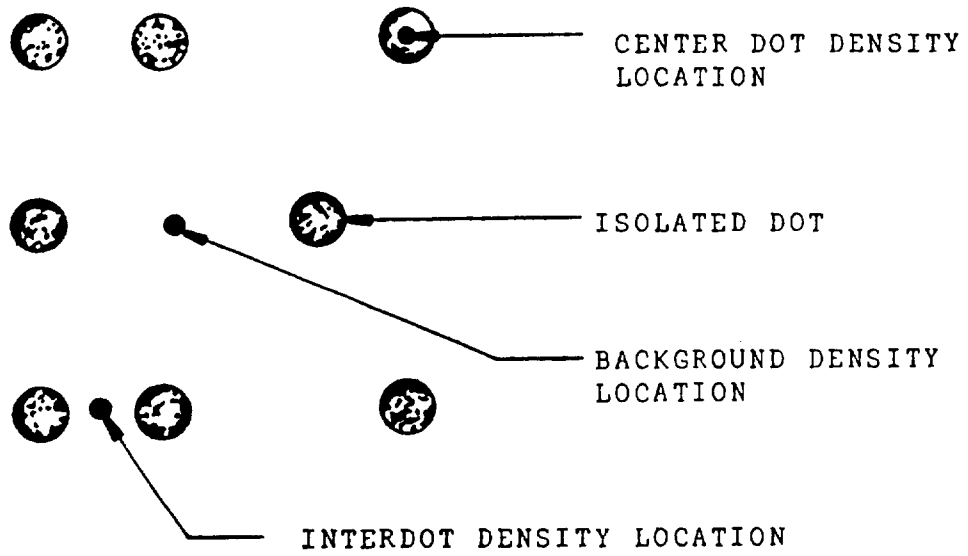MIL-STD-782D

ISOLATED DOT

CENTER DOT DENSITY
LOCATION

ISOLATED DOT

BACKGROUND DENSITY
LOCATION

INTERDOT DENSITY LOCATION

FIGURE 6

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MICRODENSITOMETER RECORDING

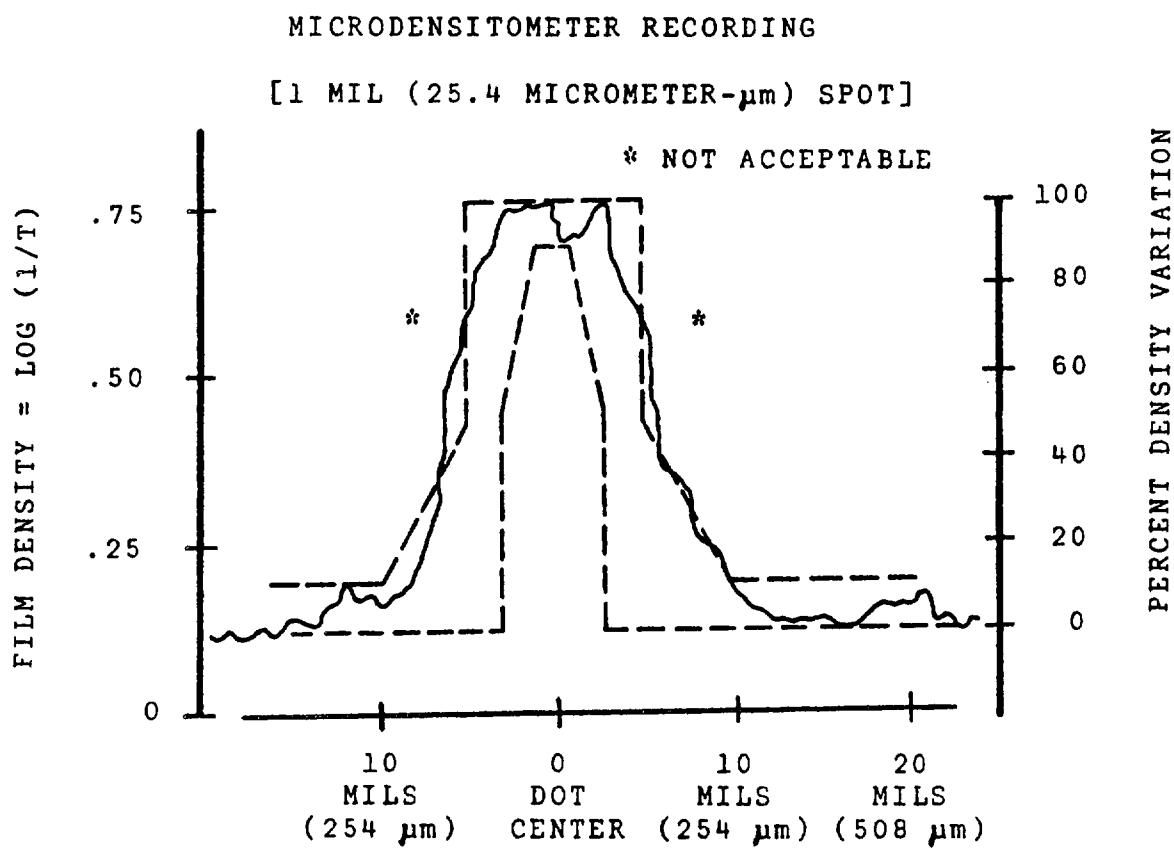### [1 MIL (25.4 MICROMETER-μm) SPOT]

