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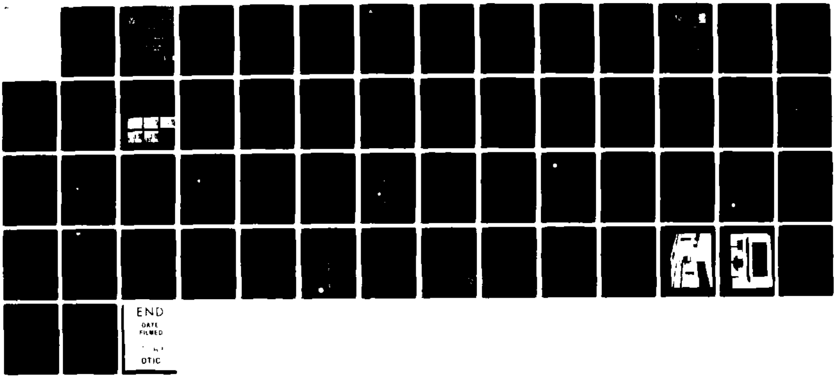
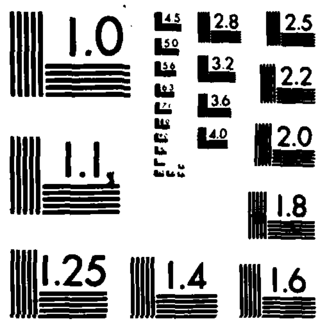
JENKINTOWN PA R SCHAPHORST ET AL. 01 NOV 82
UNCLASSIFIED NCS-TIB-82-6 DCA100-80-C-0042 F/G 14/3 NL





MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

NCS TIB 82-6

NATIONAL COMMUNICATIONS SYSTEM

AD A128893

TECHNICAL INFORMATION BULLETIN

82-6

USERS MANUAL FOR NCS FACSIMILE TEST DOCUMENT TAPES

OCTOBER 1982

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Under contract DCA100-80-C-0042 Delta Information Systems analyzed alternative resolutions for Group 4 facsimile. As part of this investigation four test documents were scanned with five candidate resolutions, and the results of all twenty scans were printed. The test documents and resolutions used in this study are listed below.

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

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Test Images	Resolutions
CCITT Image No. 1	200 lines/inch
CCITT Image No. 5	240 lines/inch
CCITT Image No. 7	300 lines/inch
Legibility Test Chart	400 lines/inch
	480 lines/inch

After these 20 images were scanned considerable interest was expressed by the facsimile technical community in obtaining copies of the scanned data on magnetic tape. These tapes are now available from the NCS*.

The purpose of this users manual is to explain the background of the tapes and to describe the format of the scanned data on the tapes. A brief description of the major sections in the manual is provided below.

* Copies of the image tapes may be obtained from:

Dennis Bodson
NCS
Attention·NCS-TS
Washington, DC 20305

Phone: (202) 692-2124
Telex: 908-041-BAL

NCS TECHNICAL INFORMATION BULLETIN 82-6

USERS MANUAL FOR NCS

FACSIMILE TEST DOCUMENT TAPES

OCTOBER 1982

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APPROVED FOR PUBLICATION:

Marshall L Cain

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Assistant Manager
Office of Technology
and Standards

FOREWORD

Among the responsibilities assigned to the Office of the Manager, National Communications System, is the management of the Federal Telecommunication Standards Program. Under this program, the NCS, with the assistance of the Federal Telecommunication Standards Committee identifies, develops, and coordinates proposed Federal Standards which either contribute to the interoperability of functionally similar Federal telecommunication systems or to the achievement of a compatible and efficient interface between computer and telecommunication systems. In developing and coordinating these standards a considerable amount of effort is expended in initiating and pursuing joint standards development efforts with appropriate technical committees of the Electronic Industries Association, the American National Standards institute, the International Organization for Standardization, and the International Telegraph and Telephone Consultative Committee of the International Telecommunication Union. This Technical Information Bulletin presents an overview of an effort which is contributing to the development of compatible Federal, national, and international standards in the area of digital facsimile standards. It has been prepared to inform interested Federal activities of the progress of these efforts. Any comments, inputs or statements of requirements which could assist in the advancement of this work are welcome and should be addressed to:

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(215) 57[illegible]

USERS MANUAL FOR
NCS FACSIMILE TEST
DOCUMENT TAPES

FINAL REPORT

October 20, 1982

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Washington, D.C. 20305

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Submitted by:

D E L T A I N F O R M A T I O N S Y S T E M S, I N C.
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USERS MANUAL FOR NCS FACSIMILE

TEST DOCUMENT TAPES

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APPENDIX

A. Image Scanning and Writing System A-1

1.0 INTRODUCTION

This document summarizes work performed by Delta Information Systems, Inc. for the office of Technology and Standards of the National Communications System, an organizaiton of the U.S. Government, under Modification P00004 to Contract DCA100-80-C-0042. The Office of Technology and Standards, headed by National Communications System Assistant Manager Marshall L. Cain, is responsible for the management of the Federal Telecommunications Standards Program, which develops telecommunication standards whose use is mandatory by all Federal agencies.

Under the basic contract DCA100-80-C-0042 Delta Information Systems has analyzed alternative resolutions for Group 4 facsimile. The final report for this study was issued in August 1982. As part of this investigation four test documents were scanned with five candidate resolutions, and the results of all twenty scans were printed. The test documents and resolutions used in this study are listed below.

Test Images	Resolutions
CCITT Image No. 1	200 lines/inch
CCITT Image No. 5	240 lines/inch
CCITT Image No. 7	300 lines/inch
Legibility Test Chart	400 lines/inch
	480 lines/inch

After these 20 images were scanned considerable interest was expressed by the facsimile technical community in obtaining copies of the scanned data on magnetic tape. The NCS is planning to make these tapes available.*

The purpose of this users manual is to explain the background of the tapes and to describe the format of the scanned data on the tapes. A brief description of the major sections in the manual is provided below.

Sections

2.0 Test Documents - a description of the four test documents.

3.0 Image Scanning - a description of the parameters and procedures used in scanning the test documents.

4.0 Format of Binary Image/Tape - One tape contains the scanned data for all 20 images where each pel is quantized to either black or white. This section describes the format of the images and the data on the tape.

5.0 Format of 8-bit Image/Tape-Eight tapes contain the scanned data for all 20 images where each pel is coded with 8 bit/pel precision. This section describes the format of the images and the data on the tape.

6.0 Sample Printed Images - The five different resolution images for CCITT document No. 1 have been printed out, and copies are included in this section.

---

* Copies of the image tapes may be obtained from:

