L2/06-388

2007 Five-Year Maintenance Review of INCITS/L2 Standards:

INCITS 4 :1986 [R2002] Information Processing - Coded character Sets -
7-Bit American National Standard Code for Information Interchange (7-Bit ASCII)

American National Standard

ANSI INCITS 4-1986 (R2002)
(formerly ANSI X3.4-1986 (R1997))

L2/06-388

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for Information Systems - Coded Character Sets - 7-Bit American National Standard Code for Information Interchange (7-Bit ASCII)

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American National Standard
for Information Systems –

Coded Character Sets – 7-Bit American National Standard Code for Information Interchange (7-Bit ASCII)

Secretariat

Computer and Business Equipment Manufacturers Association

Approved March 26, 1986

American National Standards Institute, Inc

Foreword (This Foreword is not part of American National Standard X3.4-1986.)

This American National Standard presents the standard coded character set to be used for information interchange among information processing systems, communication systems, and associated equipment.

Other standards prescribe the means of implementing this standard in media, such as perforated tape, punched cards, magnetic tape, magnetic tape cassette and cartridges, and optical character recognition. Further standards deal with error control, data communication formats, keyboards, graphic representation of control characters, code extension techniques, and media labels and file structures.

The 7-bit coded character set was developed from a careful review of past work in the field and after a comprehensive program of original research and code design was completed. Careful consideration has been given to the several conflicting requirements for code sets and their resolution is reflected in the standard code.

This standard is a revision of American National Standard Code for Information Interchange, ANSI X3.4-1977, and was developed in parallel with its international counterpart, Informational Processing – ISO 7-Bit Coded Character Set for Information Interchange, ISO 646-1983. This current revision retains the same technical relationship to ISO 646-1983 as the earlier edition. The text of this revision is quite close to that of ISO 646-1983. Changes were made to adopt more customary U.S. terminology and to reduce ambiguity. A conformance section has been added to aid users in building compatible equipment. The relationship with American National Standard Code Extension Techniques for Use with the 7-Bit Coded Character Set of American National Standard Code for Information Interchange, ANSI X3.41-1974, has also been included.

Suggestions for improvement of this standard will be welcome. They should be sent to the Computer and Business Equipment Manufacturers Association, 311 First Street, NW, Suite 500, Washington, DC 20001.

This standard was processed and approved for submittal to ANSI by American National Standards Committee on Information Processing Systems, X3. Committee approval of the standard does not necessarily mean that all committee members voted for its approval. At the time it approved this standard, the X3 Committee had the following members:

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American National Standard for Information Systems –

Coded Character Sets – 7-Bit American National Standard Code for Information Interchange (7-Bit ASCII)

1. Scope and Field of Application

1.1 This standard specifies a set of 128 characters (control characters and graphic characters, such as letters, digits, and symbols) with their coded representation. The American National Standard Code for Information Interchange may also be identified by the acronym ASCII (pronounced ask-ee). To explicitly designate a particular (perhaps prior) edition of this standard, the last two digits of the year of issue may be appended, as in "ASCII 68" or ASCII 86."

1.2 This standard is the U.S. national version of the International Standard for Information Processing – ISO 7-Bit Coded Character Set for Information Interchange, ISO 646-1983.

1.3 This character set is primarily intended for interchange of information among data processing systems and associated equipment, and within data communication systems. The need for graphic characters and control functions in data processing has also been taken into account in determining this character set.

1.4 No specific meaning is prescribed for any of the graphics in the code table except that which is understood by the users. Furthermore, this standard does not specify a type style for the printing or display of the various graphic characters. In specific applications it may be desirable to employ distinctive styling of individual graphics to facilitate their use for specific purposes.

1.5 This character set includes control characters for code extension where its 128 characters are insufficient for particular applications. The use of code extension control characters is not defined by this standard. Procedures for the use of these control characters are specified in American National Standard Code Extension Techniques for Use with the 7-Bit Coded Character Set of American National Standard Code for Information Interchange, ANSI X3.41-1974.

1.6 This standard defines a few format effector control codes. Additional control functions for use with character imaging devices are defined in American National Standard Additional Controls for Use with American National Standard Code for Information Interchange, ANSI X3.64-1979, and Information Processing – ISO 7-Bit and 8-Bit Coded Character Sets – Additional Control Functions for Character-Imaging Devices, ISO 6429-1983.

1.7 In the definitions of some control characters in this standard, it is assumed that the data associated with them are to be processed serially in a forward direction. When they are included in strings of data that are processed other than serially in a forward direction, or when they are included in data formatted for fixed-record processing, they may have undesirable effects or may require additional special treatment to ensure that they result in their desired functions.

1.8 Although some collation requirements were part of the original criteria for assigning code table positions to graphic characters, collation is considered outside the scope of this standard.

1.9 This standard does not define the structure of the data transmission characters or the formats for data transmission. Such information may be found in American National Standard for the Use of the Communication Control Characters of American National Standard Code for Information Interchange in Specified Data Communication Links, ANSI X3.28-1976.

1.10 This standard does not define a graphic representation of control characters. Such representations may

be found in American National Standard Graphic Representation of the Control Characters of American National Standard Code for Information Interchange, ANSI X3.32-1973.

2. Conformance and Implementation

2.1 Conformance. Conformance requirements for a standard on coding can be generally described as defining rules for conforming interchange (syntax) at a coding interface as well as rules for execution (semantics) by a conforming imaging receiving device.

2.1.1 Conforming Interchange. The data stream comprising the exchange of information using the coding of this standard is subject to the following rules. Conforming interchange:

(1) Shall be a sequence of 7-bit or 8-bit bit combinations.

(2) Shall use the names of all control characters as specified in this standard.

(3) Shall not include any bit combinations allocated by this standard for any purpose other than that defined in this standard, unless they represent functions or elements of other coded character sets that have been invoked by code extension in accordance with ANSI X3.41-1974, subject to mutual agreement between the interchange parties.

(4) Shall not include the bit combination for BS (0/8) for purposes of forming composite characters unless claims of conformance to this standard specify such use and enumerate the characters used for overstriking.

(5) Shall not include the bit combinations for LF (0/10), VT (0/11), or FF (0/12) to represent combined horizontal and vertical movement of the active position, unless claims of conformance to this standard specify such use.

2.1.2 Conforming Receiving Imaging Device. A conforming receiving imaging device:

(1) Shall execute CR, LF, NUL, SP, and BS, as specified in this standard. (The use of BS for forming composite characters is not required.)

(2) Shall execute all other control characters

(a) As specified in this standard or

(b) As a null function; that is, no action shall be taken and there shall be no effect on the interpretation of subsequent characters.

(3) Shall image all 94 graphic characters such that each character is recognizable as being associated with one of its names and such that each character is distinguishable from the other graphic characters. No other graphic character may be substituted for any of the graphic characters in the set.

2.2 Implementation. The use of this character set requires definitions of its implementation in various media. For example, these could include punched tapes, punched cards, magnetic media, and transmission channels, thus permitting interchange of data to take place either indirectly by means of an intermediate recording in a physical medium, or by local connection of various units (such as input and output devices and computers) or by means of data transmission equipment. The implementation of this coded character set in physical media and for transmission, taking into account the need for checking errors, is the subject of other American National Standards and International Standards (see Appendix E).

3. Definitions

3.1 Active Position. The character position at which the action required by the next character in the data stream is to be effected. If the next character is a graphic character, it is imaged at that position, if it is a control character, the corresponding function is performed relative to that position.

3.2 Bit Combination. An ordered set of bits used for the representation of characters.

3.3 Character. A member of a set of elements used for the organization, control, or representation of data.

3.4 Character Position. A position on an imaging device at which a graphic character can be imaged.

3.5 Coded Character Set; Code. A set of unambiguous rules that establishes a character set and the one-to-one relationship between the characters of the set and their assigned bit combinations.

3.6 Code Extension. The techniques for encoding characters that are not included in the character set of a given code.

3.7 Code Table. A table showing the character allocated to each bit combination in a code.

3.8 Control Character. A control function that is coded as a single bit combination.

3.9 Control Function. An action that affects the recording, processing, transmission, or interpretation of data and that has a coded representation consisting of one or more bit combinations.

3.10 Graphic Character. A character, other than a control function, that has a visual representation normally handwritten, printed, or displayed.

3.11 Graphic Symbol. A visual representation of a graphic character or of a control function.

3.12 Code Table Position. That part of a code table identified by its column and row coordinates.

3.13 Small Letter. A lowercase letter.

3.14 Capital Letter. An uppercase letter.

4. Specification of the Coded Character Set

The bits of the bit combinations of the 7-bit code are identified by b_7, b_6, b_5, b_4, b_3, b_2, and b_1, where b_7 is the highest order bit (most significant bit), and b_1 is the lowest order bit (least significant bit). The bit combination may be interpreted to represent numbers in the range 0 to 127 in binary notation by attributing the following weights to the individual bits:

Bit:	b_7	b_6	b_5	b_4	b_3	b_2	b_1
Weight:	64	32	16	08	04	02	01

In this standard, the bit combinations are identified by notation of the form x/y, where x is a number in the range 0 to 7 and y is a number in the range 0 to 15. The correspondence between the notations of the form x/y and the bit combinations consisting of the bits b_7 to b_1 is as follows:

(1) x is the number represented by b_7, b_6, and b_5, where these bits are given the weights 4, 2, and 1, respectively.