FIGURE 7

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DENSITY AND DIMENSIONAL REQUIREMENTS
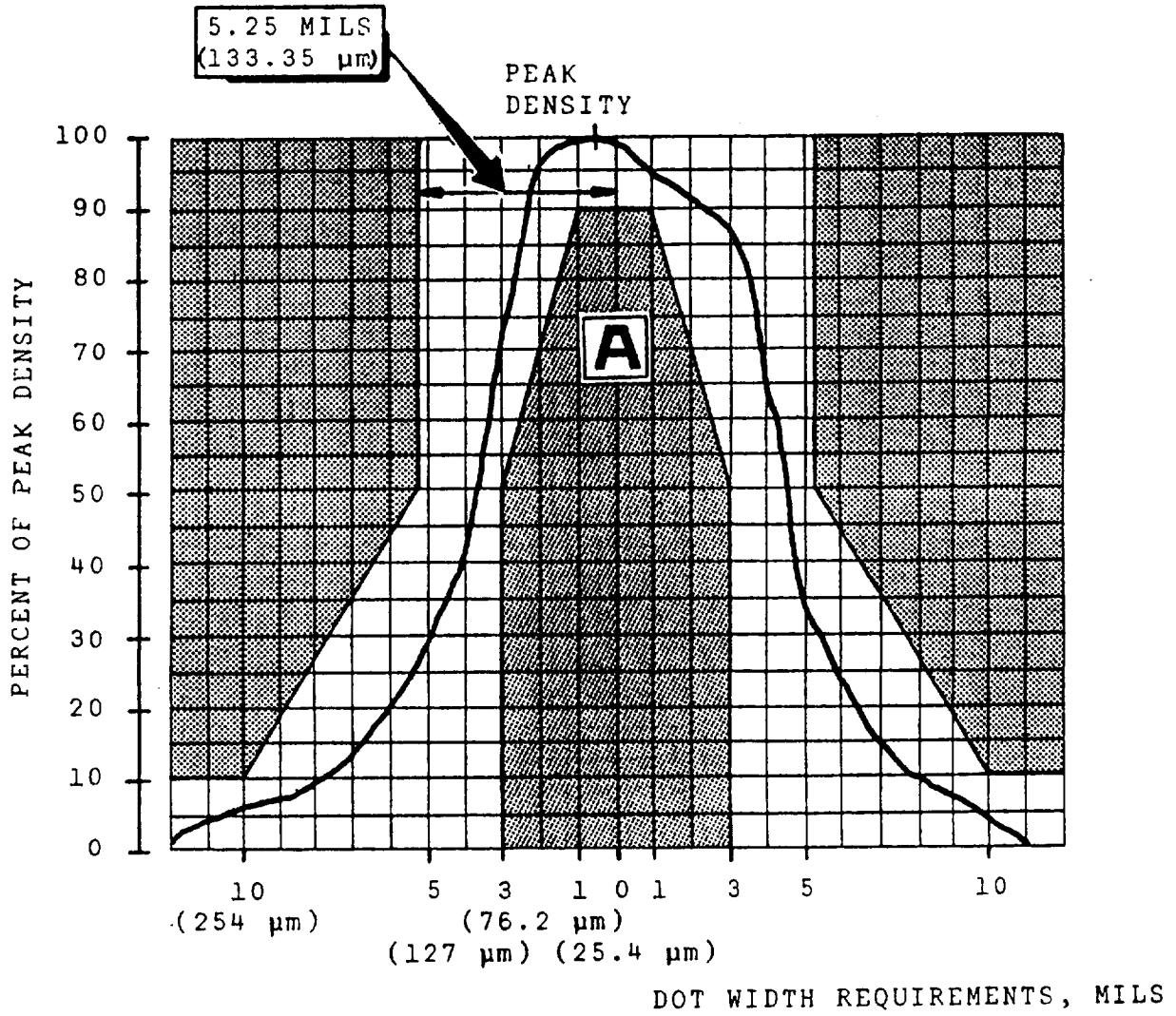FOR AN ISOLATED DOT