Dennis Bodson
NCS
Attention NCS-TS
Washington, D.C. 20305

Phone: (202) 692-2124
Telex: 908-041-BAL

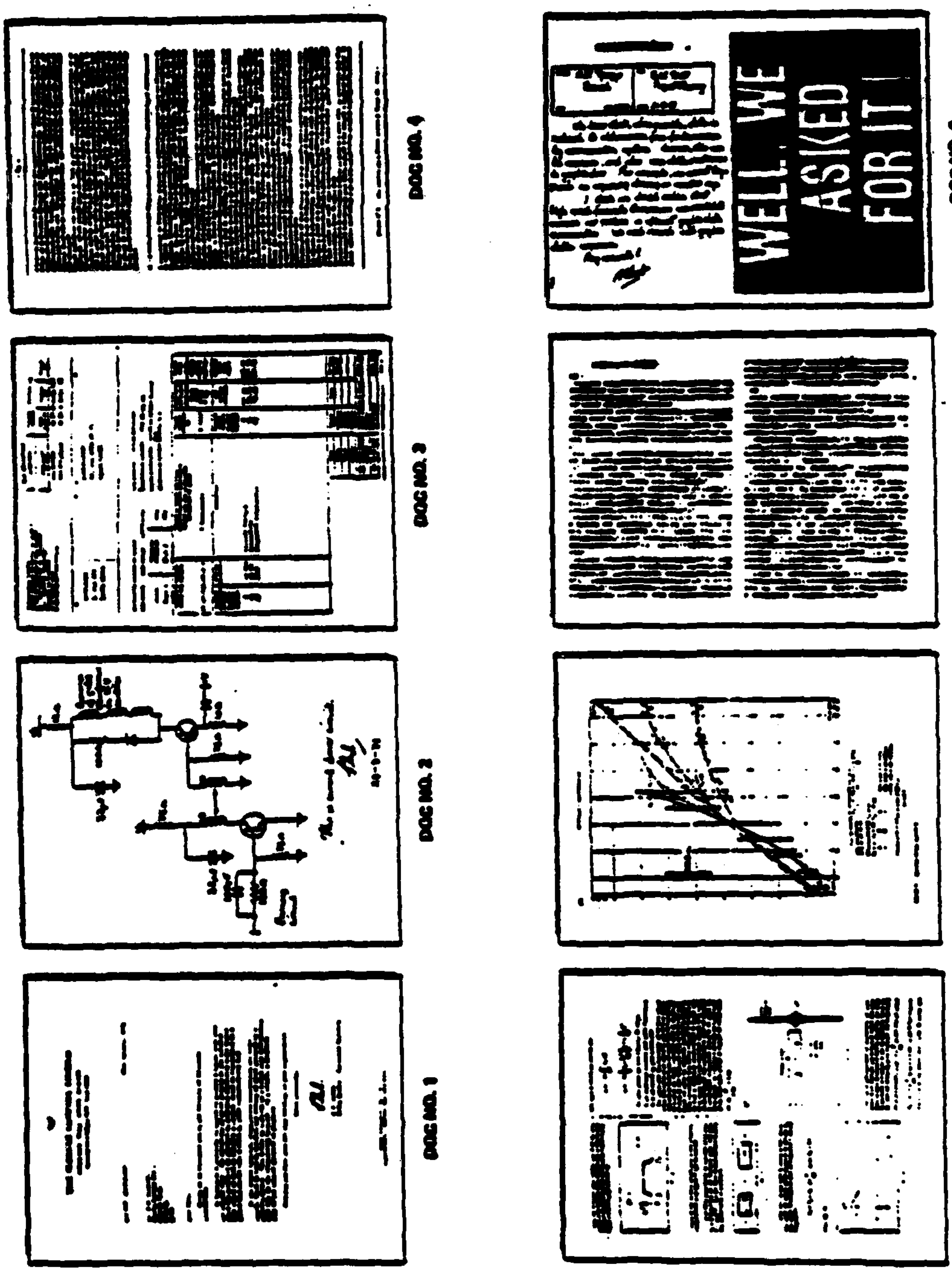
2.0 SELECTION OF TEST DOCUMENTS

Four images were selected to be used as test documents in the subject program. Three of the pages were chosen from the 8 standard CCITT test documents shown in Figure 2-1. It is advantageous to use CCITT test documents because the test results may be readily compared with other data developed by facsimile investigators. The three CCITT documents selected are listed below. The selections of these test documents were reviewed with the TR-29 Facsimile committee of the EIA to insure they agreed with the choice.

CCITT NO.	Name	Figure No.
1	English Letter	2-2
5	French Text Figures	2-3
7	Kanji	2-4

Documents 1, 5, and 7 are representative of a wide range of detail which is likely to be encountered in facsimile systems. Pages 1 and 7 are representative of documents which contain relatively small and large amounts of information respectively. Image 5 contains an intermediate amount of detail. Document 4 is also commonly used in studies of this type. The test results for documents 4 and 7 are usually very similar.

A new test chart was developed on this project to permit the quantitative measurement of image legibility. The test chart was first prepared as an offset plate. This plate was used to print a number of high quality test images. One of these offset prints was scanned as part of this resolution project. A copy of



CCITT Standard Documents for Data Compression Analysis

Figure 2-1

THE SLEREXE COMPANY LIMITED

SAPORS LANE - BOOLE - DORSET - BH 25 8 ER

TELEPHONE BOOLE (945 13) 51617 - TELEX 123456

Our Ref. 350/PJC/EAC 18th January, 1972.

Dr. P.N. Cundall,
Mining Surveys Ltd.,
Holroyd Road,
Reading,
Berks.

Dear Pete,

Permit me to introduce you to the facility of facsimile transmission.

In facsimile a photocell is caused to perform a raster scan over the subject copy. The variations of print density on the document cause the photocell to generate an analogous electrical video signal. This signal is used to modulate a carrier, which is transmitted to a remote destination over a radio or cable communications link.

At the remote terminal, demodulation reconstructs the video signal, which is used to modulate the density of print produced by a printing device. This device is scanning in a raster scan synchronised with that at the transmitting terminal. As a result, a facsimile copy of the subject document is produced.

Probably you have uses for this facility in your organisation.

Yours sincerely,

Phil.

P.J. CROSS
Group Leader - Facsimile Research

Figure 2-2

CCITT IMAGE NO. 1

Registered in England: No. 2038
Registered Office: 60 Vicara Lane, Ilford. Essex.

Cela est d'autant plus valable que $T\,\Delta f$ est plus grand. A cet égard la figure 2 représente la vraie courbe donnant $|\phi(f)|$ en fonction de f pour les valeurs numériques indiquées page précédente.

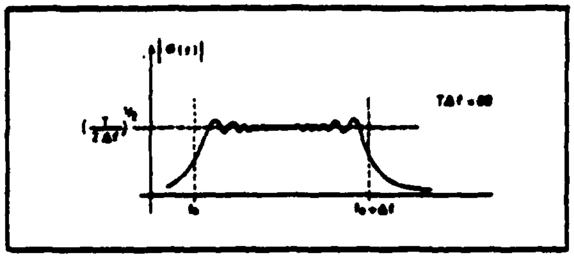


FIG. 2

Dans ce cas, le filtre adapté pourra être constitué, conformément à la figure 3, par la cascade :

— d'un filtre passe-bande de transfert unité pour $f_0 \leq f \leq f_0 + \Delta f$ et de transfert quasi *nul* pour $f < f_0$ et $f > f_0 + \Delta f$, filtre ne modifiant pas la phase des composants le traversant ;

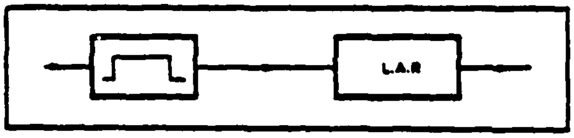


FIG. 3

— filtre suivi d'une ligne à retard (LAR) dispersive ayant un temps de propagation de groupe T_R décroissant *linéairement* avec la fréquence f suivant l'expression :

$$T_R = T_0 + (f_0 - f)\,\frac{T}{\Delta f} \quad (\text{avec } T_0 > T)$$

(voir fig. 4).

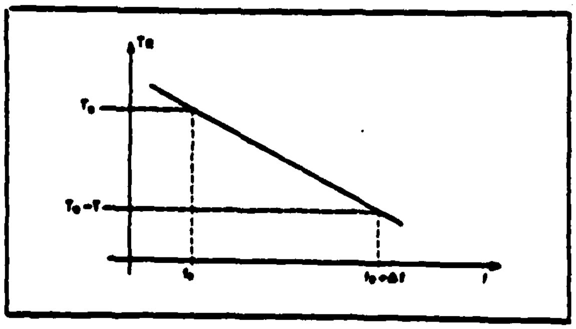


FIG. 4

telle ligne à retard est donnée par :

$$\varphi = -2\pi \int_0^f T_R \, df$$

$$\varphi = -2\pi \left[T_0 + \frac{f_0 T}{\Delta f} \right] f + \pi \frac{T}{\Delta f} f^2$$

Et cette phase est bien l'opposé de $\underline{/\phi(f)}$,

à un déphasage constant près (sans importance) et à un retard T_0 près (inévitable).