(2) y is the number represented by b_4, b_3, b_2, and b_1, where these bits are given the weights 8, 4, 2, and 1, respectively.

The notations of the form x/y are the same as the ones used to identify positions in the code table where x is the column number and y the row number (see Section 6).

The 128 bit combinations of the 7-bit code represent control characters and graphic characters. The allocation of characters to bit combinations is based on the following principles:

(1) The bit combinations 0/0 to 1/15 represent 32 control characters

(2) The bit combination 2/0 represents the character SPACE, which is interpreted both as a control character and as a graphic character

(3) The bit combinations 2/1 to 7/14 represent 94 graphic characters

(4) The bit combination 7/15 represents the control character DELETE

The allocation of individual characters to the bit combinations of the 7-bit code is specified in 4.1, 4.2, and 4.3.

This standard assigns at least one name to each character. In addition, it specifies an acronym for each control character and for the character SPACE, and a graphic symbol for each graphic character. By convention, only capital letters and hyphens are used for writing the names of the characters, except when writing the names of small letters. For acronyms, only capital letters and digits are used. It is intended that the acronyms and this convention be retained in all translations of the text.

The names chosen to denote graphic characters are intended to reflect their customary meaning. However, this standard does not restrict the meanings of graphic characters. Neither does it specify a particular style or font design for the graphic characters when imaged.

4.1 Control Characters. The control characters of the 7-bit coded character set are classified in the following categories:

(1) *Transmission Control Characters.* Transmission control characters are intended to control or facilitate transmission of information over telecommunication networks. Procedures for the use of the transmission control characters on telecommunication networks are the subjects of other standards and correspond to Open Systems Interconnection (OSI) levels 1 through 4 (see ANSI X3.28-1976 and Appendix E). Transmission control characters may also be referred to as *communication control characters.*

(2) *Format Effectors.* Format effectors are mainly intended to control the layout and positioning of information on character-imaging devices, such as printing and display devices.

(3) *Code Extension Control Characters.* Code extension control characters are used to extend the character set of the code. They may alter the meaning of one or more bit combinations that follow them in the data stream. Procedures for the use of the code extension control characters are specified in ANSI X3.41-1974.

(4) *Device Control Characters.* Device control characters are intended to control local or remote devices or ancillary devices connected to a data processing or data communication system. These control characters are not intended to control data communication systems; this should be achieved by the use of transmission control characters.

(5) *Information Separators.* Information separators are used to separate and qualify data logically. There are four such characters. They may be used in either hierarchical or nonhierarchical order; in the latter case, their specific meanings depend on the application.

(6) *Other Control Characters.* These are the control characters that fall outside the preceding categories.

The composition of each category, and the allocation of the individual control characters in each category to bit combinations of the 7-bit code are specified in 4.1.1 to 4.1.6. Each of these subsections refers to a table consisting of three columns. The first column specifies the acronym of each control character, the second column specifies the standard name of the control character, and the third column, labeled "Coded Representation," specifies the bit combination representing the control character concerned.

Detailed functional descriptions of all control characters are given in Section 7.

4.1.1 Transmission Control Characters. The transmission control characters and their coded representations are specified in Table 1.

4.1.2 Format Effectors. The format effectors and their coded representations are specified in Table 2.

4.1.2.1 Concepts. The definitions of the format effectors use the following concepts:

(1) A page is composed of a number of lines, each being composed of a number of character positions.

(2) Each character position is capable of imaging SPACE or a graphic symbol.

(3) The graphic symbol imaged at a character position represents a graphic character, a control function, or a combination of one or more graphic characters and/or control functions.

(4) The active position is the character position at which the action required by the next character in the data stream is to be effected. If the next character is a graphic character, it is imaged at that position; if it is a control character, the corresponding function is performed relative to that position.

(5) Movements of the active position are effected as follows:

(a) The active position is advanced one character position immediately after imaging a SPACE or a graphic symbol, and upon the execution of the function corresponding to a control character for which a graphic symbol is required to be imaged.

(b) The active position is moved to a specified character position upon the execution of the function corresponding to a control character that is defined to cause a movement of the active position (i.e., a format effector).

(6) The active position is not moved upon execution of the function corresponding to a control character that is neither required to be imaged by a graphic symbol nor defined to cause a movement of the active position.

(7) The effect of an attempt to place a graphic character beyond the boundaries of a line or a page is

Table 1
Transmission Control Characters

Acronym	Name	Coded Representation
SOH	START OF HEADING	0/1
STX	START OF TEXT	0/2
ETX	END OF TEXT	0/3
EOT	END OF TRANSMISSION	0/4
ENQ	ENQUIRY	0/5
ACK	ACKNOWLEDGE	0/6
DLE	DATA LINK ESCAPE	1/0
NAK	NEGATIVE ACKNOWLEDGE	1/5
SYN	SYNCHRONOUS IDLE	1/6
ETB	END OF TRANSMISSION BLOCK	1/7

Table 2
Format Effectors

Acronym	Name	Coded Representation
BS	BACKSPACE	0/8
HT	HORIZONTAL TABULATION	0/9
LF	LINE FEED	0/10
VT	VERTICAL TABULATION	0/11
FF	FORM FEED	0/12
CR	CARRIAGE RETURN	0/13

not defined by this standard. However, double-line spacing shall not result when a line of text containing the maximum number of characters that can be entered onto a single line is followed by LINE FEED (LF) (independent of whether the LF is preceded or followed by zero or more CARRIAGE RETURNs (CRs)).

4.1.2.2 Combined Horizontal and Vertical Movements of the Active Position. The format effectors are defined for applications in which horizontal and vertical movements of the active position are effected separately. If a single control character is required to effect the action of CARRIAGE RETURN in combination with a vertical movement, the format effector for that vertical movement shall be used. For example, if the function "New Line" (equivalent to the combination of CARRIAGE RETURN and LINE FEED) is required as a single control character, bit combination 0/10 shall be used to represent it. This substitution requires agreement between the sender and the recipient of the data, and the format effectors that are affected (LINE FEED, VERTICAL TABULATION, and/or FORM FEED) shall be identified.

In order to avoid the need for such prior agreement, to facilitate interchange, and to avoid conflicts with

specifications in other standards, the use of format effectors for vertical movements to effect combined horizontal and vertical movements is deprecated (see Section D4 of Appendix D). It is strongly recommended that CR be used in addition to a vertical format effector when the combined function is desired. For example, use CR and LF to obtain the effect of "New Line."

This standard does not specify which control functions are generated by which keys on a keyboard, nor the names given such keys A "New Line" key, for example, may generate the character LF on one device using the "New Line" option, but generate the sequence CR LF on another device. Conversely, a key generating the CR character alone might have the name "Return," "New Line," or only a symbolic representation of its function.

4.1.3 Code Extension Control Characters. The code extension control characters and their coded representation are specified in Table 3.

4.1.4 Device Control Characters. The device control characters and their coded representations are specified in Table 4.

4.1.5 Information Separators. The information separators and their coded representations are specified in Table 5.

The names INFORMATION SEPARATOR FOUR, INFORMATION SEPARATOR THREE, INFORMATION SEPARATOR TWO, and INFORMATION SEPARATOR ONE are alternate names for these characters as specified in ISO 646-1983, and are given here for reference only. FILE SEPARATOR, GROUP SEPARATOR, RECORD SEPARATOR, and UNIT SEPARATOR are intended for applications in which the information separators are used hierarchically. The ascending order is then US, RS, GS, and FS. In this case, data normally delimited by a particular separator cannot be split by a higher-order separator but will be considered as delimited by any higher-order separator. The information separators may also be used to separate information in a nonhierarchical manner, but their names remain the same.

4.1.6 Other Control Characters. The control characters outside the categories in 4.1.1 through 4.1.5 and their coded representations are specified in Table 6.

4.2 SPACE. The acronym of the character SPACE is SP and its coded representation is 2/0.

This character is interpreted both as a graphic character and as a control character. As a graphic character, it has a visual representation consisting of the absence of a graphic symbol. As a control character, it acts as a format effector that causes the active position to be advanced one character position.

Table 3
Code Extension Control Characters

Acronym	Name	Coded Representation
SO	SHIFT-OUT	0/14
SI	SHIFT-IN	0/15
ESC	ESCAPE	1/11

Table 4
Device Control Characters

Acronym	Name	Coded Representation
DC1	DEVICE CONTROL ONE	1/1
DC2	DEVICE CONTROL TWO	1/2
DC3	DEVICE CONTROL THREE	1/3
DC4	DEVICE CONTROL FOUR	1/4

Table 5
Information Separators

Acronym	Name	Coded Representation
FS (IS4)	FILE SEPARATOR (INFORMATION SEPARATOR FOUR)	1/12
GS (IS3)	GROUP SEPARATOR (INFORMATION SEPARATOR THREE)	1/13
RS (IS2)	RECORD SEPARATOR (INFORMATION SEPARATOR TWO)	1/14
US (IS1)	UNIT SEPARATOR (INFORMATION SEPARATOR ONE)	1/15

Table 6
Other Control Characters

Acronym	Name	Coded Representation
NUL	NULL	0/0
BEL	BELL	0/7
CAN	CANCEL	1/8
EM	END OF MEDIUM	1/9
SUB	SUBSTITUTE CHARACTER	1/10
DEL	DELETE	7/15

4.3 Graphic Characters. The 94 bit combinations 2/1 to 7/14 are used to represent graphic characters in ASCII as specified in Table 7. The first column in the table is labeled "Graphic" and specifies the graphic symbol of each graphic character; the second column, labeled "Name," specifies the standard name of the graphic character; and the third column, labeled "Coded Representation," specifies the bit combination representing the graphic character concerned.