FIGURE 8

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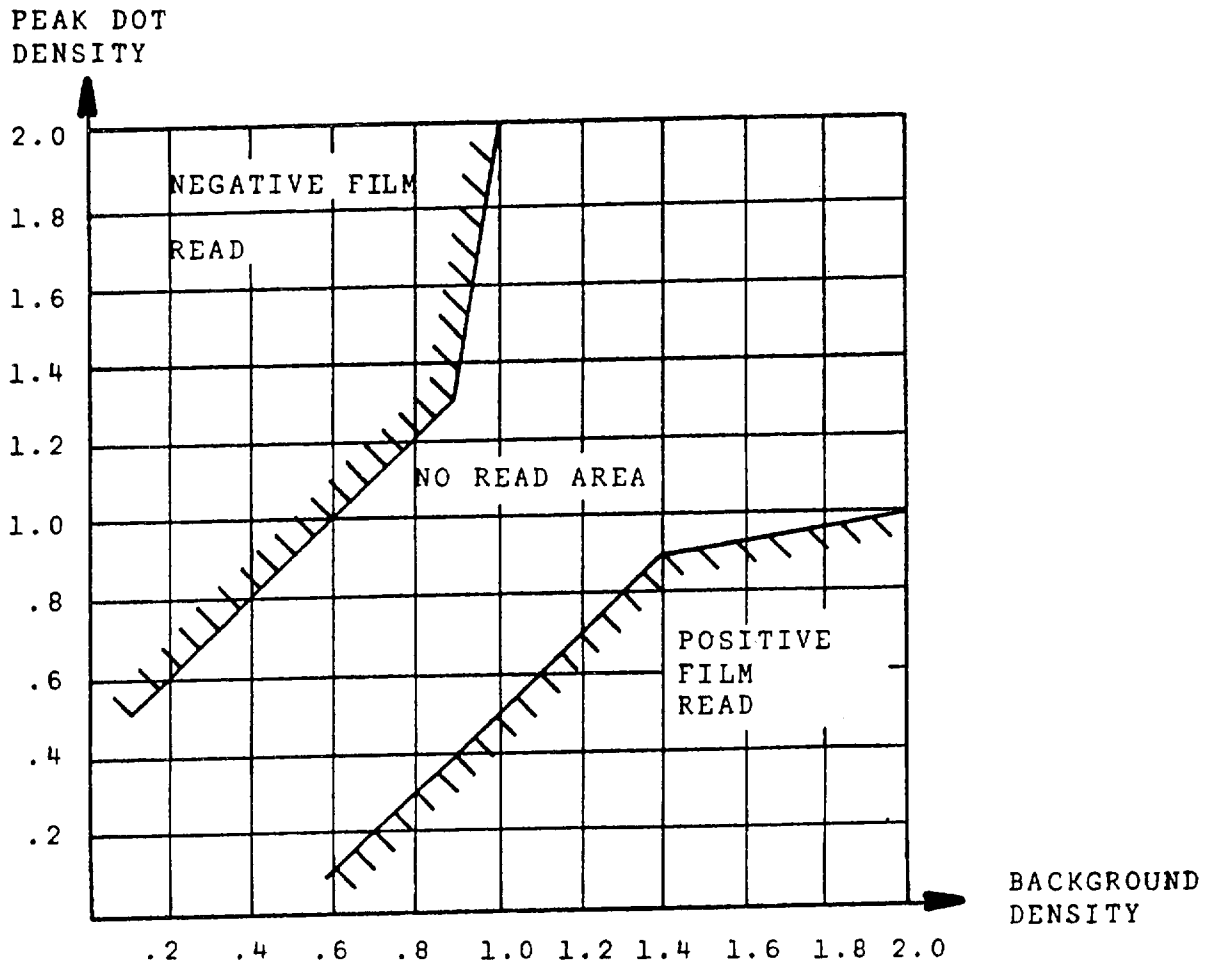
READABILITY REGIONS

FIGURE 9

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