Un signal utile $S(t)$ traversant un tel filtre adapté donne à la sortie (à un retard T_0 près et à un déphasage près de la porteuse) un signal dont la transformée de Fourier est réelle, constante entre f_0 et $f_0 + \Delta f$, et nulle de part et d'autre de f_0 et de $f_0 + \Delta f$, c'est-à-dire un signal de fréquence porteuse $f_0 + \Delta f/2$ et dont l'enveloppe a la forme indiquée à la figure 5, où l'on a *représenté* simultanément le signal $S(t)$ et le signal $S_1(t)$ correspondant obtenu à la sortie du filtre adapté. On comprend le nom de *récepteur* à compression d'impulsion donné à ce genre de filtre adapté : la « largeur » (à 3 dB) du signal comprimé étant *égale* à $1/\Delta f$, le rapport de compression est de $\dfrac{T}{1/\Delta f} = T\Delta f$

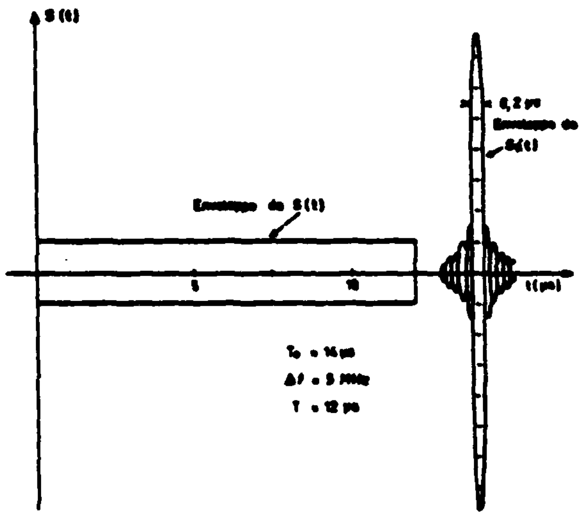


FIG. 5

On saisit physiquement le phénomène de compression en réalisant que lorsque le signal $S(t)$ entre dans la ligne à retard (LAR) la fréquence qui entre la première à l'instant 0 est la fréquence basse f_0, qui met un temps T_0 pour traverser. La fréquence f entre à l'instant $t = (f - f_0)\,\dfrac{T}{\Delta f}$ et elle met un temps $T_0 - (f - f_0)\,\dfrac{T}{\Delta f}$ pour traverser, ce qui la fait ressortir à l'instant T_0 également. Ainsi donc, le signal $S(t)$

Figure 2-3
CCITT Document No. 5

CCITTの概要

沿革

CCITTは、国際電気通信連合（ITU）の四つの常設機関（事務総局、国際周波数登録委員会、CCIR、CCITT）の一つとして、ITUの中でも、世界の国際通信上の諸問題を真先に取上げ、その解決方法を見出して行く重要な機関である。日本名は、国際電信電話諮問委員会と称する。

CCITTの前身は、CCIF（国際電話諮問委員会）とCCIT（国際電信諮問委員会）である。CCIFは、1924年にヨーロッパに「国際長距離電話通信諮問委員会」が設置され、これが1925年のパリ電信電話会議のとき、正式に、「国際電話諮問委員会」として万国電信連合の公式機関となったものである。CCITは、同じく1925年の会議のとき、CCIFと併立するものとして設置された。

そして、CCIFは、1956年の12月に第18回総会が開催されたのち、CCITは、同年同月に第8回総会が開催されたのち、併合されて現在のCCITTとなった。このCCITTは、CCIFとCCITが解散した直後、第1回総会を開催し、第2回総会は、1960年にニューデリーで、第3回総会は、1964年、ジュネーブで、第4回総会は、1968年、アルゼンチンで開催された。

CCIFとCCITが合併したのは、有線電気通信の分野、とくに伝送路について電信回線と電話回線とを技術的に分ける意味がなくなってきたこと、各国とも大体において、電信部門と電話部門は同一組織内にあること、CCIFの事務局とCCITの事務局の合併による能率増進等がおもな理由であった。

CCITTは、上述のように、ヨーロッパ内の国ぐにによって、ヨーロッパ内の電信・電話の技術・運用・料金の基準を定め、あるいは統一をはかってきたので、現在でも、その影響を受け、会合参加国は、ヨーロッパの国が多く、ヨーロッパで生起する問題の研究が多い。たとえば、1960年のCCITT勧告の中で、技術上配慮する距離は約2,500kmであったが、これはヨーロッパ内領域を想定したものである。

しかしながら、1956年9月に敷設された大西洋横断電話ケーブルは、大陸間電話通信の自動化および半自動化への技術的可能性を与え、CCITTがこの問題を取り上げるに及び、CCITTの性格は漸次、汎世界的色彩を実質的に帯びるに至った。この汎世界的性格は第2次世界大戦後目ざましくなったアジア・アフリカ植民地の独立に伴ってITUの構成員の中にこれらの国が加わり、ITUの中に新しい意見が導入されたことにも起因して、技術面、政治面の双方から導入されてきた。CCITTの汎世界化は、1960年の第2回総会がニューデリーで開催されたことにもあらわれている。この総会までは、CCIT、CCIFのいずれにしろ、アメリカやアジアで総会が開催されたことがなく、CCITT委員長も、ニューデリー総会の準備文書で、この点には注目すべきであるとのべている。

任務

ITUは、全権委員会議、主管庁会議を始めとして、七つの機関をもち、それぞれの機関の権限と任務は国際電気通信条約に明記されている。そこで条約を参照してみるならば、CCITTの任務は、つぎのとおりとなっている。

「国際電信電話諮問委員会(CCITT)は：電信および電話に関する技術、運用および料金の問題について研究し、および意見を表明することを任務とする。」（1965年モントルー条約第187号）

「各国際諮問委員会は、その任務の遂行に当たって、新しい国または発展の途上にある国における地域的および国際的分野にわたる電気通信の創設、発達および改善に直接関連のある問題について研究し、および意見を作成するように妥当な注意を払わなければならない。」（同第188号）

「各国際諮問委員会は、また、関係国の要請に基づき、その国内電気通信の問題について研究し、かつ、勧告を行なうことができる。」（同第189号）

上記第187号と第188号にいわれる「意見」とは、フランス語の Avis から訳したもので、英語では、「勧告(Recommendation)」となっている。CCITTの表明する意見は、国際法的には強制力をもたないものであって、この点が、条約、電信規則、電話規則等各国を拘束する力をもっているものと異なる。もっとも意見とは称しても、技術的分野では、電信規則のごとき、各国政府が承認してその内容を実施する強制規則をもたないので、実際にある機器の仕様を定める場合には、多くの国の意見が統一されたこの「意見」に従わなければ、円滑な国際通信を行なうことができない場合が多い。この意見（または勧告）は、国際通信を行なう場合各国が直面する問題について、具体的意見を表明するもので、たとえば、大陸間ケーブルで大陸間通話を半自動化しようとする場合、その信号方式や取り扱う通話の種類および料金は、どのようにするかを研究して意見を表明する。したがって、CCITTの活動は、つねに時代の最先端を行くもので、CCITTの活動方向は、そのまま世界の国際通信の活動方向であるともいえる。

この意見は、また、電信規則以下のその他の規則のごとく、数年以上の間隔をもって開催される主管庁会議というような大会議の決定をまたなくても表明することができ、また、その改正も容易であるので、現在のように進歩の早い国際通信界では、関係国の意見を統一した国際的見解としては非常に便利である。

Figure 2-4

CCITT Image No. 7

these same offset prints is included as Figure 2-5. The legibility chart consists of two parts. The top half of the test chart is divided into five parts each assigned a different size or point of text. Four lines of text are included for each point. Each line contains random text including numbers, upper case, and lower case characters. The text is organized in groups of five characters with a single space between the five character groups. Each of the four lines is a different type font. The four fonts are Helvetica, Times Roman, American Typewriter, and Bodoni Bold.

The bottom half of the test chart is devoted to half-tone imagery. Five different half-tone screen densities are included - 65, 85, 120, 133, and 150 lines/inch. Each of the five half-tone test areas is divided into two parts. The right side is a half-tone of a typical scene. The left side is a uniform half-tone designed to illustrate beat patterns which may appear when the image is scanned. The five different half-tone screen densities are included to represent different input material ranging from newspapers to high quality magazines.

10 Point	dKfje giewo s1weo xcaqp cNvbm xiuyt rEdv2 dkfJe giewo slW3o xcaQp c9vbm xiuy dKfje giewo s1weo xcaqp cNvbm xiuyt rEdv2 dkfJe rEdvj dkfj5 giewo sLweo xca4G cnvbm x8uyt redVJ dkfje Gie6o slwXo xcaqp dKfje giewo s1weo xcaqp cNvbm xiuyt rEdv2 dkfJe Cnvbm xiuyt redvJ d48je giewo slBUo xc2Fp cnvbm xiWyt red0j dkfje giEwo slweo xCa7p cnvbm xi26t redvj KJfje giewo Slweo xc5Tp cnvbm xiuyt Redvj dkfje gVew dKfje giewo s1weo xcaqp
8 Point	dKfje giewo s1weo xcaqp cNvbm xiuyt rEdv2 dkfJe giewo slW3o xcaQp c9vbm xiuy eikjf kjK56 defge 836dKfje giewo s1weo xcaqp cNvbm xiuyt rEdv2 dkfJe rEdvj dkfj5 giewo sLweo xca4G cnvbm x8uyt redVJ dkfje Gie6o slwXo xcaqp KL3er keich 3ks0d dKfje giewo s1weo xcaqp Cnvbm xiuyt redvJ d48je giewo slBUo xc2Fp cnvbm xiWyt red0j dkfje giEwo 3kdoc kdKod 34Ker cNvbm xiuyt rEdv2 dkfJe cNvbm xiuyt slweo xCa7p cnvbm xi26t redvj KJfje giewo Slweo xc5Tp cnvbm xiuyt Redvj dkfje gVew 3pajs kwmeJ el cNvbm xiuyt rEdv2 dkfJe cNvbm xiuyt
6 Point	[illegible]
4 Point	[illegible]
3 Point	[illegible]
2 Point	[illegible]

65 Line Screen

85 Line Screen

120 Line Screen

133 Line Screen

150 Line Screen

Facsimile Test Chart

Figure 2-5

3.0 IMAGE SCANNING

The four images described in section 2.0 were each scanned with five different resolutions to provide a total of twenty separate files of scanned images on magnetic tape. The scanning process was performed by the Applied Physics Laboratory of Johns Hopkins University. The scanning equipment, described in detail in Appendix A, was manufactured by Optronics International, Inc. and is designated as Model P-1700.