In Table 7, alternate names for graphic characters are separated by commas. When different names are used in ISO 646-1983, these names are shown in parentheses for reference only.

All graphic characters of the 7-bit coded character set are spacing characters, i.e., they cause the active position to advance.

5. Composite Graphic Characters

In this standard, all graphic characters are spacing characters that cause the active position to move forward. However, by using BACKSPACE or CARRIAGE RETURN, it is possible on some devices to image two or more graphic characters at the same character position (for example, the use of UNDERLINE and BS or CR to produce the graphic rendition "underline").

The ability to create composite characters is not required by this standard. It is recommended that when such composite characters are desired, they may be encoded using the more efficient techniques defined in other standards (such as "graphic rendition (SGR)" in ANSI X3.64-1979 or nonspacing underline in ISO 6937/2-1983).

6. Code Table

A 7-bit code table consists of 128 positions arranged in 8 columns and 16 rows. The columns are numbered 0 to 7, and the rows are numbered 0 to 15.

The code table positions are identified by notations of the form x/y, where x is the column number and y is the row number.

The 128 positions of the code table are in one-to-one correspondence with the bit combinations of the 7-bit code. The notation of a code table position, of the form x/y, is the same as that of the corresponding bit combination (see Section 4).

Each code table position contains a symbol. When a code table position corresponds to a bit combination that represents a control character or the character SPACE, the symbol is the acronym of the character allocated, otherwise, it is the graphic representing the character allocated.

Table 8 is the ASCII 7-Bit code table It shows the 7-bit coded character set specified in Section 4

7. Description of the Control Characters

The control characters are described in 7.1 through 7.32 in the alphabetical order of their acronyms. It should be noted that the control characters of ASCII are identical to those of ISO 646-1983.

7.1 ACK (ACKNOWLEDGE). A transmission control character transmitted by a receiver as an affirmative response to the sender.

7.2 BEL (BELL). A control character that is used when there is a need to call for attention; it may control alarm or attention devices.

7.3 BS (BACKSPACE). A format effector that causes the active position to move one character position backwards.

7.4 CAN (CANCEL). A character, or the first character of a sequence, indicating that the data preceding it is in error. As a result, this data is to be ignored. The specific meaning of this character shall be defined for each application and/or defined between sender and recipient (see Section D4 of Appendix D).

7.5 CR (CARRIAGE RETURN). A format effector that causes the active position to move to the first character position on the same line.

7.6 DC1 (DEVICE CONTROL ONE). A device control character that is primarily intended for turning on or starting an ancillary device. If it is not required for this purpose, it may be used to restore a device to the basic mode of operation (see also DC2 and DC3), or for any other device control function not provided by other DCs.

7.7 DC2 (DEVICE CONTROL TWO). A device control character that is primarily intended for turning on or starting an ancillary device. If it is not required for this purpose, it may be used to set a device to a special mode of operation (in which case DC1 is used to restore the device to the basic mode), or for any other device control function not provided by other DCs.

7.8 DC3 (DEVICE CONTROL THREE). A device control character that is primarily intended for turning off or stopping an ancillary device. This function may be a secondary level stop, for example, wait, pause, standby,

Table 7
Graphic Characters

Graphic	Name	Coded Representation	Graphic	Name	Coded Representation
!	EXCLAMATION POINT	2/1	R	CAPITAL LETTER R	5/2
"	QUOTATION MARK*	2/2	S	CAPITAL LETTER S	5/3
#	NUMBER SIGN†	2/3	T	CAPITAL LETTER T	5/4
$	DOLLAR SIGN†	2/4	U	CAPITAL LETTER U	5/5
%	PERCENT SIGN	2/5	V	CAPITAL LETTER V	5/6
&	AMPERSAND	2/6	W	CAPITAL LETTER W	5/7
'	APOSTROPHE, RIGHT SINGLE QUOTATION MARK, ACUTE ACCENT*	2/7	X	CAPITAL LETTER X	5/8
			Y	CAPITAL LETTER Y	5/9
			Z	CAPITAL LETTER Z	5/10
(	LEFT PARENTHESIS	2/8	[	LEFT BRACKET (LEFT SQUARE BRACKET)†	5/11
)	RIGHT PARENTHESIS	2/9			
*	ASTERISK	2/10	\	REVERSE SLANT (REVERSE SOLIDUS)†	5/12
+	PLUS SIGN	2/11			
,	COMMA*	2/12	]	RIGHT BRACKET (RIGHT SQUARE BRACKET)†	5/13
-	HYPHEN, MINUS SIGN	2/13			
	PERIOD, DECIMAL POINT (FULL STOP)	2/14	^	CIRCUMFLEX ACCENT*,†	5/14
			_	UNDERLINE (LOW LINE)	5/15
/	SLANT (SOLIDUS)	2/15	`	LEFT SINGLE QUOTATION MARK, GRAVE ACCENT†	6/0
0	DIGIT ZERO	3/0			
1	DIGIT ONE	3/1			
2	DIGIT TWO	3/2	a	SMALL LETTER a	6/1
3	DIGIT THREE	3/3	b	SMALL LETTER b	6/2
4	DIGIT FOUR	3/4	c	SMALL LETTER c	6/3
5	DIGIT FIVE	3/5	d	SMALL LETTER d	6/4
6	DIGIT SIX	3/6	e	SMALL LETTER e	6/5
7	DIGIT SEVEN	3/7	f	SMALL LETTER f	6/6
8	DIGIT EIGHT	3/8	g	SMALL LETTER g	6/7
9	DIGIT NINE	3/9	h	SMALL LETTER h	6/8
:	COLON	3/10	i	SMALL LETTER i	6/9
;	SEMICOLON	3/11	j	SMALL LETTER j	6/10
<	LESS-THAN SIGN	3/12	k	SMALL LETTER k	6/11
=	EQUALS SIGN	3/13	l	SMALL LETTER l	6/12
>	GREATER-THAN SIGN	3/14	m	SMALL LETTER m	6/13
?	QUESTION MARK	3/15	n	SMALL LETTER n	6/14
@	COMMERCIAL AT†	4/0	o	SMALL LETTER o	6/15
A	CAPITAL LETTER A	4/1	p	SMALL LETTER p	7/0
B	CAPITAL LETTER B	4/2	q	SMALL LETTER q	7/1
C	CAPITAL LETTER C	4/3	r	SMALL LETTER r	7/2
D	CAPITAL LETTER D	4/4	s	SMALL LETTER s	7/3
E	CAPITAL LETTER E	4/5	t	SMALL LETTER t	7/4
F	CAPITAL LETTER F	4/6	u	SMALL LETTER u	7/5
G	CAPITAL LETTER G	4/7	v	SMALL LETTER v	7/6
H	CAPITAL LETTER H	4/8	w	SMALL LETTER w	7/7
I	CAPITAL LETTER I	4/9	x	SMALL LETTER x	7/8
J	CAPITAL LETTER J	4/10	y	SMALL LETTER y	7/9
K	CAPITAL LETTER K	4/11	z	SMALL LETTER z	7/10
L	CAPITAL LETTER L	4/12	{	LEFT BRACE (LEFT CURLY BRACKET)†	7/11
M	CAPITAL LETTER M	4/13			
N	CAPITAL LETTER N	4/14	|	VERTICAL LINE†	7/12
O	CAPITAL LETTER O	4/15	}	RIGHT BRACE (RIGHT CURLY BRACKET)†	7/13
P	CAPITAL LETTER P	5/0			
Q	CAPITAL LETTER Q	5/1	~	TILDE (OVERLINE)*,†	7/14

*The use of the symbols in 2/2, 2/7, 2/12, 5/14, and 7/14 as diacritical marks is described in A5.2 in Appendix A.
†These characters should not be used in international interchange without determining that there is agreement between sender and recipient (see Section B5 in Appendix B).

Table 8
ASCII Code Table

b7	0	0	0	0	1	1	1	1
b6	0	0	1	1	0	0	1	1
b5	0	1	0	1	0	1	0	1

b4	b3	b2	b1		0	1	2	3	4	5	6	7
0	0	0	0	0	NUL	DLE	SP	0	@	P	`	p
0	0	0	1	1	SOH	DC1	!	1	A	Q	a	q
0	0	1	0	2	STX	DC2	"	2	B	R	b	r
0	0	1	1	3	ETX	DC3	#	3	C	S	c	s
0	1	0	0	4	EOT	DC4	$	4	D	T	d	t
0	1	0	1	5	ENQ	NAK	%	5	E	U	e	u
0	1	1	0	6	ACK	SYN	&	6	F	V	f	v
0	1	1	1	7	BEL	ETB	'	7	G	W	g	w
1	0	0	0	8	BS	CAN	(	8	H	X	h	x
1	0	0	1	9	HT	EM	)	9	I	Y	i	y
1	0	1	0	10	LF	SUB	*	:	J	Z	j	z
1	0	1	1	11	VT	ESC	+	;	K	[	k	{
1	1	0	0	12	FF	FS	,	<	L	\	l	|
1	1	0	1	13	CR	GS	-	=	M	]	m	}
1	1	1	0	14	SO	RS	.	>	N	^	n	~
1	1	1	1	15	SI	US	/	?	O	_	o	DEL

NOTE: The font used in this code table is OCR-B. It is intended only as an example of a conforming font and is not intended to indicate preference for OCR-B.

or halt (in which case DC1 is used to restore normal operation). If it is not required for this purpose, it may be used for any other ancillary device control function not provided by other DCs

7.9 DC4 (DEVICE CONTROL FOUR). A device control character that is primarily intended for turning off, stopping, or interrupting an ancillary device If it is not required for this purpose, it may be used for any other device control function not provided by other DCs.