The P-1700 scanning equipment is a highly precise device which employs a square aperture and samples the images in a rectilinear fashion; i.e. the sampling density in the horizontal and verical directions is identical. The scanner has two limitations which constrained the scanning procedure. First, the maximum size of the input copy to be scanned is 10 inches by 10 inches. Second, the number of spot sizes which are available is limited.

Due to these limitations, all input images were photographically reduced prior to being scanned. Table 3-1 shows the reduced image size and spot size for each scan.

Table 3-1

Scanning Parameters

Resolution lines/inches	Optical Reduction Ratio	Size of Scanned Image In. by In.	Scanned Spot Size μm
200	1.274	6.67 x 8.63	100
240	2.117	4.02 x 5.20	50
300	1.693	5.02 x 6.50	50
400	1.274	6.67 x 8.63	50
480	2.117	4.02 x 5.20	25

The output of the scanner was fed to an 8 bit analog-to-digital converter and each pixel was stored on magnetic tape.

4.0 FORMAT OF BINARY IMAGE/TAPE

All twenty images are recorded on one reel of 9-track tape, 2400 feet in length at a recording density of 1600 BPI. Each of the twenty images is contained in a separate data file on the tape. The files are recorded in the following order:

FILE	DOCUMENT	RESOLUTION
1	CCITT 1	200
2		240
3		300
4		400
5		480
6	CCITT 5	200
7		240
8		300
9		400
10		480
11	CCITT 7	200
12		240
13		300
14		400
15		480
16	FAX TEST CHART	200
17		240
18		300
19		400
20		480

The tape is written in IBM standard format with standard labels (EBCDIC) for each file and fixed length blocked records. (Each image is preceded and followed by a label with a tape mark). Each file is followed by a tape mark. The block size for each physical record on tape is given in Table 4-1. Each block contains four or eight image scan lines as shown. The number of pels/line and lines per image are also given in the table. The upper left pel of each image is the most significant bit of the first byte of each file. White is zero and black is one.

Table 4-1

BINARY IMAGE FORMAT

PELS/ INCH	PELS/ LINE	BYTES/ LINE	LINES/ BLOCK	BLOCK SIZE	LINES/ IMAGE	NO. OF BLOCKS
200	1728 (8.64")	216	8	1728	2336 (11.68)	292
240	2048 (8.53)	256	8	2048	2800 (11.67)	350
300	2560 (8.53)	320	4	1208	3500 (11.67)	875
400	3456 (8.64")	432	4	1728	4672 (11.68)	1168
480	4096 (8.53)	512	4	2048	5600 (11.67)	1400

5.0 FORMAT OF 8-BIT IMAGE TAPE

The 8-bit images are recorded on a total of eight tapes, two tapes containing all resolutions of each document as shown below:

TAPE	FILE	DOCUMENT	RESOLUTION
1	1	CCITT 1	200
	2		300
	3		400
2	1		240
	2		480
3	1	CCITT 5	200
	2		300
	3		400
4	1		240
	2		480
5	1	CCITT 7	200
	2		300
	3		400
6	1		240
	2		480
7	1	FAX TEST CHART	200
	2		300
	3		400
8	1		240
	2		480

These tapes are also recorded at 1600 BPI on 9-track, 2400 reels with IBM standard labels and fixed length records. Each scan line is one physical record (or block) on tape as shown in table 5-1. The remaining data is similar to that described in the previous section for the one-bit tapes.

Table 5-1

8-BIT IMAGE FORMAT

PELS/ INCH	PELS/ LINE	BYTES/ LINE	LINES/ BLOCK	BLOCK SIZE	LINES/ IMAGE	NO. OF BLOCKS
200	1728 (8.64")	1728	1	1728	2336 (11.68)	2336
240	2048 (8.53)	2048	1	2048	2800 (11.67)	2800
300	2560 (8.53)	2560	1	2560	3500 (11.67)	3500
400	3456 (8.64")	3456	1	3456	4672 (11.68)	4672
480	4096 (8.53)	4096	1	4096	5600 (11.67)	5600

6.0 SAMPLE PRINTED IMAGES

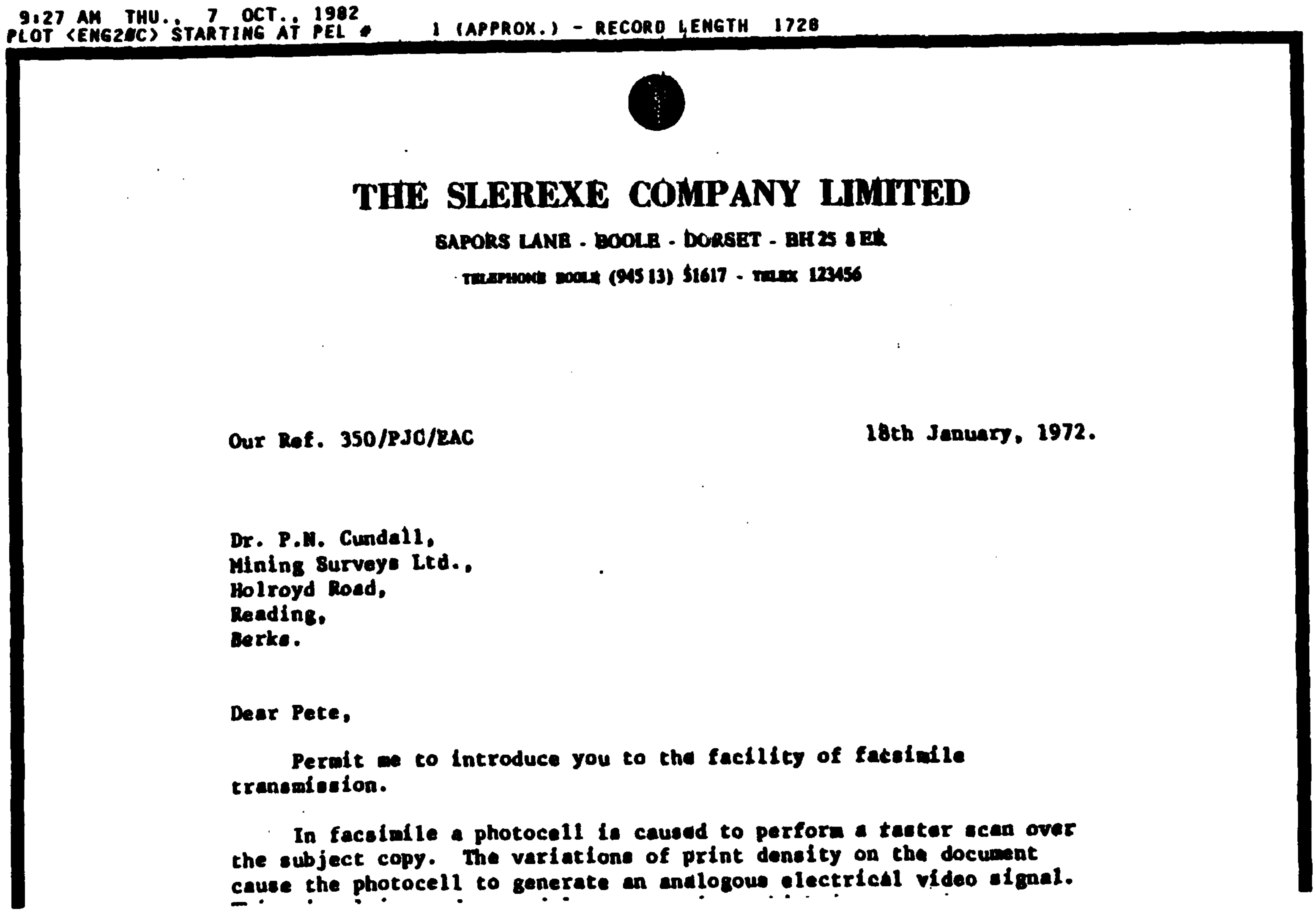
All of the twenty images have been printed to verify the integrity of the data on the tapes. The printouts of CCITT document number 1 at all five resolutions are included in this section as a sample of the printed images (Figures 6-1 through 6-24).

The scanned data has been printed on a Versatec V-80 printer having a resolution of 200 pels/inch. A black border has been printed around the image to indicate the exact location of the edge of the scanned data on the tape. The images having a resolution greater than 200 pels/inch are printed in an enlarged format since they were all printed at 200 pels/inch. Table 6-1 is a list of the printouts of CCITT document number 1. In the case of Figures 6-18, 6-19, 6-22, and 6-23 the horizontal black border does not represent the edge of the test document. Instead it indicates the point of separation between two computer printouts in the middle of the image.

TABLE 6-1

LIST OF CCITT DOCUMENT NO. 1 PRINTED IMAGES

Figure No.	Resolution	Portion of Page
6-1	200 lpi	Top
6-2	200 lpi	Bottom
6-3	240 lpi	Top
6-4	240 lpi	Bottom
6-5	300 lpi	Top-left
6-6	300 lpi	Middle-left
6-7	300 lpi	Bottom-left
6-8	300 lpi	Top-right
6-9	300 lpi	Middle-right
6-10	300 lpi	Bottom-right
6-11	400 lpi	Top-left
6-12	400 lpi	Middle-left
6-13	400 lpi	Bottom-left
6-14	400 lpi	Top-right
6-15	400 lpi	Middle-right
6-16	400 lpi	Bottom-right
6-17	480 lpi	Top-left
6-18	480 lpi	Upper Middle-left
6-19	480 lpi	Lower Middle-left
6-20	480 lpi	Bottom-left
6-21	480 lpi	Top-right
6-22	480 lpi	Upper Middle-right
6-23	480 lpi	Lower Middle-right
6-24	480 lpi	Bottom-right



9:27 AM THU., 7 OCT., 1982
PLOT <ENG2ØC> STARTING AT PEL # 1 (APPROX.) - RECORD LENGTH 1728

THE SLEREXE COMPANY LIMITED

SAPORS LANE - BOOLE - DORSET - BH25 8ER

TELEPHONE BOOLE (945 13) 51617 - TELEX 123456

Our Ref. 350/PJC/EAC

18th January, 1972.

Dr. P.N. Cundall,
Mining Surveys Ltd.,
Holroyd Road,
Reading,
Berks.

Dear Pete,

Permit me to introduce you to the facility of facsimile transmission.

In facsimile a photocell is caused to perform a raster scan over the subject copy. The variations of print density on the document cause the photocell to generate an analogous electrical video signal.

Figure 6-1 200 lpi

This signal is used to modulate a carrier, which is transmitted to a remote destination over a radio or cable communications link.

At the remote terminal, demodulation reconstructs the video signal, which is used to modulate the density of print produced by a printing device. This device is scanning in a raster scan synchronised with that at the transmitting terminal. As a result, a facsimile copy of the subject document is produced.

Probably you have uses for this facility in your organisation.

Yours sincerely,

Phil.

P.J. CROSS
Group Leader - Facsimile Research

Registered in England: No. 2068
Registered Office: 60 Vicara Lane, Ilford, Essex.

Figure 6-2 200 lpi

9:33 AM THU., 7 OCT., 1982   1 (APPROX.) - RECORD LENGTH 2848
PLOT <ENG24C> STARTING AT PEL #

6-5

THE SLEREXE COMPANY LIMITED

SAPORS LANE - BOOLE - DORSET - BH 25 8 ER

TELEPHONE BOOLE (945 13) 51617 - TELEX 123456

Our Ref. 350/PJC/EAC

18th January, 1972.

Dr. P.N. Cundall,
Mining Surveys Ltd.,
Holroyd Road,
Reading,
Berks.

Dear Pete,

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This signal is used to modulate a carrier, which is transmitted to a remote destination over a radio or cable communications link.

At the remote terminal, demodulation reconstructs the video signal, which is used to modulate the density of print produced by a printing device. This device is scanning in a raster scan synchronised with that at the transmitting terminal. As a result, a facsimile copy of the subject document is produced.

Probably you have uses for this facility in your organisation.

Yours sincerely,

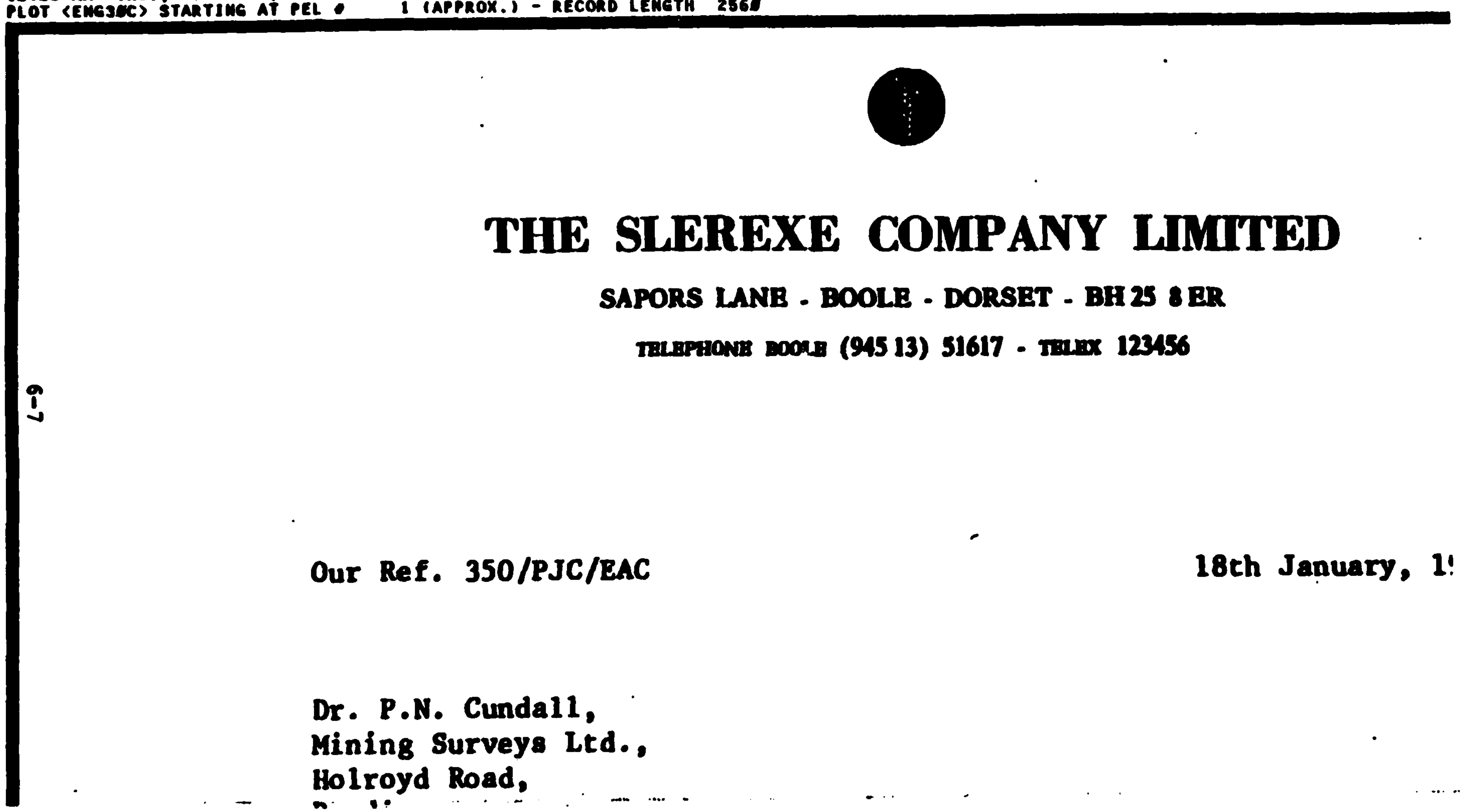
Phil.