7.10 DEL (DELETE). A character used primarily to erase or obliterate an erroneous or unwanted character in punched tape. DEL characters may also serve to accomplish media-fill or time-fill. They may be inserted into or removed from a stream of data without affecting the information content of that stream, but such action may affect the information layout and/or the control of equipment If media-fill or time-fill is required, it is preferred that the NUL character be used (see Section D4 of Appendix D).

7.11 DLE (DATA LINK ESCAPE). A transmission control character that changes the meaning of a limited number of contiguously following bit combinations. It is used exclusively to provide supplementary transmission control functions. Only graphic characters and transmission control characters may be used in DLE sequences. Appropriate sequences are defined in ANSI X3.28-1976.

7.12 EM (END OF MEDIUM). A control character that may be used to identify the physical end of a medium, the end of the used portion of a medium, or the end of the wanted portion of data recorded on a medium. The position of this character does not necessarily correspond to the physical end of the medium.

7.13 ENQ (ENQUIRY). A transmission control character used as a request for a response from a remote station – the response may include station identification and/or station status. When a "Who are you" function is required on a switched transmission network, the first use of ENQ after the connection is established shall have the meaning "Who are you" (station identification). Subsequent use of ENQ may or may not include the function "Who are you," as determined by agreement.

7.14 EOT (END OF TRANSMISSION). A transmission control character used to indicate the conclusion of the transmission of one or more texts.

7.15 ESC (ESCAPE). A control character that is used to provide additional characters (code extension). It alters the meaning of a limited number of contiguously following bit combinations. The use of this character is specified in ANSI X3.41-1974

7.16 ETB (END OF TRANSMISSION BLOCK). A transmission control character used to indicate the end of a transmission block of data where data is divided into such blocks for transmission purposes.

7.17 ETX (END OF TEXT). A transmission control character that terminates a text.

7.18 FF (FORM FEED). A format effector that causes the active position to advance to the corresponding character position on a predetermined line of the next form or page. The use of FF to cause combined horizontal and vertical movement of the active position is discussed in 4.2.3.3.

7.19 FS (FILE SEPARATOR) (INFORMATION SEPARATOR FOUR). A control character used to separate and qualify data logically; its specific meaning has to be defined for each application. If this character is used in hierarchical order, as specified in the general definition of the information separators (see 4.1.5), it delimits a data item called a "file."

7.20 GS (GROUP SEPARATOR) (INFORMATION SEPARATOR THREE). A control character used to separate and qualify data logically; its specific meaning has to be defined for each application. If this character is used in hierarchical order, as specified in the general definition of the information separators (see 4.1.5), it delimits a data item called a "group."

7.21 HT (HORIZONTAL TABULATION). A format effector that causes the active position to advance to the next predetermined character position.

7.22 LF (LINE FEED). A format effector that causes the active position to advance to the corresponding character position of the next line. The use of LF to cause combined horizontal and vertical movement of the active position is discussed in 4.1.2.2.

7.23 NAK (NEGATIVE ACKNOWLEDGE). A transmission control character transmitted by a receiver as a negative response to the sender.

7.24 NUL (NULL). A control character used to accomplish media-fill or time-fill. NUL characters may be inserted into or removed from a stream of data without affecting the information content of that stream, but such action may affect the information layout and/or the control of equipment.

7.25 RS (RECORD SEPARATOR) (INFORMATION SEPARATOR TWO). A control character used to separate and qualify data logically; its specific meaning has to be defined for each application. If this character is used in hierarchical order, as specified in the general definition of the information separators (see 4.1.5), it delimits a data item called a "record."

7.26 SI (SHIFT-IN). A control character that is used in conjunction with SO and ESC to extend the graphic character set of the code. It may reinstate the standard meanings of the bit combinations that follow it. The effect of this character is described in ANSI X3.41-1974

7.27 SO (SHIFT-OUT). A control character that is used in conjunction with SI and ESC to extend the graphic character set of the code. It may alter the meaning of the bit combinations that follow it until an SI character is reached. The effect of this character is described in ANSI X3.41-1974.

7.28 SOH (START OF HEADING). A transmission control character used as the first character of a heading of an information message.

7.29 STX (START OF TEXT). A transmission control character that precedes a text and that is used to terminate a heading.

7.30 SUB (SUBSTITUTE CHARACTER). A control character used in the place of a character that has been found to be invalid or in error. SUB is intended to be introduced by automatic means, as, for example, when a transmission error is detected.

7.31 SYN (SYNCHRONOUS IDLE). A transmission control character used by a synchronous transmission system in the absence of any other character (idle condition) to provide a signal from which synchronism may be achieved or retained between data terminal equipment.

7.32 US (UNIT SEPARATOR) (INFORMATION SEPARATOR ONE). A control character used to separate and qualify data logically; its specific meaning has to be defined for each application. If this character is used in hierarchical order, as specified in the general definition of the information separators (see 4.1.5), it delimits a data item called a "unit."

7.33 VT (VERTICAL TABULATION). A format effector that causes the active position to advance to the corresponding character position on the next predetermined line. The use of VT to cause combined horizontal and vertical movement of the active position is discussed in 4.1.2.2.

Appendixes (These Appendixes are not part of American National Standard X3.4-1986, but are included for information only.)

Appendix A
Design Considerations for the Coded Character Set

A1. Introduction

The standard coded character set is intended for the interchange of information processing systems, communication systems, and associated equipment.

A2. Considerations Affecting the Code

There were many considerations that determined the set size, set structure, character selection, and character placement of the code. Among these were (not listed in order of priority):

(1) Need for adequate number of graphic symbols
(2) Need for adequate number of device controls, format effectors, communication controls, and information separators
(3) Desire for a nonambiguous code, that is, one in which every code combination has a unique interpretation
(4) Physical requirements of media and facilities
(5) Error control considerations
(6) Special interpretation of the all-zeros and all-ones characters
(7) Ease in the identification of classes of characters
(8) Data manipulation requirements
(9) Collating conventions
  (a) Logical
  (b) Historical
(10) Keyboard conventions
  (a) Logical
  (b) Historical
(11) Other set sizes
(12) International considerations
(13) Programming languages
(14) Existing coded character sets

A3. Set Size

A 7-bit set is the minimum size that will meet the requirements for graphics and controls in applications involving general information interchange.

A4. Set Structure

A4.1 In discussing the set structure, it is convenient to divide the set into eight columns and sixteen rows as indicated in this standard.

A4.2 It was considered essential to have a dense subset that contained only graphics. For ease of identification, this graphic subset was placed in six contiguous columns.

A4.3 The first two columns were chosen for the controls for the following reasons.

(1) The character NUL by its definition has the location 0/0 in the code table. NUL is broadly considered a control character.

(2) The representations in column 7 were felt to be most susceptible to simulation by a particular class of transmission error – one that occurs during an idle condition on asynchronous systems.

(3) To permit the considerations of graphic subset structure described in Section A6 to be satisfied, the two columns of controls had to be adjacent.

A4.4 The character set was structured to enable the easy identification of classes of graphics and controls

A5. Choice of Graphics

A5.1 The following graphics are included in the coded character set: The digits 0 through 9; uppercase and lowercase Latin letters A through Z; and those punctuation, mathematical, and business symbols considered most useful. The set includes the characters commonly encountered in the major programming languages (except APL).

A5.2 In order to permit the representation of languages other than English, two diacritical (or accent) marks have been included, and provision has been made for the use of four punctuation symbols alternatively as diacritical marks in conjunction with backspace. (The use of BS to form composite characters is now deprecated (see Section 5)). The pairing of these punctua-

Table A1
Punctuation and Diacritical Marks

Col/ Row	Code Table Symbol	Use	
		Punctuation	Diacritical
2/2	"	QUOTATION MARK	DIAERESIS
2/7	'	APOSTROPHE	ACUTE ACCENT
2/12	,	COMMA	CEDILLA
5/14	^	(None)	CIRCUMFLEX
6/0	`	LEFT SINGLE QUOTATION MARK	GRAVE ACCENT
7/14	~	(None)	TILDE

tion symbols with their corresponding diacritical marks was done to facilitate the design of a typeface that would be acceptable for both uses.

These arrangements are given in Table A1.

A6. Graphic Subset Structure

A6.1 The basic structure of the dense graphic subset was influenced by logical collating considerations, the requirements of simply related 6-bit sets, and the needs of typewriter-like devices. For information processing, it is desirable that the characters be arranged in such a way as to minimize both the operating time and the hardware components required for ordering and sequencing operations. This requires that the relative order of characters, within classes, be such that a simple comparison of the binary codes will result in information being ordered in a desired sequence.

A6.2 Conventional usage requires that SP (SPACE) be ahead of any other symbol in a collatable set. This permits a name such as "JOHNS" to collate ahead of a name such as "JOHNSON." The requirement that punctuation symbols such as a comma also collate ahead of the alphabet ("JOHNS, A" should also collate before "JOHNSON") establishes the special symbol location, including SP, in the first column of the graphic subset.

A6.3 To simplify the design of the typewriter-like devices, it is desirable that there be only a common 1-bit difference between characters to be paired on keytops. This, together with the requirements for a contiguous alphabet and the collating requirements outlined in A6.2, resulted in the placement of the alphabet in the last four columns of the graphic subset and the placement of the digits in the second column of the graphic subset.

NOTE: As keyboard technology has evolved since 1968, bit pairing is less used. See ANSI X4.23-1982.

A6.4 It is expected that systems or parts of systems that do not distinguish between uppercase and lowercase letters will continue to be important (for example, operating system command interpreters and programming language compilers or interpreters). To facilitate this, there is a single bit difference between the capital and small representations of these letters. (Originally, this was to accommodate 64-character devices that are no longer expected to be important and that do not conform to this standard.) Combined with the requirement that a given case of the alphabet be contiguous, this dictated the assignment of the alphabet, as shown in columns 4 through 7.

A6.5 The assignment of REVERSE SLANT and VERTICAL LINE, the BRACKETs and BRACEs, and the CIRCUMFLEX and TILDE to code table positions was made to cause as little ambiguity as possible if a single bit is used to fold the lowercase letters onto the uppercase letters as described in A6.4.

A6.6 The resultant structure of "specials" (S), "digits" (D), and "alphabetics" (A) does not conform to the most prevalent collating convention (S-A-D) because of other code requirements (see Section A8).

A6.7 The need for a simple transformation from the set sequence to the prevalent collating convention was recognized, and it dictated the placement of some of the "specials" within the set. Specifically, those special symbols, namely, AMPERSAND (&), ASTERISK (*), COMMA (,), HYPHEN (-), PERIOD (.), and SLANT (/), that are most often used as identifiers for ordering information and normally collate ahead of both the alphabet and the digits were not placed in the column containing the digits. Thus the entire numeric column could be rotated via a relatively simple transformation to a position higher than the alphabet. The sequence of the aforementioned "specials" was also established to the extent practical to conform to the prevalent collating convention.

A6.8 The need for a useful 4-bit numeric subset also played a role in the placement of characters. Such a 4-bit subset, including the digits and the symbols ASTERISK (*), PLUS SIGN (+), COMMA (,), HYPHEN (-), PERIOD (.), and SLANT (/), can easily be derived from the code.

A6.9 Considerations of other domestic code sets, including the former Department of Defense standard 7-bit data transmission code ("Fieldata" – 1961), as well as international requirements, played an important role in deliberations that resulted in the code. The selection and grouping of the symbols DOLLAR SIGN ($), PERCENT SIGN (%), AMPERSAND (&), APOSTROPHE ('), LESS-THAN SIGN (<), EQUALS SIGN (=), and GREATER-THAN SIGN (>) facilitate contraction to either a business or scientific 6-bit subset. The position of these symbols, and of the symbols COMMA, HYPHEN, PERIOD, and SLANT, facilitates achievement of commonly accepted pairing on a keyboard. The historic pairing of QUESTION MARK and SLANT is preserved and the LESS-THAN SIGN and GREATER-THAN SIGN symbols, which have comparatively low usage, are paired with PERIOD and COMMA, so that in dual-case keyboard devices where it is desired to have PERIOD and COMMA in both cases, the LESS-THAN SIGN and GREATER-THAN SIGN symbols are the ones displaced. Provision was made for the accommodation of alphabets containing more than 26 letters and for 6-bit contraction by the location of low-usage characters in the area following the alphabet.

A7. Control Subset Content and Structure

A7.1 The control characters included in the set are those required for the control of terminal devices, input and output devices, format, or communication transmission and switching, and are general enough to justify inclusion in a standard set.

A7.2 Many control characters may be considered to fall into the following categories:

(1) Communication (transmission) controls
(2) Format effectors
(3) Device controls
(4) Information separators

To the extent that was practical, controls of each category were grouped in the code table.

A7.3 The information separators (FS, GS, RS, and US) identify boundaries of various elements of information, but differ from punctuation in that they are primarily intended to be machine sensible. They were arranged in accordance with an expected hierarchical use, and the lower end of the hierarchy is contiguous in binary order with SP (SPACE), which is sometimes used as a machine-sensible separator. Subject to this hierarchy, the exact nature of their use within data is not specified.

A7.4 The character SYN (SYNCHRONOUS IDLE) was located so that its binary pattern in serial transmission was unambiguous as to character framing, and also to optimize certain other aspects of its communication usage.

A7.5 ACK (ACKNOWLEDGE) AND NAK (NEGATIVE ACKNOWLEDGE) were located so as to gain the maximum practical protection against mutation of one into the other by transmission errors.

A7.6 The use of the "New Line" option described in 4.1.2.2 is being discouraged. Consideration will be given to deleting this option in future editions of this standard (see D4.4 of Appendix D).

A7.7 Data processing keyboard implementors are cautioned of a potential confusion between the use of the terms "Return" and "New Line." The large key on the right side of keyboards has often been marked "Return," although it sometimes accomplishes a "New Line" function rather than a "Return" function (which according to this standard has only a horizontal motion). Though labeled "New Line" or "Return," this key may in fact generate the sequence CR/LF.

A7.8 The functions VT (VERTICAL TABULATION) and FF (FORM FEED) are defined to advance the active position to the same character position of the subsequent line similarly to LF (LINE FEED). By agreement, these functions may also return the active position to the first character position on the subsequent line. Consideration will be given to deleting this option in future editions of this standard (see D4.4 of Appendix D).

A8. Collating Sequence

This supplements the consideration of collating sequence in Section A6.

It is recognized that the binary collating sequence defined by the bit combinations of this standard cannot be used in many specific applications that define their own sequence. In some applications, groups of characters may be assigned exactly equal collating weights to preserve an initial ordering. In other applications a different sequence may be desired to meet the needs of the particular application.

The binary sequence will facilitate, but will not provide directly by means of simple sorting, the ordering of items customarily found in (1) algebraically signed data, in which the largest positive value is the highest value and the largest negative value is the lowest value, and (2) complex alphabetic listings, such as those found in telephone directories, library catalogs, or dictionaries.

Appendix B
Notes on Application

B1. Introduction

B1.1 The standard code was developed to provide for information interchange among information processing systems, communication systems, and associated equipment. In a system consisting of equipment with several local or native codes, maximum flexibility will be achieved if each of the native codes is translated to the standard code whenever information interchange is desired.

B1.2 Within any particular equipment, system, or community of activity, it may be necessary to substitute characters. For example, some systems may require special graphic symbols, and some devices may require special control functions. (Design efforts on the standard code included consideration of these types of adaptations.) So called "secular sets" produced by such substitutions, though not conforming to this standard, may nonetheless be consonant with it if substitutions are made in accordance with the guidelines of Section B2.

B1.3 In recognition of these requirements for control and graphic characters, additional national and international standardization efforts beyond those provided in this standard are in progress to extend the 7-bit code. The techniques for this extension are provided by ISO 2022-1982 and ANSI X3.41-1974. An example of control function extension is provided in ANSI X3.64-1979. A prime example of graphic character extension is provided in ANSI X3.110-1983. (See Appendix E for a listing of related standards.)

B2. Character Substitutions

B2.1 Any character substitution will result in a coded character set that does not conform to this standard.

B2.2 It is recommended that when a character is substituted in the code table for a standard character, the standard character should not be reassigned elsewhere in the table. Such a substituted character, once assigned, should not be subsequently reassigned elsewhere.

B2.3 It is recommended that graphic substitutions be made only in the graphic area and control substitutions only in the control area. Any substitution involving a control should be made only with full cognizance of all possible operational effects.

B2.4 It should be noted that this standard specifies, for each position of the code table, the information represented by the character and not necessarily the precise action taken by the recipient when the character is received. In the case of graphics, considerable variation in the actual shape printed or displayed may be appropriate to different units, systems, or fields of application. In the case of controls, the action performed is dependent upon the use for which the particular system is intended, the application to which it is being put, and a number of conventions established by the user or designer – some system-wide and some unique to a particular unit.

B2.5 Typical examples of diversity in execution not necessarily contrary to this standard are:

(1) A number of graphic symbols, other than those used in the code table, are used for AMPERSAND in various type styles; still other symbols may be more appropriate to electronic display devices. The use of such alternate symbols does not in itself constitute deviation from the standard as long as ampersand is the concept associated with the character. Note that this does not necessarily restrict the use of such an alternate symbol design to mean "and"; in any type style, ampersand may, of course, be used with arbitrary meaning.

(2) A card punch in one application may "skip" when the characters HT (HORIZONTAL TABULATION: used as skip) is presented to it; in another application, the character HT may be recorded in the card without further action.