P.J. CROSS
Group Leader - Facsimile Research

Registered in England: No. 2038
Registered Office: 80 Vicars Lane, Ilford, Essex.

Figure 6-4 240 lpi

10:00 AM THU., 7 OCT., 1982
PLOT <ENG3BC> STARTING AT PEL # 1 (APPROX.) - RECORD LENGTH 2560



THE SLEREXE COMPANY LIMITED

SAPORS LANE - BOOLE - DORSET - BH 25 8 ER

TELEPHONE BOOLE (945 13) 51617 - TELEX 123456

Our Ref. 350/PJC/EAC 18th January, 1!

Dr. P.N. Cundall,
Mining Surveys Ltd.,
Holroyd Road,

Figure 6-5 300 lpi

Reading,
Berks.

Dear Pete,

Permit me to introduce you to the facility of facsimile transmission.

In facsimile a photocell is caused to perform a raster scan ov
the subject copy. The variations of print density on the document cause the photocell to generate an analogous electrical video signa
This signal is used to modulate a carrier, which is transmitted to
remote destination over a radio or cable communications link.

At the remote terminal, demodulation reconstructs the video signal, which is used to modulate the density of print produced by
printing device. This device is scanning in a raster scan synchron
with that at the transmitting terminal. As a result, a facsimile copy of the subject document is produced.

Probably you have uses for this facility in your organisation.

Yours sincerely,

Figure 6-6 300 lpi

Phil.

P.J. CROSS
Group Leader - Facsimile Reseai

Registered in England: No. 2088
Registered Office: 60 Vicars Lane, Ilford. Essex.

Figure 6-7 300 lpi

10:01 AM THU., 7 OCT., 1982 481 (APPROX.) - RECORD LENGTH 2560
PLOT <ENG30C> STARTING AT PEL #

THE SLEREXE COMPANY LIMITED

SAPORS LANE - BOOLE - DORSET - BH 25 8 ER

TELEPHONE BOOLE (945 13) 51617 - TELEX 123456

18th January, 1972.

ır Ref. 350/PJC/EAC

r. P.N. Cundall,
ining Surveys Ltd.,
ɔlroyd Road,

Figure 6-8 300 lpi

:auing,
:rks.

:ar Pete,

Permit me to introduce you to the facility of facsimile :ansmission.

In facsimile a photocell is caused to perform a raster scan over ıe subject copy. The variations of print density on the document ıuse the photocell to generate an analogous electrical video signal. ıis signal is used to modulate a carrier, which is transmitted to a :mote destination over a radio or cable communications link.

At the remote terminal, demodulation reconstructs the video :gnal, which is used to modulate the density of print produced by a :inting device. This device is scanning in a raster scan synchronised :th that at the transmitting terminal. As a result, a facsimile ›py of the subject document is produced.

Probably you have uses for this facility in your organisation.

Yours sincerely,

Figure 6-9 300 lpi

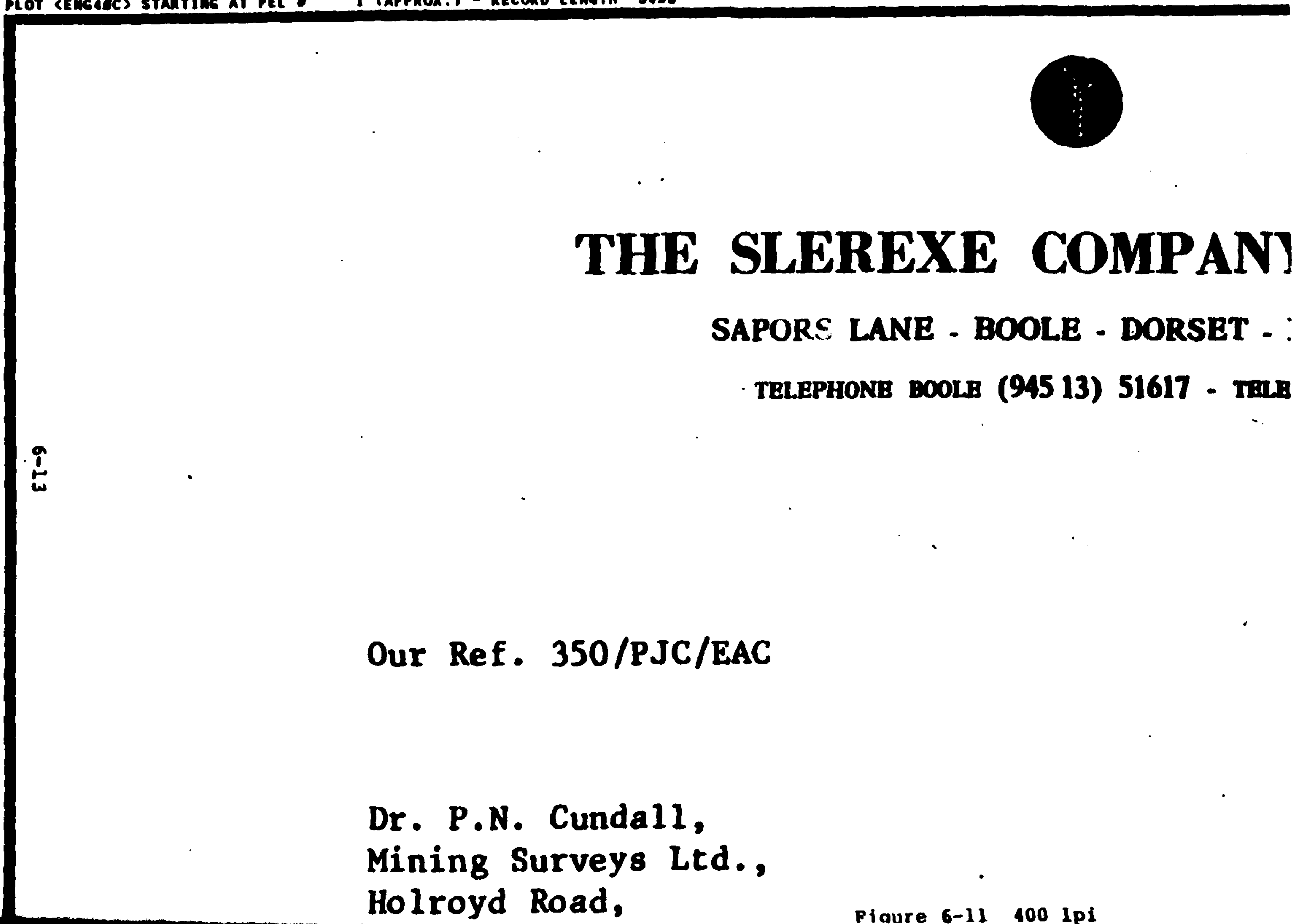
Phil.

P.J. CROSS
Group Leader - Facsimile Research

Registered in England: No. 2038
Registered Office: 80 Vicars Lane, Ilford. Essex.

Figure 6-10 300 lpi

4:18 PM THU., 7 OCT., 1982
PLOT <ENG4BC> STARTING AT PEL # 1 (APPROX.) - RECORD LENGTH 3456



THE SLEREXE COMPAN

SAPORS LANE - BOOLE - DORSET - :

TELEPHONE BOOLE (945 13) 51617 - TELE

Our Ref. 350/PJC/EAC

Dr. P.N. Cundall,
Mining Surveys Ltd.,
Holroyd Road,

Figure 6-11 400 lpi

Berks.

Dear Pete,

Permit me to introduce you to the facilit
transmission.

In facsimile a photocell is caused to per
the subject copy. The variations of print den
cause the photocell to generate an analogous e
This signal is used to modulate a carrier, whi
remote destination over a radio or cable commu

At the remote terminal, demodulation reco
signal, which is used to modulate the density
printing device. This device is scanning in a
with that at the transmitting terminal. As a
copy of the subject document is produced.

Probably you have uses for this facility

Yours sin

Figure 6-12 400 lpi

Phi

P.J. CROS
Group Lea

Registered in England: No. 2038
Registered Office: 60 Vicara Lane, Ilfo

Figure 6-13 400 lpi

4:20 PM THU., 7 OCT., 1982
PLOT <ENG40C> STARTING AT PEL # 1377 (APPROX.) - RECORD LENGTH 3456

REXE COMPANY LIMITED

LANE - BOOLE - DORSET - BH 25 8 ER

ONE BOOLE (945 13) 51617 - TELEX 123456

18th January, 1972.

Figure 6-14 400 lpi

luce you to the facility of facsimile

ocell is caused to perform a raster scan over
ariations of print density on the document
enerate an analogous electrical video signal.
odulate a carrier, which is transmitted to a
a radio or cable communications link.

nal, demodulation reconstructs the video
modulate the density of print produced by a
evice is scanning in a raster scan synchronised
tting terminal. As a result, a facsimile
ment is produced.

ses for this facility in your organisation.

Phil.

P.J. CROSS
Group Leader - Facsimile Research

Registered in England: No. 2038
ed Office: 60 Vicars Lane, Ilford. Essex.

Figure 6-16 400 lpi

3:31 PM FRI., 8 OCT., 1982
PLOT <ENG4BA> STARTING AT PEL # 1 (APPROX.) - RECORD LENGTH 4896

THE SLERELEXE C(

SAPORS LANE - BOOLE

TELEPHONE BOOLE (945 1:

Our Ref. 350/PJC/EAC

Figure 6-17 480 lpi

Dr. P.N. Cundall,
Mining Surveys Ltd.,
Holroyd Road,
Reading,
Berks.

Dear Pete,

Permit me to introduce you to t
transmission.

In facsimile a photocell is cau
the subject copy. The variations of
cause the photocell to generate an a
This signal is used to modulate a ca

3:25 PM FRI., 8 OCT., 1982
PLOT <ENG48B> STARTING AT PEL # 1 (APPROX.) - RECORD LENGTH 4#96

remote destination over a radio or c

At the remote terminal, demodul
signal, which is used to modulate th
printing device. This device is sca
with that at the transmitting termir
copy of the subject document is prod

Probably you have uses for this

Figure 6-19 480 lpi

Registered in Engl
Registered Office: 60 Vi

Figure 6-20 480 lpi

3:32 PM FRI., 8 OCT., 1982
PLOT <ENG48A> STARTING AT PEL # 2017 (APPROX.) - RECORD LENGTH 4096

COMPANY LIMITED

)LE - DORSET - BH 25 8 ER

15 13) 51617 - TELEX 123456

18th January, 1972.

Figure 6-21 480 lpi

o the facility of facsimile

caused to perform a raster scan over
of print density on the document
n analogous electrical video signal.
carrier, which is transmitted to a

3:20 PM FRI., 8 OCT., 1982
PLOT <ENG480> STARTING AT PEL # 2017 (APPROX.) - RECORD LENGTH 4096

r cable communications link.

dulation reconstructs the video
the density of print produced by a
scanning in a raster scan synchronised
minal. As a result, a facsimile
roduced.

his facility in your organisation.

Yours sincerely,

Phil.

Figure 6-23 480 lpi

P.J. CROSS
Group Leader - Facsimile Research

ngland: No. 2038
0 Vicara Lane, Ilford. Essex.

Figure 6-24 480 lpi

APPENDIX A

IMAGE SCANNING AND WRITING SYSTEM

Image Scanning and Writing System

The image scanning and writing system provides a unique capability within APL for the computer processing of color and black and white photographic data. A photographic image on either film or opaque paper can be scanned and digitized, and the resultant data then written on a computer storage medium such as magnetic tape or disk. Conversely, properly formatted computer data can be written on film (either ordinary silver halide film or Polaroid film) to construct a photographic image. Computer processing of the data provides a powerful means for image analysis, manipulation, and enhancement. The computer processing can be performed by either the PDP-11/70 or the central computing system. The choice depends on the characteristics of the processing to be performed. Standard image processing programs are available now, and special application programs can be prepared on request.

The system uses two units of equipment purchased from Optronics International, Inc. One unit (a P-1700) scans both black and white (B/W) and color images and also writes B/W images; the other unit (a C-4300) writes both B/W and color images, but is used ordinarily for writing only color images. The P-1700 is shown in Figure 3. The C-4300 (not shown) is similar to the P-1700 but does not include scanning components.

Data are transmitted between the PDP-11/70 and the scanning or writing device as eight-bit bytes at a rate of 28 kilobytes per second. Each byte represents the density of one square picture element, a "pixel." Pixel sizes are selectable in six geometrically increasing steps from 12.5 micrometers to 400 micrometers. With eight-bit bytes, 256 density levels can be represented. For scanning operations, one may confidently expect a density resolution approaching that number. For writing operations, 64 repeatable density levels for B/W and 32 for each primary color can be achieved.

Both the P-1700 and the C-4300 employ electro-mechanical rotating drums for scanning and writing. Color scan and color write operations are performed using filters for the three (additive) primary colors, red, green, and blue. Color operations, therefore, require three passes for scanning or writing.

Both units accommodate media in sizes up to 10-in. by 10-in., but the maximum usable image area is 9-in. by 9-in. in the P-1700 and 9-in. by 10-in. in the C-4300. Film types stocked for the image writer are as follows: Linagraph Shellburst 2474 (B/W, 10-in. by 10-in.); Ektachrome SO-278, emulsion equipment to ET-160 amateur film, process E-6 (color transparency, 10-in. by 10-in.); and Polacolor 2, type 808 (fast color prints, 8-in. by 10-in.).

Figure 2. Dicomed D48C and PDP-11/70

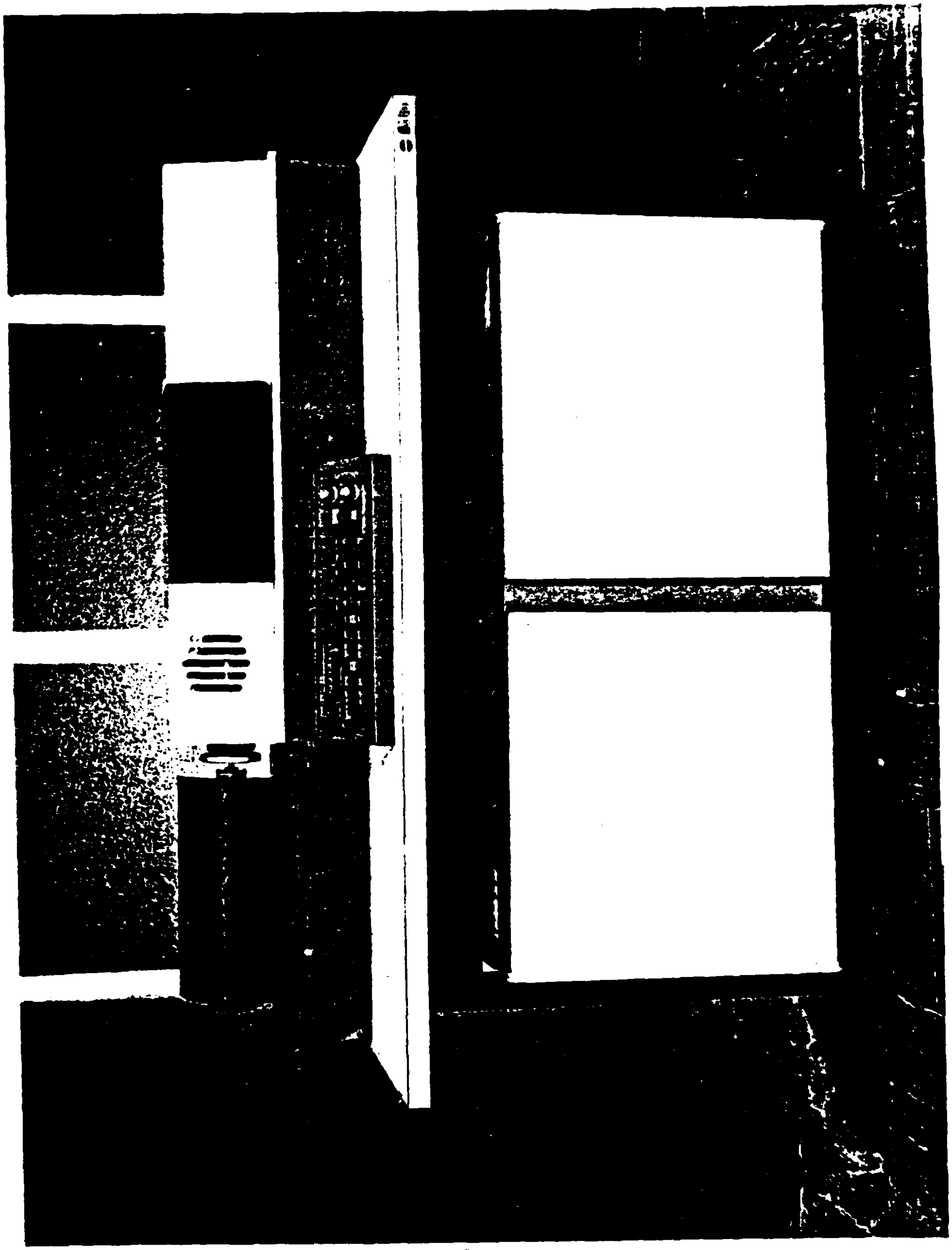


Figure 3. P-1700 Image Scanning and Writing System

Scanning Operations

The scanning portion of the P-1700 (used for both B/W and color) consists of a rotating, horizontally aligned drum and a movable "C" carriage. One arm of the carriage moves into and out of the open-ended drum along a line parallel to the drum's axis. The other arm of the carriage, rigid with respect to the first arm, is located outside the drum. The medium to be scanned is attached to the periphery of the drum where a section of the wall has been removed. Drum rotation and carriage movement provide the Y and X scanning motions, respectively.