B3. Interoperation of "LF" and "NL" ASCII Equipment

Several bit pattern sequences in ASCII will cause a device receiving these sequences to move its active position to the first (leftmost) column and also move the active position down one row. Some of these sequences are as follows:

Using "LINE FEED" convention:
CR LF
CR CR LF
CR CR LF NUL

Using "New Line" option:
NL
CR NL
CR CR NL NUL,

where NUL (NULL) is merely a "time waster" to accommodate mechanical devices. The functions involving only horizontal motion are shown preceding those involving vertical motion because mechanical devices may require more time to accomplish the horizontal motion.

Interoperation of equipment conforming to the ASCII control conventions of CR (CARRIAGE RETURN) and LF (LINE FEED) with equipment conforming to the optional control NL (New Line) in position 0/10 can be assured if the operational sequences CR NL or CR CR NL or CR NL NUL or CR CR NL NUL are always used to move the active position to the first position of the next line. The sequence CR NL sent from an "option" device will be received by a "conventional" device as CR LF, and the reaction will be the desired one. Likewise, the sequence CR LF sent from a "conventional" device will be received as CR NL on an "option" device, and reaction will be as desired.

B4. Related Larger and Smaller Sets

Consideration has been given to the relationship between the standard set and sets of other sizes. A number of straightforward logical transformations are possible, which result in a variety of sets related to the standard. None of the transformed sets is recognized by this standard, except through the related standards concerning code extension.

Table B1
National Use Positions

Column/Row	Character (U.S.)	Name
4/0	@	COMMERCIAL AT
5/11	[	LEFT BRACKET
5/12	\	REVERSE SLASH
5/13	]	RIGHT BRACKET
7/11	{	LEFT BRACE
7/12	|	VERTICAL LINE
7/13	}	RIGHT BRACE
5/14	^	CIRCUMFLEX ACCENT
6/0	`	LEFT SINGLE QUOTATION MARK
7/14	~	TILDE

B5. International Considerations

B5.1 General. This standard conforms to the recommendations of the International Organization for Standardization (ISO) and the International Telegraph and Telephone Consultative Committee (CCITT)[1] for a 7-bit code. It includes all the character assignments specified by those bodies for international standardization. Their recommendations, however, permit national standardization by the various countries in ten code table positions.

The ten national use positions and their assignments in this standard are shown in Table B1.

In the international interchange of information, the ten characters in Table B1 should not be used except when there is agreement between sender and recipient. In such an interchange, where accented letters are to be formed via combinations of graphics and BACKSPACE, users are cautioned that other standards prescribe the syntax of such constructs rigidly. In addition, in other countries, the NUMBER SIGN (#) (in position 2/3) may be replaced by POUND SIGN (£), and the DOLLAR SIGN ($) (in position 2/4) may be replaced by the CURRENCY SIGN (¤).

B5.2 International Reference Version. The related standard, ISO 646-1983, describes an International Reference Version (IRV). The IRV is the default case of ISO 646-1983 in the absence of a need for a defined national version. The CCITT permits international interchange using the IRV.

[1] An international body that establishes standards and conventions for international telecommunications. Their recommendations are often embodied in the regulations applying to such services.

The graphic characters of this standard (ASCII) are consistent with the IRV with the exception of the following two positions

Column/ Row	Character (US)	Character (IRV)
2/4	$ (DOLLAR SIGN)	¤ (CURRENCY SIGN)
7/14	~ (TILDE)	¯ (TILDE, OVERLINE)

B5.3 International Terminology Differences. Where practical, this standard has adopted terminology in use in the English version of associated International Standards Variations from these related standards are due to the demands of common American usage and the desire for consistency with prior versions of this standard.

B5.4 Use of ASCII with Other Code Sets. The ASCII code set may be used with other 7-bit or 8-bit code sets as provided for in ANSI X3.41-1974 and ISO 2022-1982 (the code extension standards) and in ISO 2375-1985 (registration of ESC sequences). ASCII comprises both a C-set of 32 control characters and a G-set of 94 graphic characters. The G-set of ASCII has been assigned the "final" 4/2 according to the procedures of ISO 2375-1985 and hence the following ESC sequences may be used for designating the G-set of ASCII as a G0, G1, G2, or G3 graphics code set.

ASCII G-set as G0 set: ESC 2/8 4/2
ASCII G-set as G1 set: ESC 2/9 4/2
ASCII G-set as G2 set: ESC 2/10 4/2
ASCII G-set as G3 set: ESC 2/11 4/2

The C-set of ASCII is identical to that of ISO 646-1983 and therefore may be designated and invoked by the following ESC sequence:

ASCII C-set as C0 set: ESC 2/1 4/0

B6. Communication Considerations

Certain control characters are designated as "Transmission Controls." They are:

SOH (START OF HEADING)
STX (START OF TEXT)
ETX (END OF TEXT)
EOT (END OF TRANSMISSION)
ENQ (ENQUIRY)
ACK (ACKNOWLEDGE)
DLE (DATA LINK ESCAPE)
NAK (NEGATIVE ACKNOWLEDGE)
SYN (SYNCHRONOUS IDLE)
ETB (END OF TRANSMISSION BLOCK)

These may be used by communication systems for their internal signaling or for the exchange of information relating to the control of the communication system between that system and its end terminals. Some of these systems may impose restrictions on the use of these communication control characters by the end terminals. For example, the use of some of them may be completely prohibited; others may be restricted to use in conformity with the formats and procedures required by the communication system for its operation.

B7. Graphic Character Distinguishability

Conformance to this standard requires that all graphic characters be distinguishable when imaged. This section indicates a number of characters for which distinguishability is a particular problem. Although examples are given, no preference should be implied as to the method for achieving distinguishability.

B7.1 DIGIT ZERO (0) and CAPITAL LETTER O (O). Methods that can be used to distinguish these symbols are:

(1) Make the letter narrower than the digit (e.g., OCR A and B)
(2) Make the digit narrower than the letter
(3) Slash the digit
(4) Slash the letter
(5) Put a dot in the center of the digit

B7.2 SMALL LETTER L (l) and DIGIT ONE (1). Methods that can be used to distinguish these symbols are

(1) The digit has serifs but the letter does not
(2) The digit has a hook (serif) on the top while the letter has a tail on the bottom (e.g., OCR B)
(3) The upper serif on the digit is slanted while that on the letter is horizontal

B7.3 CAPITAL LETTER S (S) and DIGIT FIVE (5). Normally no problem unless image resolution is very limited.

B7.4 CAPITAL LETTER B (B) and DIGIT EIGHT (8). Normally no problem unless image resolution is very limited.

B7.5 SMALL LETTER B (b) and DIGIT SIX (6). Normally no problem unless image resolution is very limited.

B7.6 Underline. Since the character UNDERLINE is included in this character set and composite imaging is permitted (see Section 5), care should be taken that underlined characters remain distinguishable. When underlined, confusion might arise between Q and O, v or u and y, or E and F.

Appendix C
Original Criteria

C1. Introduction

C1.1 This Appendix contains the original criteria upon which the design of the code was based. Not all criteria have been entirely satisfied. Some are conflicting, and the characteristics of the set represent accepted compromises of these divergent criteria.

C1.2 The criteria were drawn from the communication, processing, and media recording aspects of information interchange.

C2. Criteria

C2.1 Every character of the code set should be represented by the same number of bits.

C2.2 The standard set should be so structured as to facilitate derivation of logically related larger or smaller sets.

C2.3 In a code of n bits, all possible 2^n patterns of ones and zeros should be permitted and considered valid.

C2.4 The number of bits, n, should be sufficient to provide for the alphabetic and numeric characters, commonly used punctuation marks, and other special symbols, along with those control characters required for interchange of information.

C2.5 The digits 0 through 9 should be included within a 4-bit subset.

C2.6 The digits 0 through 9 should be so represented that the four low-order bits are the binary-coded decimal form of the particular digit that the code represents.

C2.7 The interspersion of control characters among the graphic characters should be avoided. The characters devoted to controls should be easily separable from those devoted to graphics.

C2.8 Within the standard set, each character should stand by itself and not depend on surrounding characters for interpretation.

C2.9 An entire case of the Latin alphabet (A through Z) should be included within a 5-bit subset. Consideration should be given to the need for more than 26 characters in some alphabets.

C2.10 The letters of each case of the alphabet should be assigned, in conventional order (A through Z), to successive, increasing binary representations.

C2.11 Suitable control characters required for communication and information processing should be included.

C2.12 Escape functions that provide for departures from the standard set should be incorporated.

C2.13 A simple binary comparison should be sufficient to determine the order within each class of characters. (In this regard, the special graphics, the digits, and the alphabet are each defined as distinct classes.) Simple binary rules do not necessarily apply between classes when ordering information.

C2.14 Space should collate ahead of all other graphics.

C2.15 Special symbols used in the ordering of information should collate ahead of both the alphabet and the digits.

C2.16 Insofar as possible, the special symbols should be grouped according to their functions; for example, punctuation and mathematical symbols. Further, the set should be so organized that the simplest possible test is adequate to distinguish and identify the basic alphabetic, numeric, and special symbol subsets.

C2.17 Special symbols should be placed in the set so as to simplify their generation by typewriters and similar keyboard devices. This criterion means, in effect, that the codes for pairs of characters that normally appear on the same keytops on a typewriter should differ only in a common single-bit position.

C2.18 The set should contain the graphic characters of the principal programming languages.

C2.19 The codes for all control characters should contain a common, easily recognizable bit pattern.

C2.20 The NULL (0000000) and DELETE (1111111) characters should be provided.

Appendix D
Revision Criteria and Guidelines

D1. Introduction

This Appendix has been added to assist users of the standard. The criteria used in coming to a given revision are briefly stated in this Appendix. Also included are guidelines now in use as well as recommended guidelines for successive revisions (at the mandatory 5-year intervals).

D2. The 1977 Revision

D2.1 General. The 1968 edition was reviewed and revised to bring terminology into more consistent U.S. practice.

D2.2 Graphics. The primary considerations in revision of the graphics area of the standard were:

(1) To eliminate the formerly recognized dualities (positions 2/1, 5/14). These allowed stylization of these characters to reflect their possible usage as logical OR and NOT, respectively. Evolving practice has shown these to be unnecessary.

(2) To eliminate a formerly recognized duality (position 2/3), which allowed substitution of the "Pound Sterling" (£) symbol. Evolving practice has shown this to be unnecessary.

(3) To clarify the conflict between graphic shape and description (position 7/12).

D2.3 Controls. The primary considerations in revision of the controls area of the standard were:

(1) To adopt definitions consistent with associated standards (positions 0/14, 0/15, and 1/11)

(2) To make no change of substance to the communications controls without the explicit request of the group responsible for data communication procedures

(3) To accommodate the definitions of the controls of ISO 646-1973 wherever domestic conflicts did not exist

(4) To clarify definitions where use application had given indications of need for clarification

(5) To recognize evolving practice aimed at providing an "optional implicit CR" function with all three vertical-movement Format Effectors (positions 0/10, 0/11, and 0/12)

Table D1
Name Changes

ASCII 77 Name	ASCII 86 Name
Substitute	SUBSTITUTE CHARACTER
Quotation marks	QUOTATION MARK
Opening parenthesis	LEFT PARENTHESIS
Closing parenthesis	RIGHT PARENTHESIS
Plus	PLUS SIGN
Hyphen (minus)	HYPHEN, MINUS SIGN
Less than	LESS-THAN SIGN
Equals	EQUALS SIGN
Greater than	GREATER-THAN SIGN
Uppercase latin letter	CAPITAL LETTER
Opening bracket	LEFT BRACKET
Closing bracket	RIGHT BRACKET
Circumflex	CIRCUMFLEX ACCENT
Opening single quotation mark	LEFT SINGLE QUOTATION MARK
Lowercase latin letter	SMALL LETTER
Opening brace	LEFT BRACE
Closing brace	RIGHT BRACE

D3. The 1986 Revision

The 1986 revision changes the format and text of the standard to be in close conformity to ISO 646-1983. This was done to clarify terms and relationships and because U.S. participation in the revision of ISO 646-1973 to produce ISO 646-1983 was very active. Although the text has changed considerably, there was no intention of significantly changing any technical aspect of the standard from ASCII 77.

Some of the names of characters have been changed slightly to be in closer conformity with ISO 646-1983 and to avoid ambiguity (e.g., "opening" and "closing" have been replaced with "left" and "right" to remove the assumption of the left to right interpretation of the symbols). Where the ASCII name differs significantly from the name used in ISO 646-1983, the latter has also been included in parentheses in Section 4. For reference, the names of characters that have changed, along with the names that were used in ASCII 77, are listed in Table D1.

The alternate names DIAERESIS and CEDILLA have been dropped in the 1986 revision in order to open the possibility of including these characters in an extended ASCII character set and in order to remove ambiguity.

D4. Succeeding Revisions

D4.1 General. A review will be made for domestic and international consistency of use.

D4.2 Use of DEL. There seems to be little need for the use of DEL as a media-fill or time-fill control character. Emerging standards, however, are making use of character sets with 96 characters. When such 96-character sets are used, the meaning of the bit combination 7/15 may change dynamically and hence its use as a time-fill character would be inconvenient. For this reason, the use of 7/15 as the control character DEL will be reviewed at the next revision of this standard. New implementations are therefore discouraged from using the DEL character for time-fill.

D4.3 Composite Characters Using BS. Although it is permitted in this standard to use BS to compose characters by overstriking (see Section 5), consideration will be given during the next revision of proscribing such use. Several other standards now provide for more efficient coding of the characters that normally would be composed using BS (e.g., accents and underline as nonspacing characters in ISO 6937/2-1983; underline, bold, and the like as graphic renditions in ANSI X3.64-1979). These standards should be used when there is a need for accented characters, additional characters, or graphic renditions.

D4.4 Combined Horizontal and Vertical Movement. It is believed that the "New Line" option (see 4.1.2.2) has not been widely implemented. In the interest of eliminating options (and therefore lessening the amount of prior agreement necessary between interchange parties), consideration will be given during the next revision of this standard to eliminating this option along with the corresponding options for VT and FF.

D4.5 Alternate Name ACUTE ACCENT. Consideration will be given in the next revision of ASCII to dropping the alternate name ACUTE ACCENT for the character at 2/7. This would open the possibility of adding this character to an extended character set and remove ambiguity in names and character interpretation.

D4.6 Meaning of CAN. The meaning of the CAN control character as specified in 7.4 will be reviewed and consideration will be given to removing all ambiguity in its meaning.

Appendix E
Related Standards

E1. American National Standards[2]

E1.1 Codes and Code Extension

ANSI X3.41-1974, Code Extension Techniques for Use with the 7-Bit Coded Character Set of American National Standard Code for Information Interchange. This is a general purpose information interchange standard for structuring coded character sets in 7-bit or 8-bit environments and for extending the number of characters that can be represented above 128 and 256, respectively. ANSI X3.41-1974 is essentially identical to ISO 2022-1973. ANSI X3.41-1974 also specifies the complete syntax of escape sequences that are variable in length Escape sequences are used to designate and invoke control and graphic character sets and to represent other control functions.

ANSI X3.64-1979, Additional Controls for Use with American National Standard Code for Information Interchange. This is a general purpose information interchange standard that specifies a C1 set of control functions to be used with ASCII to facilitate data interchange with two-dimensional character-imaging input-output devices. ANSI X3.64-1979 is a subset of ISO 6429-1983. ANSI X3.64-1979 will be revised to track the latest revision of ISO 6429-1983. ANSI X3.64-1979 can be used in 7-bit or 8-bit environments following the coding structure in ANSI X3.41-1974.

The additional controls described in ANSI X3.64-1979, in combination with the controls of ASCII, are intended to be used with: interactive terminals of the cathode ray tube and printer types, line printers, microfilm printers, form-filling terminals, composition imaging (such as typesetting and word processing input-output devices with auxiliary devices), and buffered and nonbuffered devices. These controls can also be used for general software.

[2] Available from the American National Standards Institute, Inc, 1430 Broadway, New York, NY 10018.

ANSI X3.98-1983, Information Interchange – Text Information Interchange in Page Image Format (PIF). This standard is an application-oriented information interchange standard that specifies a subset of the control functions of this standard, ANSI X3.64-1979, and ISO 6429-1983, to be used for the presentation of text in Page Image Format (PIF). As an application-oriented standard, some of the controls are specified more completely than those of this standard and ANSI X3.64-1979. ANSI X3.98-1983 is a subset of ISO DIS 6937/3-1984 for use in North America. Page image format is defined as the basic method used in transmitting character-coded text from one device to another such that no text processing is required at the receiver; the presentation at the receiver is then in the format determined by the sender.

ANSI X3.110-1983, Videotex/Teletext Presentation Level Protocol Syntax (North American PLPS). This standard is an application-oriented coded character set standard for use in Videotex and Teletext applications in North America. Canadian Standard CSA T500-1983 was developed jointly with ANSI X3.110-1983 and is identical. The basic coding scheme is built upon the framework established by CCITT Recommendation S.100-1980. Videotex and teletext services are two-way and one-way services, respectively, providing users with access to "pages" or "frames" that include alphanumeric and graphic information. The primary graphic character set is identical to the set used in this standard. The supplemental graphic character set is a superset of that of ISO 6937/2-1983 and is used to represent a 339-character repertoire supporting 40 Latin-based languages. The C0 set is similar to that of ANSI X3.4-1986, with some substitutions. The C1 set is a specific Videotex/Teletext C1 set.

ANSI X3.110-1983 also includes a picture description instruction (PDI) set that provides geometric drawing primitives, color mapping, a controllable stroke width, macros, continuous character scaling, programmable texture masks, unprotected fields, partial screen scrolling, and incremental coding for highly compact descriptions of certain classes of images. A dynamically redefinable character set (DRCS) is provided to down line load arbitrary symbols. An alpha mosaic set is provided which is compatible with that in CCITT Recommendation S.100-1980. The syntax described in ANSI X3.110-1983 can be used in 7-bit or 8-bit environments following the coding structure in ANSI X3.41-1974.

ANSI X3.114-1984, Information Systems – Alphanumeric Machines – Coded Character Sets for Keyboard Arrangements in ANSI X4.23-1982 and X4.22-1983. This standard specifies a general purpose coded character set for use with keyboard arrangements described in ANSI X4.23-1982 and X4.22-1983. ANSI X3.114-1984 contains the graphic character set of ANSI X3.4-1986 (ASCII) and a supplemental set that is a subset of ISO 6937/2-1983 and ANSI X3.110-1983, for use in word processing in the United States.