The light source is a halogen-filled incandescent lamp located away from the carriage area; light is transmitted from the source to the carriage area by means of fiber optics bundles. For scanning transparencies, the light is emitted from the end of the arm within the carriage and transmitted through the transparency to a photodetector mounted on the carriage arm outside the drum. For scanning opaque media, the light is emitted from the carriage arm outside the drum and reflected from the medium to the detector.

Before it is emitted, the light is transmitted through an optical system that ensures uniform illumination, focusing, and spot size selection. Before its intensity is measured by the densitometer photodetector, the light passes through an imaging aperture. Each measurement defines the density of one pixel. The output from the photodetector is amplified logarithmically (giving a selectable density range of 0-2D or 0-3D) or linearly (giving a transmittance range of 0 to 100 percent).

Around the circumference of the drum (Y direction), the optical density is measured at the selected pixel interval. After each drum revolution, a precision lead screw and stepping motor move the "C" carriage axially (in the X direction) by the raster width (pixel dimension) until the entire area of interest has been scanned. Pixel positional accuracy in both X and Y is ±2 micrometers rms/cm. Once per revolution, the densitometer photodetector is reset to an optical density of 0 as defined by the air path through an opening in the drum, or from a reflector on the drum if an opaque medium is being scanned.

Writing Operations

For write operations, eight-bit bytes from the computer are converted to analog signals, which modulate a light source to expose the photosensitive medium. The P-1700 is used for writing B/W images, and the C-4300 is used for writing color images. The writing portion of each device includes a rotating drum to which the unexposed medium is attached in a darkroom. The drum is enclosed in a light-tight cassette, which can be easily attached to and removed from the device proper. (A slide opening on the cassette permits exposure of the medium when the cassette is attached.) The optical system that writes on the film is located on a carriage under the cassette, and it is moved by the same precision lead screw and stepping motor as the scanning carriage.

For the C-4300 (color writing), the optical system consists of a white-light glow crater tube, a color-filter select assembly, a selectable aperture, and a lens system to focus the beam onto the film plane. The film is exposed at every selected raster point along the circumference of the drum (Y direction) by pulse modulation of the light beam, and the optical carriage is stepped in the axial (X) direction by the raster width after each revolution of the drum. The C-4300 is capable of writing up to 32 repeatable density levels for each primary color and has a dynamic range of 0-2D.

The writing portion of the P-1700 (B/W writing) differs from the C-4300 principally in that a red light-emitting diode is used as the source, rather than a white-light glow crater tube. This difference in light source allows B/W imagery to be written with greater or lesser resolution (smaller or larger pixel sizes) than color imagery. The P-1700 is capable of writing up to 64 repeatable density levels and has a dynamic range of 0-2.5D.

Functional characteristics and specifications of the image processing system are summarized in Figure 4. A chart of the scan and write times as a function of specimen size (at different resolutions) is given in Figure 5.

Figure 4
Image Processing System
Functional Characteristics and Specifications&

Operation	Pixel/Raster Size in um	Range*	Resolvable Levels
SCANNING Black & White and Color (P-1700)	12.5, 25, 50, 100, 200 & 400	0-2D or 0-3D or 0-100%T	256
WRITING Black & White (P-1700)	12.5, 25, 50, 100, 200 & 400	0-2.5D	64
WRITING Color (C-4300)	25, 50, 100 & 200	0-2D	32/Color

* D (density) = Log(10) [I(i)/I(t)],
T (transmittance) = [I(t)/I(i)],
where I(i) = incident light and
I(t) = transmitted light

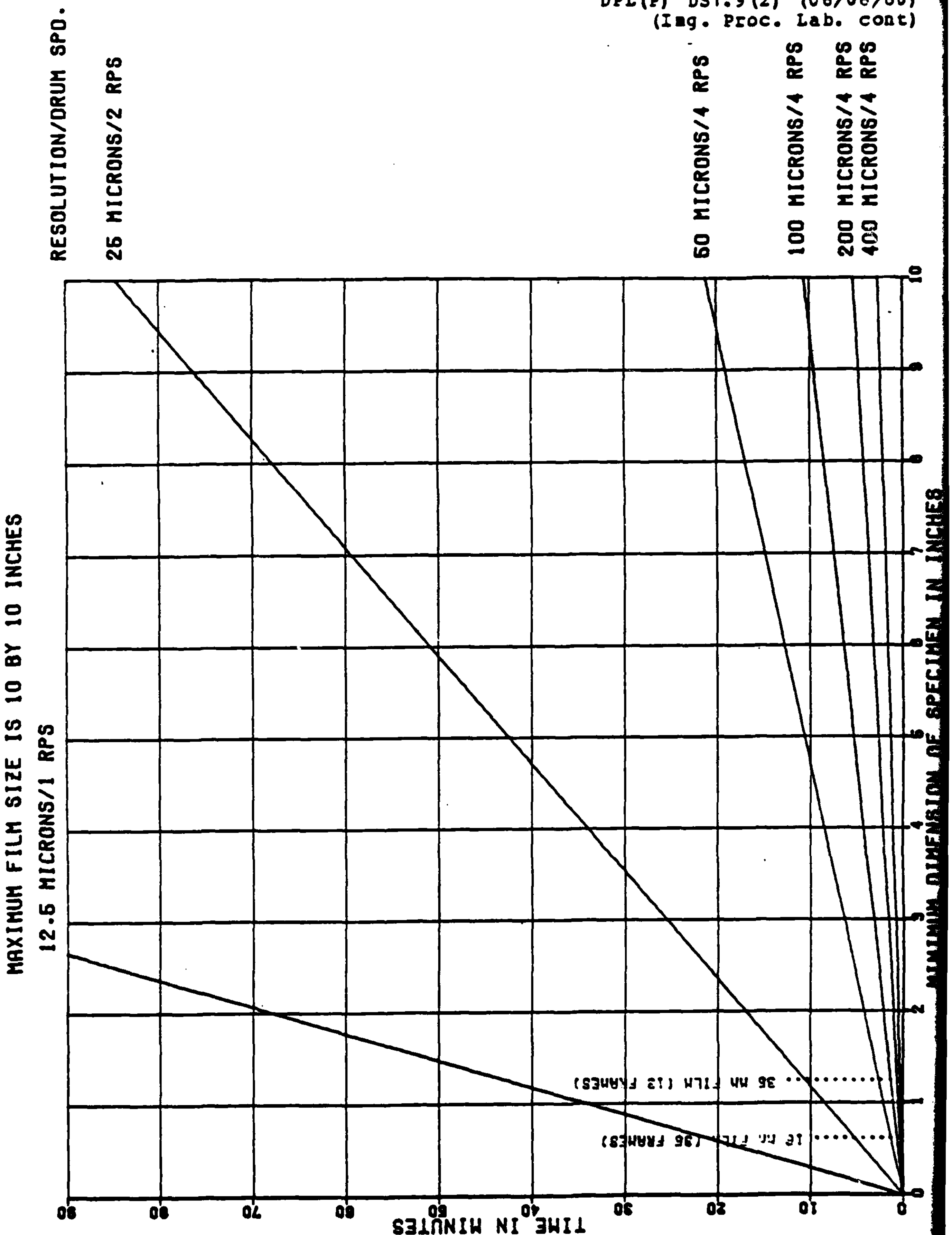


Figure 5. Scan and Write Times

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