E1.2 Implementation

ANSI X3.6-1965 (R1973), Perforated Tape Code for Information Interchange.

ANSI X3.14-1983, Information Systems – Recorded Magnetic Tape for Information Interchange (200 CPI, NRZI)

ANSI X3.15-1976, Bit Sequencing of the American National Standard Code for Information Interchange in Serial-by-Bit Data Transmission

ANSI X3.16-1976, Character Structure and Character Parity Sense for Serial-by-Bit Data Communication in the American National Standard Code for Information Interchange

ANSI X3.17-1981, Character Set for Optical Character Recognition (OCR-A)

ANSI X3.22-1983, Information Systems – Recorded Magnetic Tape for Information Interchange (800 CPI, NRZI)

ANSI X3.25-1976, Character Structure and Character Parity Sense for Parallel-by-Bit Data Communication in the American National Standard Code for Information Interchange

ANSI X3.26-1980, Hollerith Punched Card Code

ANSI X3.27-1978, Magnetic Tape Labels and File Structure for Information Interchange

ANSI X3.28-1976, Procedures for the Use of the Communication Control Characters of American National Standard Code for Information Interchange in Specified Data Communication Links

ANSI X3.32-1973, Graphic Representation of the Control Characters of American National Standard Code for Information Interchange

ANSI X3.39-1986, Information Systems – Recorded Magnetic Tape for Information Interchange (1600 CPI, Phase Encoded)

ANSI X3.45-1982, Information Systems – Character Set for Handprinting

ANSI X3.48-1986, Information Systems – Magnetic Tape Cassettes for Information Interchange – 3.81-mm (0.150-in) Tape at 32 bpmm (800 bpi), Phase Encoded

ANSI X3.49-1975, Character Set for Optical Character Recognition (OCR-B)

ANSI X3.54-1986, Information Systems – Recorded Magnetic Tape for Information Interchange (6250 CPI, Group-Coded Recording)

ANSI X3.56-1986, Information Systems – Recorded Magnetic Tape Cartridge for Information Interchange – 4 Track, 0.250 inch (6.30 mm), 1600 bpi (63 bpmm), Phase Encoded

ANSI X3.57-1977, Structure for Formatting Message Headings for Information Interchange Using the American National Standard Code for Information Interchange for Data Communication Systems Control

ANSI X3.59-1981, Magnetic Tape Cassettes for Information Interchange, Dual Track Complementary Return-to-Bias (CRB) Four-States Recording on 3.81-mm (0.150-in) Tape

ANSI X3.72-1981, Parallel Recorded Magnetic Tape Cartridge for Information Interchange, 4 Track, 0.250 Inch (6.30 mm), 1600 bpi (63 bpmm), Phase Encoded

ANSI X4.22-1983, Office Machines and Supplies – Alphanumeric Machines – Alternate Keyboard Arrangement

ANSI X4.23-1982, Office Machines and Supplies – Alphanumeric Machines – Keyboard Arrangement

E1.3 Other Related Standards

ANSI X3.32-1973, Graphic Representation of the Control Characters of American National Standard Code for Information Interchange. This standard specifies the graphic symbols to be used for the 32 controls of ASCII, SPACE, and DELETE when there is a need to have a graphic representation. ISO 2047-1975 is identical to ANSI X3.32-1973.

ANSI X3.83-1980, ANSI Sponsorship Procedures for ISO Registration According to ISO 2375. This standard specifies the procedures to be followed in order for ANSI to act as a sponsor for coded character set registrations according to ISO 2375. After a control or graphic set is registered, a unique designating escape sequence is assigned to the set by the ISO Registration Authority. At the time of the approval of this American National Standard, the ISO Registration Authority is the European Computer Manufacturers Association (ECMA). The ISO "Registry of Character Sets to be Used with Escape Sequences" is published by ECMA and available from ANSI at the following address:

American National Standards Institute, Inc
1430 Broadway
New York, NY 10018

E2. International Standards[2]

E2.1 Codes and Code Reduction and Extension Techniques

ISO 646-1983, Information Processing – ISO 7-Bit Character Set for Information Interchange

ISO 963-1973, Guide for the Definition of 4-Bit Character Sets Derived from the 7-Bit Coded Character Set for Information Processing Interchange

ISO 2022-1982, ISO 7-Bit and 8-Bit Coded Character Sets – Code Extension Techniques

ISO 4873-1979, 8-Bit Coded Character Set for Information Interchange

ISO 6429-1983, ISO 7-Bit and 8-Bit Coded Character Sets – Additional Control Functions for Character-Imaging Devices

ISO 6937/1-1983, Information Processing – Coded Character Sets for Text Communication – Part 1: General Introduction

ISO 6937/2-1983, Information Processing – Coded Character Sets for Text Communication – Part 2: Latin Alphabetic and Non-Alphabetic Graphic Characters

ISO DIS 6937/3-1984, Information Processing – Coded Character Sets for Text Communication – Part 3: Control Functions for Page-Image Format

E2.2 Implementation

ISO 962-1974, Implementation of the 7-Bit Coded Character Set and Its 7-Bit and 8-Bit Extensions on 9-Track, 12,7 mm (0.5 in) Magnetic Tape

ISO 1001-1986, Information Processing – File Structure and Labelling of Magnetic Tapes for Information Interchange

ISO 1113-1979, Representation of 7-Bit Coded Character Set on Punched Tape

ISO 1155-1978, Use of Longitudinal Parity to Detect Errors in Information Messages

ISO 1177-1985, Character Structure for Start/Stop and Synchronous Transmission

ISO 1745-1975, Basic Mode Control Procedures for Data Communication Systems

ISO 2033-1983, Coding of Machine Readable Characters (MICR and OCR)

ISO 2111-1985, Data Communication – Basic Mode Control Procedures – Code Independent Information Transfer

ISO 3407-1983, 3,81 mm (0.150 in) Magnetic Tape Cassette, 4 cpmm (100 cpi), Phase Encoded at 63 ftpmm (1600 ftpi)

ISO 3561-1976, Interchangeable Magnetic Six-Disk Pack – Track Format

ISO 3563-1976, Interchangeable Magnetic Single-Disk Cartridge (Top Loaded) – Track Format

ISO 4057-1979, Data Interchange on 6,30 mm (0.25 in) Magnetic Tape Cartridge, 63 bpmm (1600 bpi) Phase-Encoded

ISO 4337-1977, Interchangeable Magnetic Twelve-Disk Pack (100 Mbytes)

ISO 4341-1978, Information Processing – Magnetic Tape Cassette and Cartridge Labelling and File Structure for Information Interchange

ISO 5653-1980, Interchangeable Magnetic Twelve-Disk Pack (200 Mbytes)

ISO 5654/1-1984, Data Interchange on 200 mm (8 in) Flexible Disk Cartridges Using Two-Frequency Recording at 13 262 ftprad on One Side – Part 1: Dimensional, Physical, and Magnetic Characteristics

ISO 5654/2-1985, Data Interchange on 200 mm (8 in) Flexible Disk Cartridges Using Two-Frequency Recording at 13 262 ftprad on One Side – Part 2: Track Format

ISO 6586-1980, Data Processing – Implementation of the ISO 7-Bit and 8-Bit Coded Character Sets on Punched Cards

ISO 6596/1-1985, Data Interchange on 130 mm (5.25 in) Flexible Disk Cartridges Using Two-Frequency Recording at 7 958 ftprad on One Side – Part 1: Dimensional, Physical, and Magnetic Characteristics

ISO 6596/2-1985, Data Interchange on 130 mm (5.25 in) Flexible Disk Cartridges Using Two-Frequency Recording at 7 958 ftprad on One Side – Part 2· Track Format

ISO DIS 6863-1981, Information Processing – Flexible Disk Cartridge Labelling and File Structure for Information Interchange – Specification

ISO 7065/1-1985, Data Interchange on 200 mm (8 in) Flexible Disk Cartridges Using Modified Frequency Modulation Recording at 13 262 ftprad on Two Sides – Part 1· Dimensional, Physical, and Magnetic Characteristics

ISO 7065/2-1985, Data Interchange on 200 mm (8 in) Flexible Disk Cartridges Using Modified Frequency Modulation Recording at 13 262 ftprad on Two Sides – Part 2: Track Format

ISO 7487/1-1985, Data Interchange on 130 mm (5.25 in) Flexible Disk Cartridges Using Modified Frequency Modulation Recording at 7 958 ftprad on Two Sides – Part 1· Dimensional, Physical, and Magnetic Characteristics

ISO 7487/2-1985, Data Interchange on 130 mm (5.25 in) Flexible Disk Cartridges Using Modified Frequency Modulation Recording at 7 958 ftprad on Two Sides – Part 2: Track Format

ISO 7487/3-1984, Data Interchange on 130 mm (5.25 in) Flexible Disk Cartridges Using Modified Frequency Modulation Recording at 7 958 ftprad, 1,9 tpmm (48 tpi), on Two Sides – Part 3: Track Format B

E2.3 Other Related Standards

ISO 2047-1975, Information Processing – Graphical Representations for the Control Characters of the 7-Bit Coded Character Set

ISO 2375-1985, Data Processing – Procedure for Registration of Escape Sequences

ISO 7350-1984, Text Communication – Registration of Graphic Character Subrepertoires